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Synopsis

Emergency Medical Services Streaming Enabled Evaluation In Trauma: The SEE-IT Feasibility RCT

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Abstract

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Background: The use of bystander video livestreaming from scene in emergency medical services is becoming increasingly common to inform decisions about the resources and support required. Possible benefits include clinical and financial gains, but evidence is sparse. We aimed to investigate the feasibility of conducting a definitive randomised controlled trial of its use in major trauma incidents.

Objectives:

i. To obtain data required to design a subsequent randomised controlled trial.
ii. To test trial processes.
iii. To embed a process evaluation.

Design: A feasibility randomised controlled trial with embedded process and economic evaluations where working shifts (n = 62) in 6 trial weeks were randomised 1 : 1 to video livestreaming or standard care only; and two observational substudies: (1) assessment of acceptability in a diverse inner-city emergency medical service that routinely uses video livestreaming; and (2) assessment of staff well-being in an emergency medical service that does not use livestreaming (for comparison to the trial site). Qualitative data collection included observations (286 hours) and interviews with staff (n = 25) and bystander callers (n = 2).

Setting: A pre-hospital emergency medical service in South-East England, with follow-up in associated major trauma centres and trauma units; substudies in (1) London and (2) East of England emergency medical services.

This synopsis should be referenced as follows:
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Participants: (1) Patients involved in trauma incidents (*n* = 269); (2) bystander callers (*n* = 11); and (3) ambulance service staff (*n* = 67).
Intervention: Video livestreaming using GoodSAM's Instant-On-Scene.
Main outcome measures: Progression to a definitive randomised controlled trial based on four pre-defined criteria and consideration of qualitative data: (1) ≥ 70% bystanders with smartphones agreeing and able to activate livestreaming; (2) ≥ 50% requests to activate livestreaming resulting in footage being viewed; (3) helicopter emergency medical services stand-down rate reducing by ≥ 10% due to livestreaming; and (4) no evidence of psychological harm to bystanders or staff caused by livestreaming.
Results: Sixty-two shifts were randomised, contributing 240 eligible incidents (132 control; 108 intervention). In a further three shifts, we randomised by individual call, which contributed four eligible incidents (two control; two intervention), thereby totalling 244 incidents involving 269 patients. Video livestreaming was successful in 53 incidents in the intervention arm. Patient recruitment (to access medical records to assess appropriateness of dispatch) and bystander recruitment (to measure potential harm) were both low (58/269, 22% of patients, 4/244, 2% of bystanders). Two progression criteria were met: (1) 86% of bystanders with smartphones agreed and were able to activate livestreaming; (2) 85% of requests to activate livestreaming resulted in viewed footage; and two were indeterminate due to insufficient data: (3) 2/6 (33%) stand-down due to livestreaming; and (4) no evidence of psychological harm from survey, observations or interviews. In substudy (i), dispatch staff reported that non/limited English language and older age may present barriers to video livestreaming.
Limitations: Poor recruitment of patients and bystanders limited assessment of appropriateness of dispatch decisions and potential psychological harm.
Conclusions: Video livestreaming is feasible to implement, acceptable to both bystanders and dispatchers, and may aid dispatch decision-making, but further assessment of benefits and harm is required.
Future work: Findings support the design and conduct of a future multicentre study taking account of different triage systems and dispatch personnel, potentially using an alternative to a randomised controlled trial due to rapid uptake of video livestreaming in this setting.
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Introduction

Rationale for research and background

Major trauma describes an incident where a patient incurs serious injuries with a high possibility of either long-term disability or death.[1] In 2021, the World Health Organization (WHO) reported that unintentional and violence-related injuries accounted for approximately 4.4 million deaths per year worldwide, with the leading causes of death (related to injuries) being road traffic collisions, homicide and suicide.[2] Every year, major trauma results in approximately 5400 deaths in England, estimated to cost the economy up to £3.7 billion per year.[1] The majority of deaths due to trauma happen within 4 hours of the incident occurring, which means efficient pre-hospital systems are vital to save lives and prevent disability.[3]

Previous studies have found that rates of mortality double after 30 minutes for trauma patients, and immediate intervention is crucial for their survival.[4] Therefore, timely and accurate response of emergency medical services (EMS) is critical for improved patient outcomes and in the prevention of serious injury or death.[4] Helicopter emergency medical services (HEMS) and specialist paramedics in critical care are often dispatched to trauma incidents where severe injury is suspected.[5] Ensuring that this specialist care is allocated appropriately is important, as resources are limited and costly.

Appropriate dispatch of specialist care teams is often referred to as the weak link in the chain of EMS response.[6] The ability to accurately identify, triage and transport patients who need specialist care for trauma often starts with a call to the EMS from a member of the public (e.g. 999).[3] Lay members of the public do not always provide accurate information when they call EMS, often due to limited medical knowledge and the emotional impact of witnessing an incident.[5] This can result in both over-resourcing or under-resourcing of calls.[7–10]

Technological advances provide the possibility of using video livestreaming between mobile smartphones and EMS. This can enable emergency dispatchers to view patients' injuries and the scene of medical emergencies. The potential benefits include improving the speed and accuracy of decision-making about the resources required at the scene (with associated clinical and financial gains); yet research supporting such benefit (particularly for trauma incidents) is currently sparse. Furthermore, it has also omitted assessment of potential

psychological harm (to bystanders and/or to EMS dispatchers) of using video livestreaming, as indicated in our scoping review.[11] In this review, we found that while video livestreaming for time-critical incidents (such as trauma) could potentially offer significant benefits, the current evidence base is sparse and methodologically limited. Furthermore, while there was evidence of acceptability and potential benefit, this was coupled with evidence of challenges in its use, and a lack of evidence regarding experiences and impacts on users (both clinical dispatchers and lay callers).

Despite this limited evidence base, some emergency services across the UK have already implemented video technology.[12–14] It is important to determine the benefits and any harms associated with using video livestreaming to inform implementation in new organisations and governance/operationalisation in existing organisations. Prior to undertaking a definitive randomised controlled trial (RCT) to determine the clinical and cost-effectiveness of using video livestreaming in major trauma incidents, it is necessary to conduct a feasibility study.

Objectives and research questions

Our primary research question was:

Is it feasible to conduct a future RCT to assess the clinical and cost-effectiveness of using GoodSAM's Instant-On-Scene[15] video livestreaming to improve targeting of EMS?

The main objectives were to:

i. obtain data required to inform the design of a RCT;
ii. test trial processes, including randomisation and data collection methods; and
iii. embed a process evaluation to test the acceptability and feasibility of using video livestreaming from provider [emergency operations centre staff (EOCS)] and public (999 callers) perspectives.

Associated research questions are published in the research protocol.[16] The primary outcome of the study is the decision regarding the feasibility of undertaking a definitive RCT, based on meeting pre-defined progression criteria,[17] and independent consideration by the study Steering Committee. This synopsis presents a summary of the funded work to meet the above objectives, which included an initial scoping review, together with the feasibility trial and two observational studies. Initial sections summarise the methods and results from the work conducted, in particularly referring to work summarised in the published papers (*Table 1*). Following this, there are separate sections regarding patient and public involvement and engagement (PPIE), equality, diversity and inclusion (EDI), impact and learning, and implications of findings for decision-makers and research recommendations.

TABLE 1 Published research papers synthesised in this synopsis

1. Ollis L, Skene SS, Williams J, Lyon R, Taylor C; SEE-IT Trial Group. The SEE-IT Trial: emergency medical services Streaming Enabled Evaluation In Trauma: study protocol for an interventional feasibility randomised controlled trial. *BMJ Open* 2023;**13**:e072877. https://doi.org/10.1136/bmjopen-2023-072877
2. Taylor C, Ollis L, Lyon RM, Williams J, Skene SS, Bennett K, *et al.*; SEE-IT Trial Group. The SEE-IT Trial: emergency medical services Streaming Enabled Evaluation In Trauma: a feasibility randomised controlled trial. *Scand J Trauma Resusc Emerg Med* 2024;**32**:7. https://doi.org/10.1186/s13049-024-01179-0
3. Magnusson C, Ollis L, Munro S, Maben J, Coe A, Fitzgerald O, Taylor C. Video livestreaming from medical emergency callers' smartphones to emergency medical dispatch centres: a scoping review of current uses, opportunities, and challenges. *BMC Emerg Med* 2024;**24**:99. https://doi.org/10.1186/s12873-024-01015-9

Overall design and setting

The study comprised a feasibility RCT with an embedded process evaluation and two substudies. The substudies included: (1) an observational study within an inner-city ambulance service who had already implemented video livestreaming for trauma; and (2) an observational staff well-being study in an ambulance service who do not use video livestreaming for comparison to staff in the main trial site.

The research setting was predominantly the pre-hospital emergency medical setting (with follow-up data collection from associated hospitals). The main feasibility RCT was conducted within South East Coast Ambulance Service NHS Foundation Trust (SECAmb) emergency operations centre (EOC), including the linked HEMS service [Air Ambulance Charity Kent Surrey Sussex (KSS)]. The existing pathway for emergency call handling in the trial study site was for a non-clinical call handler to use NHS Pathways (algorithm-based questioning) to determine priority and type of vehicles to be sent to the scene. Critical care desk (CCD) dispatchers [who dispatch air ambulance and/or critical care paramedics (CCPs)] can silent monitor (listen) to the calls to determine the need (or not) for additional resources. Resources may be sent or stood down once a crew reaches the scene. Substudy (1) took place in London Ambulance Service NHS Trust (LAS)/London's Air Ambulance (LAA); and substudy (2) in East of England Ambulance Service NHS Trust (EEAST).

Methods for data collection and analysis

Main feasibility randomised controlled trial

Comprising a RCT with an embedded process evaluation,[16] the study was mixed methods, comprising integration of data from ambulance computer systems/medical records, surveys (EOCS and 999 callers) and qualitative observational fieldwork and semistructured interviews. See *Figure 1* for the research pathway. See also *Appendix 1* for data flow charts and the Consolidated Standards of Reporting Trials (CONSORT) flow charts (see *Figures 2–5*, *Table 7*), and *Appendix 2* (including *Tables 8–13*) for the full report (including methods) for the health economic analysis. The testing of livestreaming was approved at an organisational level, and staff who may be required to use the livestreaming in intervention shifts were given the option to 'opt out' of shifts where the trial was running if they were not willing to participate (no staff did this). Confidentiality Advisory Group (CAG) approval was granted for participation of patients and callers in the study without the need for informed consent due to the nature of the study and pre-hospital setting. Informed consent for all postintervention activities (survey, interviews and access to medical records) was sought and is described where appropriate and in the published protocol/papers.

Observational substudy (i)

This study used a concurrent mixed-methods design to investigate video livestreaming usage for trauma dispatch. The primary research question was: 'what is the acceptability and usefulness of video livestreaming for trauma incidents in an inner-city urban setting with a diverse population?' The study involved both pre-hospital critical care teams within LAS/LAA, namely: the LAS Advanced Paramedic Practitioners in Critical Care (APP-CC) and LAA HEMS dispatchers (who are paramedics in this setting). Methods of data collection included non-participant observation during working shifts, semistructured interviews with dispatch desk staff from LAS/LAA, and a survey sent to 999 callers who were observed using video livestreaming (with attempts to also conduct follow-up interviews with those who completed surveys).

Observational substudy (ii)

The purpose of this substudy was to provide a comparison group for psychological harm in an EOC who were not using video livestreaming (EEAST) as a proxy control for change over time in well-being caused by general ambulance/pre-hospital activities/events. EOCS (HEMS dispatchers and CCPs), identified to be in 'matching' roles to the staff involved in the study in the main trial site, were invited to complete an online survey. The survey contained the same measures as those included in the staff survey for the main trial site [the General Health Questionnaire-12[18] (GHQ-12) and the Impact of Events Scale – Revised[19] (IES-R)] and was sent before and after the trial period.

Results summary

The main findings from the feasibility trial are reported in the overall findings paper[20] and are summarised below. We first present findings in relation to the approved progression criteria, then according to each objective.

Main feasibility randomised controlled trial: progression criteria

The main aim of this study was to assess the feasibility of implementing and evaluating GoodSAM video livestreaming in a definitive RCT. Progression criteria were reviewed and approved by the independent Steering Committee and have been published in full in the protocol paper.[17] The findings in relation to each criterion have been published in the main results paper[20] and are summarised in *Table 2*. The data and denominators are explained further in *Appendix 1* (flow charts).

In summary, two of the four progression criteria (1 and 2) were confirmed as 'met' (proceed to definitive study), and two were indeterminate (3 and 4) due to having insufficient data to be confident of conclusions. Taking all data into account, the review by the Steering Committee confirmed that progression to a subsequent definitive study was warranted.

Summary of findings against each study objective

Main feasibility randomised controlled trial Objective 1: to obtain data required to inform the design of a subsequent randomised controlled trial

This included obtaining data regarding the event rate, the screening rate and the effect size/precision for outcomes; developing and validating a method of measuring appropriateness of dispatch; and collecting data required for health economic analyses. The 6 trial weeks enabled us to obtain the necessary data to inform the design of a subsequent study, as summarised in *Table 3* (and see also *Appendix 1* and *Appendix 2*).

Main feasibility RCT Objective 2: to test trial processes including randomisation and data collection methods

Trial processes were tested across 6 trial weeks (once a month between June and November 2022). A total of nine amendments were submitted to HRA to immediately respond to barriers and challenges identified during each

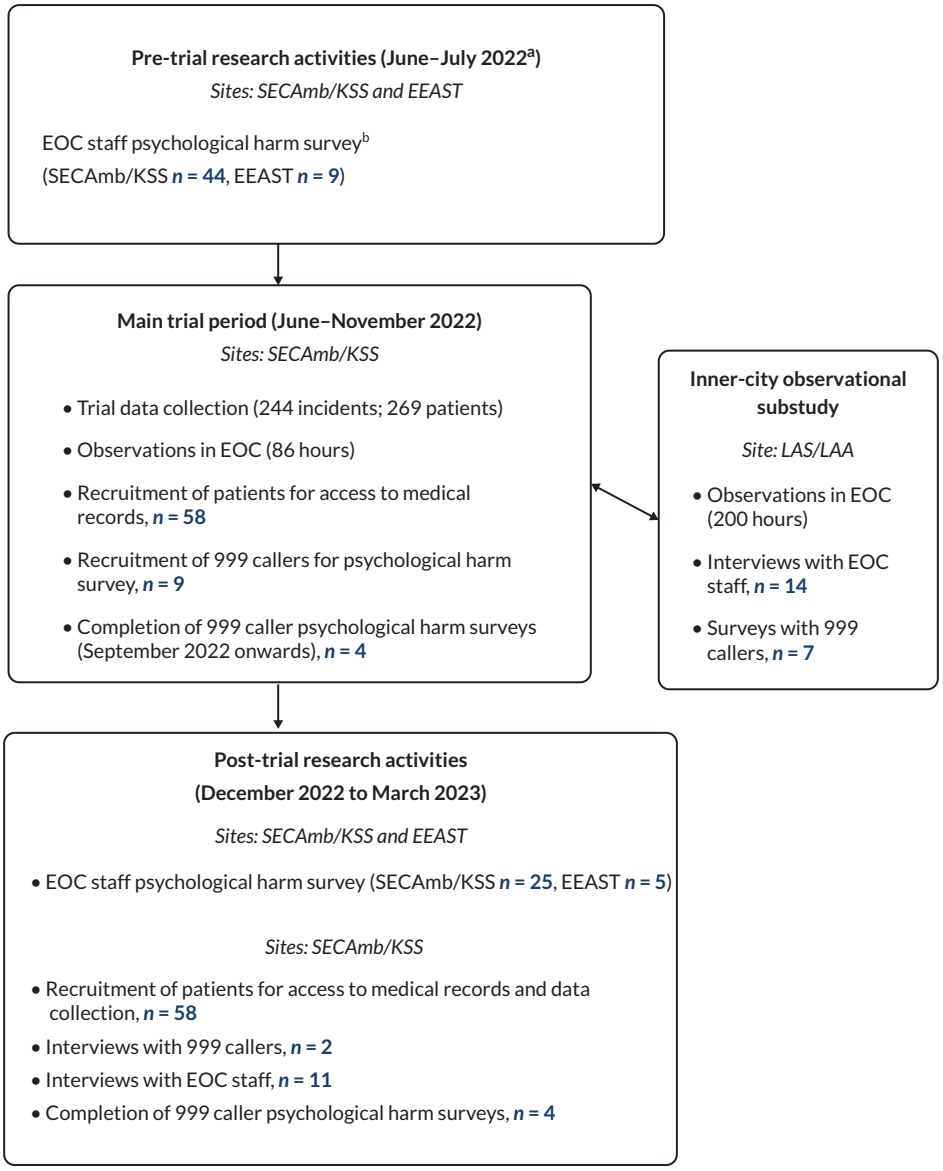

FIGURE 1 Diagram of research pathway. a, Survey recruitment was kept open until July but could only be completed by staff that had not been exposed to livestreaming. b, Sent to all staff that may be exposed to livestreaming: all HEMS dispatchers and CCD paramedics, and the study-specific research paramedics.

trial week (summarised in *Appendix 3*, *Table 14*). A summary of findings in relation to this objective are provided in *Table 4*. We found randomisation and real-time/retrospective data collection to be feasible, and the risk of contamination to be low. The main challenge regards obtaining data from callers (discussed in more detail later in the report; see *Impact and learning*).

Observational sub-study

A nested process evaluation was successfully conducted. This comprised of 86 hours of observational field work in the SECAmb EOC (by a postdoctoral researcher from a psychology background), two interviews with 999 callers (one who used video livestreaming) and 11 EOCS interviews [3 HEMS dispatchers, 5 CCPs and 3 research paramedic (RP)]. A brief overview of findings is presented in *Table 5*. Note: a more detailed summary of findings can be seen in *table 10* within the main outcomes paper,[20] which also contains exemplar quotes to support qualitative findings.

Main feasibility RCT Objective 3: to conduct a nested process evaluation to test the acceptability, feasibility, and risk of psychological harm of using GoodSAM from provider and public perspectives

A total of 25 shifts, including 200 hours of observation, was completed. During these shifts, video livestreaming was used 39 times. Despite 34/49 (87%) of callers consenting to be sent a survey about their experiences,

TABLE 2 Results in relation to pre-determined trial progression criteria

Progression criteria	Findings	Supplementary data
1. ≥ 70% bystanders with smartphones agreeing and able to activate livestream	62/72 (86.1%) of bystanders with smartphones agreed and were able to activate video livestreaming	72/75 calls (96.0%) that were transferred successfully (dispatcher able to ask if caller was using a smartphone) were confirmed as smartphones. Only three callers with smartphones (4.2%) were not willing to use video livestreaming; seven callers were willing but not able to use video livestreaming (9.7%), as they did not receive the SMS text with the link to activate streaming.
2. ≥ 50% requests to activate resulting in footage being viewed	53/62 (85.5%) of requests to activate video livestreaming resulted in viewed footage	Reasons why footage was not viewed included: connectivity/signal issues (*n* = 4); restrictions on the caller's phone (*n* = 2); caller's camera not working (*n* = 1); caller was unable to use their smartphone/follow instructions (*n* = 1), and clinician arrived on scene before video livestreaming could commence (*n* = 1)
3. HEMS stand-down rate reducing by ≥ 10% due to live footage	2/20 (10%) stand-down due to video livestreaming (ITT analysis)	2/6 (33%) only including incidents where GoodSAM was used
4. No evidence of psychological harm in bystanders or staff	No evidence of psychological harm from survey, observations or interviews	See *Table 5* (objective 3 summary)

ITT, intention to treat; SMS, Short Message Service.

TABLE 3 Findings in relation to Objective 1

Research question	Answer
How many calls meet the proposed inclusion criteria?	Estimated event rate was 250 incidents: 125 intervention/125 control Actual event rate was 240 incidents: 108 intervention/132 control. In addition, four incidents (2 intervention; 2 control) were allocated through individual randomisation. Although 110 eligible calls were identified in intervention periods, livestreaming was only used in less than half of these (*n* = 53); see *Figure 4*, *Appendix 1*. This would need to be considered when designing future studies, and discussed further in *Impact and learning*
How easily are eligible calls identified?	In the first few weeks of the trial, the protocol was clarified to support operationalisation of the inclusion criteria, and short guides were produced. Qualitative feedback from HEMS dispatchers/CCPs was that the guides were useful, and processes were easy to follow: *'That [having the guides on the desk] would have helped me to remember and get it right, what to put in [the codes]' (HEMS dispatcher).* *'They were really useful, really clear, easy to … easy to follow through'* (CCP) Reports run by Business Intelligence in the Ambulance Trust to identify calls during trial periods where enhanced dispatch (either CCP or HEMS) had been requested from scene, but where the code identifying the call as eligible had not been entered (SEESM) found only 8 calls. This supports the conclusion that eligible calls were easily identified
What is the effect size/ precision for primary outcome(s) being considered for a subsequent trial?	*Table 8* in the overall findings paper[20] presents the data on what we initially considered might be the candidate outcomes based on the speed of appropriate dispatch. The standard deviations would allow a sample size to be calculated with consensus on what a clinically meaningful effect (difference) between groups might be. Further discussion can now happen regarding the candidate outcomes for a subsequent study
Can appropriateness be reliably measured?	The algorithms for determining appropriateness of dispatch, developed by the expert panel within our trial (see *Study/trial design*), were applied by two RPs independently and resulted in 96.6% agreement. A sample (*n* = 30) was reviewed by the expert panel, leading to some further amendments to the criteria and changes to appropriateness ratings. The development and validation of the algorithms will be published to enable further critique and use in other pre-hospital studies. The main challenge was gaining consent from patients involved in incidents to access their medical records. The algorithms were applied to these data, and thereby appropriateness could only be judged for a subsample (58/269, 21.6%) of patients involved in the trial. Only nine declined to participate, the main challenge being identifying, locating and contacting patients (see *Appendix 1*, *Figure 3* and further discussion of this challenge in *Impact and learning*)
Is it feasible to collect the data required to conduct a health economic analysis?	See *Appendix 2* for full report on health economic evaluation data collection and analysis Exploratory analyses suggest it is possible to estimate costs of resources dispatched to incidents, and consequences in terms of appropriateness of dispatch. Additional data collection would be necessary to broaden the analysis. Challenges accessing patient medical records (see above) also affected exploratory economic analyses and would be a consideration in future study design

Note
Main feasibility RCT Objective 2: to test trial processes, including randomisation and data collection methods.

TABLE 4 Findings in relation to Objective 2

Research question	Answer
Is it feasible to randomise by workforce shift?	Yes. A minimisation algorithm was used to ensure balance between day shifts (06:00–18:00) and night shifts (18:00–06:00) and weekdays (Monday–Thursday) vs. weekend days (Friday–Sunday). Shifts were only randomised if the HEMS desk and CCD were colocated. A total of 62 shifts were randomised: 31 to control and 31 to intervention (see *Appendix 1*, *Figure 2* CONSORT flow chart)
Is it feasible to randomise by individual call?	Yes. This was tested within three working shifts in the final trial week, using a pre-prepared randomisation list. Feedback via interviews and e-mail correspondence with the RPs who observed these shifts suggested that randomisation by call was feasible
What is the potential for contamination?	There is a small risk that the control group may be unintentionally exposed to the intervention (use of video livestreaming). However, multiple steps in the trial protocol (e.g. entering different codes for intervention vs. control), together with having RPs present during trial live periods, should avoid this situation
Can we collect dispatch decision data in real time and obtain accurate follow-up decision data retrospectively?	We found that decision-making data could be collected accurately in real time (during trial weeks), and that follow-up data collected retrospectively were also accurate. The proforma completed by the RPs 'real time' was reported to be easy to use. A process of checking and validating was employed to ensure accuracy of data entry into the study database. Dispatch of HEMS resources is also recorded within their systems (HEMSbase), so it would be possible in a future study to triangulate validation with this The aspect of dispatch decision-making that was most difficult to collect was DCA dispatch. Typically, DCA resources can change multiple times due to being reallocated (sometimes automatically to other more urgent jobs), with an alternate resource being sent instead, so it was very challenging to get accurate data on DCA stand-downs. In contrast, a stand-down for CCP/HEMS usually means the resource is not sent to the scene at all
What is the response rate to a follow-up 999 caller survey?	The response rate to the follow-up 999 caller survey was very low (n = 4/244, 1.6%). Most callers (198/244, 81.1%) were invited to participate by being sent a SMS text (101/134 callers in the control arm; 97/110 callers in the intervention arm); but only 9 callers agreed to be sent the survey 6–8 weeks after the incident, and only 4 completed it. See *Impact and learning* for further discussion of this challenge

CCD, critical care desk; CCP, critical care paramedic; DCA, double-crewed ambulance; SMS, Short Message Service.

Note
Main feasibility RCT Objective 3: to conduct a nested process evaluation to test the acceptability, feasibility and risk of psychological harm of using GoodSAM from provider and public perspectives.

TABLE 5 Brief overview of findings in relation to Objective 3

Research question	Answer
Is brief training on use of GoodSAM's Instant-On-Scene (< 60 minutes) feasible to deliver and sufficient?	Short training was feasible to deliver and sufficient
What proportion of eligible calls are made using smartphones?	72/75 (96.0%) of callers transferred for potential video livestreaming were confirmed as calling from a smartphone
Will/can the public follow instructions?	58/62 (93.5%) callers who received the GoodSAM text were able to follow the instructions easily
Is video useful in informing emergency dispatch?	All HEMS dispatchers/CCPs interviewed reported video livestreaming could be useful in informing emergency dispatch. This was due to providing more information about the state of the patient(s), viewing what had happened at the scene, and helping them to decide whether enhanced care was needed, for example, for pain relief or transport. See case study (see *Report Supplementary Material 1*)
How is video from multiple calls about the same incident used to inform decision-making?	There were no attempts to use video livestreaming with more than one 999 callers about the same incident. The consensus from staff interviews was that in such cases they would select a caller based on proximity to the incident and whether they 'sounded' like they would be able to follow instructions
How does the total call length compare between intervention and control arms?	Use of NHS Pathways meant that livestreaming had to be activated after the end of 'standard care', meaning the total call length was not useful. Instead, we examined the speed of HEMS and CCP dispatch (time from initiation of 999 call to dispatch) and found they were not significantly different when comparing arms (HEMS 19.1 minutes control vs. 17.4 minutes intervention, p = 0.67); CCP 9.5 minutes control vs. 8.9 minutes intervention, p = 0.50, see *table 8* in overall findings paper for more detail.[20] We also measured the length of livestreaming, which averaged 6.07 minutes [95% CI (3.31 to 8.83), *Appendix 2*, *Table 8*]

continued

TABLE 5 Brief overview of findings in relation to Objective 3 (*continued*)

Research question	Answer
Is using video acceptable to 999 callers?	69/72 callers who were asked to activate video livestreaming consented to do so (95.8%). Only two 999 callers were interviewed (one that used livestreaming); both were positive about video livestreaming and its acceptability to them: '*It must have been straightforward for me to be able to access it whilst in shock/panic*' (*999 caller survey response*)
Is using video acceptable to dispatch control room staff?	The consensus from interviews and survey responses was that livestreaming was acceptable to staff. Observations supported this, though a few CCPs stated that time pressures prevented them feeling able to activate livestreaming themselves
Is there any evidence that video livestreaming is associated with risk of psychological harm for 999 callers?	The very low recruitment rate of 999 callers (see *table 6* in overall findings paper[20]) meant we were unable to compare rates of psychological distress/PTSD in the control and intervention arm callers. Triangulation of all data that examines this, including the 999 caller surveys, 999 caller interviews, staff interviews and observational data, suggests that the use of video livestreaming was unlikely to cause additional distress to 999 callers compared to audio-only 999 calls Callers felt reassured that someone with medical knowledge/experience was able to see what they could see
Is there any evidence that video livestreaming is associated with risk of psychological harm for staff who view the streamed footage?	We cannot confidently answer this due to the very low recruitment of staff in the comparator site; however, change over time in the measures (from pre to post trial, and the difference in change between trial and comparator sites) provided no evidence of increased harm after video livestreaming was introduced in the trial site (see *table 7* in overall findings paper[20]) Furthermore, none of the staff interviewed for the study reported any negative psychological impact of viewing livestreamed images from trauma incidents, and no visible stressful or emotional reactions were observed. Some staff felt that despite it not causing harm in this study, there was potential for harm, particularly for incidents such as violent suicide attempts, or patients with injuries incompatible with life

CI, confidence interval; PTSD, post-traumatic stress disorder.

Note
Observational substudy.

it was only completed by seven (21%), one of whom reported not speaking English fluently. None of the callers participated in follow-up interviews. There were no incidents noted by the research fellow (RF) during the observation shifts where the caller or patient's characteristics or demographics influenced the use of video livestreaming, and nor did the HEMS dispatchers'/APP-CCs' comment on these factors when deciding which calls to request for transfer to start video livestreaming.

Information about diversity of callers using video livestreaming was therefore limited and relied predominantly on interviews with the HEMS dispatchers/APP-CCs. Fourteen dispatch desk staff (HEMS dispatchers and APP-CCs) participated in semistructured interviews. Findings from these interviews suggested that neither ethnicity, culture or religious beliefs of the caller or patient influenced the decision to use video livestreaming, primarily because dispatchers typically do not have this information, and nor did they report any such influence of these factors on the use of streaming once they had decided to use it:

> *I don't think [ethnicity, religion or culture] comes into it. Again, often you never see the face of the caller anyway, so you're never aware of what their ethnic background [is], you know, religion, colour of their skin, anything like that, none of it really comes into play.*
>
> *LAS APP-CC*

However, in calls where there were language barriers (e.g. requiring the use of language line), HEMS dispatchers/APP-CCs were less likely to attempt to use video livestreaming, and some felt that older age might be a barrier to using the technology due to potential limitations in access and familiarity with smartphone technology:

> *This is probably a bit ageist, but if they don't sound like they're going to be able to use the technology on their phone to do it, that might put me off … Some elderly patients have sometimes not understood what you're asking them to do.*
>
> *LAS APP-CC*

Discussion/interpretation

Principal findings and achievements

This study has uniquely investigated the feasibility of conducting a definitive trial of the impact of using video livestreaming in an NHS Ambulance Trust EOC. This is the first RCT of the use of video livestreaming in the EMS dispatch setting. Principle findings include:

- Our scoping review[11] showed that the evidence base was sparse, and mostly focused on the use of video livestreaming during cardiopulmonary resuscitation (CPR). Most studies (15/24) were simulation-based rather than undertaken in real-life settings, and many were methodologically weak. Regardless, these studies support the acceptability and ease of use of video livestreaming by staff and lay members of the public and usefulness to staff to inform dispatch/priority decisions. Very few studies investigated the experience of using video livestreaming by callers, or potential harm in staff or callers.
- Our feasibility trial[20] showed that video livestreaming was acceptable and easy to use by most callers and staff, and progression criteria in relation to these criteria were met.
- We found evidence that video livestreaming led to HEMS stand-down, but the event rate for this was very low and needs further investigation in a future study.
- We did not find evidence of harm caused by video livestreaming, but recruitment issues for 999 callers and for staff (in the comparison site group) – see *Impact and learning* – meant that we cannot be confident about this. In qualitative interviews, staff suggested that harm may be possible for certain staff or incidents, and further research must prioritise investigating this.
- We found that we could collect dispatch data and data around dispatch decision-making (real-time and retrospectively) to inform both health economic and trial design for a future study, including providing estimates for a range of outcomes to consider for a future study.
- We developed and validated algorithms for determining the appropriateness of dispatch which were applied reliably to the data we collected.
- We found little evidence of impact of diversity in the lay public population on the use of video livestreaming, except that there may be perceived barriers where callers cannot speak English or are older adults. These perceived barriers deserve further attention in future studies.
- A future study to build on the findings of this feasibility study is supported by our findings and endorsed by the independent Steering Committee appointed by National Institute for Health and Care Research (NIHR).

Contribution to existing knowledge

Our scoping review[11] showed that there had been very limited previous research into the use of video livestreaming during emergency medical calls, especially for trauma incidents. Findings from these previous studies reported opportunities offered by using video livestreaming in this setting, including: that it was perceived to be useful, easy to use, reassuring for both dispatchers and callers, and informed dispatch decision-making. The synthesis also highlighted challenges, such as the potential emotional impact for dispatchers and callers, potential impact on workload/workflow, and the need to ensure appropriate governance around use and sharing of footage obtained. Most of the studies were methodologically weak, reliant on self-report measures only and did not have control/comparison groups. None of the studies in real-life settings had a randomised design.

Our feasibility RCT is the first RCT of the use of video livestreaming in the emergency dispatch setting. Findings replicate many of those reported in previous research, synthesised in our review,[11] supporting the acceptability and ease of use of the technology to both lay public callers and staff; and that it may support improvements to triage and dispatch decisions. In relation to harm, while there is also no evidence from other studies that it *does* cause harm to callers or dispatchers, the suggestion that it *might* cause harm (to some people, or in some contexts/incidents) was present in previous research also, both for callers and dispatchers. On the other hand, previous studies reported similar perceptions to those reported in our study from dispatchers/staff that video livestreaming resulted in callers feeling reassured, satisfied and comforted, from having 'expert' support.[21,22]

Our study particularly builds on the previous small pilot study of use by HEMS in the same service as our study,[5] and addressed the future research needs to test the technology in more urban areas (where authors suggest there may be more language barriers). Our substudy in LAS/LAA, where video livestreaming (via GoodSAM) is routinely used, was an attempt to broaden the lay public population base for investigation. There was very little evidence of language providing a barrier from surveys and observations, but in interviews, the HEMS dispatchers/APP-CCs stated that callers that did not speak English very well and/or older adults may not be requested for transfer to attempt livestreaming. A previous study found language barriers as a reason for 'challenging cooperation' in 14 of 604 calls (2.3%).[22]

The observational and qualitative element of our study enabled us to also examine 'how' video livestreaming works to support dispatch decision-making. Akin to previous studies that have reported findings in relation to this,[21] we found that it worked by improving situational awareness,[23] especially when information given from

callers was ambiguous or misleading, when HEMS dispatchers/CCPs were concerned that a call had been over- or under-triaged, or to get a better understanding about the response required by evaluating different situational elements (e.g. blood loss) that could impact dispatch of resources. Determining whether or not to use video livestreaming (in studies where there was choice, and from our observational substudy) found that dispatchers had to weigh up the potential benefit in terms of obtaining clarifying information so they can confirm/make dispatch decisions, with the potential 'costs' such as being distracted from other tasks and additional time demands, as reported previously.[21]

Strengths and limitations

The key strength of this study is the methodological rigour of using a RCT design together with an embedded process evaluation, thus overcoming many of the methodological limitations of previous studies. The mixed-methods approach enabled us to comprehensively answer the wide range of feasibility questions necessary to inform whether a future study would be desirable and, if so, how it should be designed. Other strengths include (1) the design (having a trial week each month for 6 months) allowing not only for seasonal variability in types and frequency of trauma incidents but also for us to amend the protocol so the design could be iterative and maximise learning during the feasibility trial period; and (2) the development and validation of a method for assessing the appropriateness of dispatch, which will be published in full. This will be available for use in other research, enabling assessment of the appropriateness of decisions about dispatch to trauma incidents (e.g. research evaluating other interventions or service changes).

Limitations include the low recruitment of patients, 999 callers and EOCS (from the comparison site), which led to two of the progression criteria being rated as indeterminate; and the imbalance in arms in relation to timing/assessment of eligibility of incidents, which impacted on the appropriateness of ITT approaches to analysis in this study (see further discussion of these below).

Take-home messages

The key take-home messages from this study are: (1) this is the first (feasibility) RCT of the use of video livestreaming between lay public 999 callers and dispatchers in an ambulance dispatch control centre; (2) we found that it is feasible to implement and evaluate video livestreaming in a busy pre-hospital setting (EOC), and a definitive study of the effectiveness and cost-effectiveness of use in this setting is warranted; (3) video livestreaming is acceptable to both dispatchers and lay bystander callers; and (4) future studies need to focus on improving recruitment of patients and 999 callers (to ensure robust assessment of appropriateness of dispatch and of potential harm), and may need to consider alternative study designs to account for the rapid uptake of video livestreaming; (5) there is a need to conduct further research on potential harm to staff.

Challenges faced and limitations

Key challenges we faced (also referred to in *Impact and learning*, where we discuss the implications for future research) included:

Information governance restrictions

Following information governance (IG) review of our proposed study protocol, various amendments had to be made to gain approval for the study to commence. These included: (1) restricting inclusion criteria to calls from mobile phones only, as we could not get permission for a caller from a landline to be asked if they also had a smartphone (required for video livestreaming) which limited the potential pool of eligible incidents; (2) not being able to call a 999 caller back if they were lost in the transfer between the call handler [emergency medical advisor (EMA)] and the HEMS dispatcher/CCD (n = 11) or if the connection was lost (n = 6), limiting the number of uses of video livestreaming; (3) invitations for 999 callers to participate in the study had to be sent by SMS [via the computer-aided dispatch (CAD)] in a very short time frame following the incident (this was amended over the course of the study, but the maximum length of time was 24 hours, and one reminder was approved in the final trial week). We do not fully understand the reasons for the poor recruitment of 999 callers, and more work needs to be done to explore this, but the restrictions regarding timing of invitations may have been a contributory factor.

Training in the use of the intervention (GoodSAM's Instant-On-Scene)

To adapt to organisational demands and the operational differences between staff groups, the training to use video livestreaming was inconsistently provided across potential users. The HEMS dispatchers were offered face-to-face training before the trial started, but some chose not to attend, as they had used the same software in a previous study. The CCPs mostly received training via an instructional video with associated documents, though a few of them received face-to-face training with the HEMS dispatchers. The CCPs were less likely to activate video livestreaming than the HEMS dispatchers, which may be related to the different approach to training.

Recruitment of 999 callers

Following from the *Information governance* section above, we found it very challenging to recruit 999 callers to

complete surveys and interviews as part of this study, and thereby to assess potential harm and acceptability of livestreaming. The method approved by the IG was to send 999 callers included in eligible incidents a SMS text message via the CAD, inviting them to participate in the study, which would involve completing a survey in 6–8 weeks' time. They were offered a £10 shopping voucher or donation to their local air ambulance charity as an incentive to participate. As reported earlier in this report (see *Table 4*), despite most callers being sent the study invitation, recruitment was very low, with only nine callers agreeing to receive the survey, which four completed (2% response rate), with only two callers completing interviews. Changes we implemented to try to improve recruitment included: (1) changing the timing of the text (from while the call was live in week 1 and 2, up to 4 hours in week 3, up to 8 hours weeks 4–6); (2) the content of the text to be more 'user-friendly' (with direction from the PPIE group, from week 2 onwards); (3) questionnaire link was changed to a University of Surrey link to look less like 'spam' (from week 3 onwards); and (4) a reminder text was added up to 48 hours after the call had ended (for week 6 only). The approvals to make these changes were challenging, due to ethics amendments and required approvals through IG at the main trial site (SECAmb). The changes did not yield additional uptake. Furthermore, in the observational substudy in LAS/LAA, similar challenges with 999 caller recruitment were faced, despite the procedure differing due to there being no control group, so all callers that used video livestreaming during observed shifts were included. In this study, the HEMS dispatcher/APP-CC requested permission from the caller to give their details to the researcher so they could contact them about the study. All who consented were sent an invitation to participate via SMS, including a survey link, and the researcher also attempted to call to speak to them to answer any questions they might have, leaving a message if there was no response (this also meant that the caller could verify that the telephone number with the invitation and survey link was legitimate, based on feedback from our PPIE group that this may be a limiting factor). The low recruitment of 999 callers impacted directly on our ability to determine the experience, acceptability and potential harm of them using live video streaming.

Recruitment of emergency operations centre staff for psychological harm survey

Based on estimates of the number of eligible staff provided by the two EOCs (EEAST and SECAmb), we estimated that we would recruit up to 86 staff members per site, but the sample and recruitment (particularly at the comparison site) was considerably lower than expected. The initial pre-trial survey was sent to 48 staff at EEAST, including HEMS paramedics, advanced paramedics in critical care, CCPs, HEMS/CCD dispatchers and HEMS/CCD supervisors. Only nine staff (18.8%) responded to the pre-trial survey, of whom only five responded to the post-trial survey (55.6% retention). Furthermore, two of the staff members who completed the post-trial survey stated they had used live video streaming from the scene of a trauma incident in the interim period, meaning they could no longer act as 'comparison' staff to the trial site staff, as they had also been exposed to video livestreaming.

Recruitment of patients for consent to access medical records and assess appropriateness of dispatch

Patients were recruited by hospital research teams within the trauma units/major trauma centres that they were conveyed to. Recruitment was to gain consent for the RPs to access their medical records in order to extract information about the patients' injuries and the treatments they received (up to 3 months post incident), so the appropriateness of dispatch could be assessed. These data were also required for the health economic analysis.

In the protocol, we estimated there would be approximately 250–300 patients involved in the estimated 250 incidents we expected to include in the study. The estimate was confirmed to be correct (there were 269 patients involved in the 244 eligible incidents). However, due to several reasons, only 58/269 patients (21.6%) were recruited. A large proportion of the remaining patients (n = 108, 40.1%) were not even approached to ask for consent due to: (1) the hospital the patient was transported to was either outside of the SECAmb area or the hospital trust did not agree to be part of the trial (n = 60/269, 22.3%); (2) the patient was not conveyed to hospital (n = 43/269, 16.0%); (3) the patient deceased at the scene (n = 4/269, 1.5%); and (4) reason not recorded by the RPs (n = 1/269, 0.4%). A total of 161/269 (59.9%) patients were approached for consent, either in person at the hospital, or via the telephone or post. Of the 103/161 (64.0%) patients who did not consent, the two most frequent reasons were: (1) the hospital contacted the patient, but no response was received (n = 51/161, 31.7%); and (2) the patient had no or incorrect contact details (n = 17/161, 10.6%). Only nine patients (9/161, 5.6%) declined to be involved in the study. The remaining reasons for no consent can be found in the flow charts in *Appendix 1*.

Engagement with partners and stakeholders

At the outset of this study, we formed a PPIE group (see *Patient and public involvement and engagement*), Project Advisory Group (PAG) and expert panel group. The PAG (consisting of members with clinical, ethical and

methodological expertise) acted as critical friends for us to engage with at key points in the study to discuss challenges we were having and/or gain their input and expertise into design, conduct and interpretation of findings. The expert panel comprised six experts in pre-hospital service provision, and their role was to determine how we should measure the 'appropriateness' of resources dispatched to the scene of major trauma incidents, and to help us validate and refine the measure for future studies. We also engaged with stakeholders in the general public through various outreach activities (see *Patient and public involvement and engagement*).

Individual training and capacity-strengthening activities

Training activities included:

- **PPIE members** being provided with training (on study design/methods and emergency medical dispatch processes) following a training needs assessment (see *Patient and public involvement and engagement* for further details).
- Potential **users of video livestreaming** (the HEMS dispatchers, CCPs and RPs) being trained in the use of GoodSAM's Instant-On-Scene.
- **Research paramedics**: most had not worked in a research role previously and were provided with generic research inductions (at SECAmb) together with study-specific training in research methods and data collection (including database development, data cleaning and validation) relevant to this study. Two of the RPs were also trained in extracting and synthesising data as part of the scoping review and contributed to the publication as coauthors.
- The **trial co-ordinator and study researcher** roles were undertaken by LO, and this was her first postdoctoral research post. While there was no formal training provided, through supervision and engagement with the wider team, LO has gained a wide range of skills and expertise that she will take forwards into future research roles.

Institutional capacity strengthening

The design, conduct and completion of this study as a collaboration between the University of Surrey, SECAmb and KSS has served to strengthen relationships between all three organisations, and between research and practice, which will enable future research opportunities to be explored and driven by clinical priorities in the real-world setting. For the University of Surrey specifically, this project has increased our expertise in pre-hospital research methods, and built further capacity in this area for future research (e.g. SM, the RP for the observational substudy, is now employed part-time as a lecturer at the University of Surrey, and is being supported to submit a postdoctoral clinical academic research fellowship application that will build on this trial). For SECAmb, this study enabled the trust to recruit six part-time seconded posts as RPs which helps to build research capability across the trust; plus, emergency medical services Streaming Enabled Evaluation In Trauma (SEE-IT) has added to our ever-increasing portfolio of research and trials within the trust, and it has made a direct contribution to the KSS Clinical Research Network (CRN) research specialities. In addition, it has included the SECAmb EOC in their first trial, and there is a demand for further studies involving this staff group.

The study required real-time collaboration between the KSS dispatcher and SECAmb CCD and has demonstrated that research is feasible in this critical decision-making environment. KSS has gained further experience of undertaking a RCT, which will be invaluable for future projects.

Patient and public involvement and engagement

Patient and public involvement and engagement processes in this study followed the NIHR standards for public involvement. The PPIE group was led by Janet Holah (PPIE co-applicant) and comprised five members of the public of varying age (18–mid-70s) and gender (also see *Impact and learning*), including one participant where English was not her first language, and one who had experience of calling 999 during a trauma incident. The aim of PPIE for this project was to ensure there was meaningful input from members of the public, to improve the quality and relevance of the research. The PPIE group met eight times over the duration of the study. Meetings included an introduction session and training needs assessment; provision of training; updates on study progress; discussions about any challenges we were facing; and discussions about dissemination of study findings. Training included: an introduction to NHS research; reviewing study documents; research designs; NHS ethics; and in-depth training on the research methods used in the trial.

Patient and public involvement and engagement input

The PPIE lead was involved from the outset of the study, including reviewing, and contributing to the grant application and research proposal. PPIE input during the application stage led to the addition of the evaluation of psychological harm for callers and EOCS. Before the study received ethical approval, the PPIE lead reviewed and edited language on public-facing documents (e.g. participant information sheets, consent forms, social

media campaigns and surveys). The initial proposed title of the study included the word 'video', which was removed after a PPIE member of the REC misunderstood this to believe footage was recorded. In addition, clarification about this was included in subsequent study materials/documents. PPIE input also highlighted the view that callers would need to download an app to use GoodSAM; future communications ensured it was explained that an app was not needed to use GoodSAM's Instant-On-Scene. In the first trial week, it was realised that recruitment of 999 callers was low. The PPIE group met to discuss and agree new content for the 999-caller text message, changing the survey link, and reviewed the ideal timing for the 999 callers to receive the invitation to participate in the survey.

Further PPIE activities

A key part of our communication strategy with the general public was the production of a SEE-IT Newsletter (see *Report Supplementary Material 2*). Three newsletters have been produced to date (Summer 2022, Autumn 2022 and Spring 2023). Thirty-four members of the public have signed up to receive the newsletter via the SEE-IT website. The newsletters included information about the study, including the background; what the study entailed; introductions to SEE-IT team members and PPIE group; updates on study progress; and an explanation of how GoodSAM video livestreaming works. The newsletter was also shared with University of Surrey School of Health Sciences staff and students; and all SEE-IT stakeholder groups and advertised via Twitter. All draft versions of the SEE-IT Newsletters were shared with the PPIE group for review and suggested changes were made before final versions were approved. The final SEE-IT Newsletter will be shared in Autumn 2023, including an overview of the findings. Feedback from the newsletters has been very positive both at the University of Surrey and externally:

> *Loved the newsletter! Thanks for sending it out – I know sometimes you don't get feedback about these things, and I appreciate how much time they take to put together.*
> *Thanks for sharing this – really great to see this and hear more about the study!*

Other public engagement and dissemination strategies have included the 'Pint of Science' (May 2023) annual event led by the University of Surrey, where a range of current research projects are presented in pubs and other venues in the Guildford area to reach out, involve and disseminate to members of the public. Project team members presented an overview of the SEE-IT project, which included a live demonstration of video livestreaming (including simulation of a trauma incident using an actor). Furthermore, members of the project team also attended the 'Surrey Showcase' (June 2023), where demonstrations of video livestreaming were held throughout the day for prospective students and the public. Feedback from both events reinforced study findings about the acceptability and ease of use of video livestreaming by the general public (see *Table 6* and *Equality, diversity and inclusion*).

TABLE 6 Outreach questions with members of the public

	Source 1 KSS Twitter (pre-grant submission)[a]		Source 2 Pint of Science		Source 3 Surrey Showcase		Source 4 SEE-IT Newsletter mailing list		Total	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Q1. If you were injured in an emergency, would it be acceptable for a 999 caller to stream live video to ambulance control in order to try to improve your care?	535 98.3%	9 1.7%	29 100%	0 –	19 100%	0 –	9 100%	0 –	592 98.5%	9 1.5%
Q2. If you called 999 for an incident you witnessed, would it be acceptable to you to use video livestreaming?	N/A	N/A	28 100%	0 –	19 100%	0 –	9 100%	0 –	56 100%	0 –
Q3. Do you think using video livestreaming could cause additional distress to you in such circumstances, compared with just speaking on the phone?	37 7.7%	445 92.3%	3 10.7%	25 89.3%	3 16.7%	15 83.3%	3 33.3%	6 66.6%	46 8.6%	491 91.4%

a KSS Twitter: Q2 was not asked; Q3 was worded slightly differently: If you witnessed an accident and called 999, would livestreaming video from the scene significantly worsen your psychological distress above what you have already experienced? (Video footage is not recorded and is viewable only by health professionals.)

Patient and public involvement and engagement support with dissemination of results

The SEE-IT PPIE group have been and will continue to be involved in the design of an animated video(s) intended to share the main findings of the SEE-IT Trial. The PPIE group met in May 2023 to discuss and review different design options for the video(s) and discuss what they wanted the video(s) to include. In June 2023, the PPIE group met for a 'creative day', where they were given an overview of the main findings of the trial and completed a pre-scripting document for the appointed video production company, to steer the drafting of the script for the film. The PPIE group were also involved in key milestones of the video production, including reviewing the video scripts and storyboards. The final edit will be shared with the PPIE group in October 2023 before further dissemination.

Equality, diversity and inclusion

Observational substudy

In the first review of the funding application, reviewers expressed concerns about the diversity of the population served by the main trial site SECAmb, and the types of incidents that may occur in this area compared to other areas in the UK. Therefore, an observational substudy was appended, comprising mixed methods (observation, surveys and interviews) to investigate the use of video livestreaming in an ambulance service that had already implemented the technology routinely for trauma-related 999 calls (LAS/LAA). The main aim of this substudy was to examine the acceptability and feasibility of video livestreaming within an inner-city population with greater diversity than Kent, Surrey, and Sussex. It was hoped that this substudy would supplement the main feasibility trial by enabling investigation of the impact (if any) of different cultural and ethnic backgrounds (in particular, whether there were any language barriers) of 999 callers in relation to acceptability and use of video livestreaming, and also explore any other diversity factors that appear to present barriers (or facilitate) to the use of video livestreaming.

Inclusivity and accessibility

All public-facing documents (e.g. information sheets, consent forms) were reviewed by the PPIE lead to ensure accessible language and terminology. To ensure those under the age of 16 had equal opportunity to participate, participant information sheets and assent forms were created for patients aged under 13 years and 14–16 years old. Advice was sought from, and documents reviewed by, colleagues who had experience of creating participant information sheets and assent forms that were accessible for children (easy read format). A consultee information sheet and declaration form were created to ensure those without the capacity to consent could still be involved in the research if a friend or family member were willing to act on their behalf. Patients were able to consent to take part in the study via telephone rather than via e-mail or post. All potential participants were given equal opportunity to participate. The ethnicity of the 999 caller and patients was unknown to the EOCS or research team at the point of recruitment.

Patient and public involvement and engagement outreach activities

Due to challenges with recruiting an ethnically diverse PPIE group (detailed in *Impact and learning*) and limited evidence in the LAS/LAA substudy with regards to acceptability in those with English as a second language, further outreach activities were attempted to try to connect with members of the public from diverse cultural and/or ethnic backgrounds. Approximately 60 groups were contacted, targeting those that represented specific age groups (e.g. for 'older' or 'younger' people specifically), and minority ethnic or religious groups. They were contacted by e-mail to ask if anyone in the group would be willing to meet with the project team to share their thoughts on video livestreaming in the context of an emergency medical incident. The PPIE group were provided with a draft e-mail that included a brief explanation of the study (that they were advised to adapt if needed) and were encouraged to outreach as much as possible to their local communities, for example, local churches, libraries, doctor surgeries, social clubs, universities, colleges, as well as actively discussing with peer groups, friends and family. They reported that this resulted in much interest in the project, including some signing up to our study newsletter (though were unable to recruit additional members to the group). All postgraduate research students within the School of Health Sciences at the University of Surrey (who are a diverse group of students in relation to ethnic and religious backgrounds) were contacted via e-mail requesting assistance with understanding any religious, cultural, gender, age or ethnic barriers with video livestreaming (no responses). Despite efforts, these outreach activities did not yield additional feedback/interest from the groups we were targeting for input.

In addition, we sought wider input from the general public about the acceptability of livestreaming in the context of emergency calls for trauma incidents by using a few brief questions. These were originally asked via the KSS twitter account to inform our original grant application, and then during the study, we asked them again in two events that we held to inform and engage with the public about the

study, and also sent via e-mail to our newsletter mailing list. *Table 6* shows the questions and results from this exercise. The findings show that although use of video livestreaming was acceptable to most respondents (98.5%), a minority (8.6%) said they thought video livestreaming *could* cause additional distress to them in comparison to just speaking to the call taker on the phone.

Impact and learning

What difference has been made already?

The findings from this study will be used to inform future studies of video livestreaming in the pre-hospital emergency setting, and further dissemination of the findings through this report and other publications can inform others' work in this area as well as our proposed next steps. We have shown that the technology can be implemented into a busy EOC environment, that we can collect the ambulance service data that we will need to evaluate its use, that training needs are minimal and that it is largely acceptable to both lay and staff users. We have also highlighted a considerable challenge relevant to all pre-hospital research regarding recruitment of lay 999 callers, and hope that this can inform further work to determine methods of overcoming these barriers which will be relevant to the evaluation of any service changes introduced to the pre-hospital environment that potentially impact on 999 callers.

What longer-term impact might there be (e.g. economy, efficiency, effectiveness, equity and environmental impact)?

The longer-term impact depends to a large degree on the findings from the subsequent study we hope to undertake, which we hope will determine the clinical and cost-effectiveness of using video livestreaming in this context. These impacts are likely to include: (1) influencing *if* video livestreaming should be implemented in the UK/national setting and internationally; (2) influencing *how* video livestreaming should be implemented, governed/monitored and sustained. If findings support improvements to the speed and appropriateness of dispatch decisions, the longer-term impacts would be significant clinical and financial gains and could lead to the further spread of uptake of such technology in other parts of the ambulance service dispatch.

Lessons learnt for future research

There have been many lessons learnt through conducting this feasibility study, many of which were implemented during the study through the protocol amendments. Further to these, the key lessons learnt for future research of this topic include:

Study/trial design

- We need to understand how best to determine incident eligibility and the entry point to the study for randomisation such that it provides a balance between the arms (e.g. that in the intervention arm once randomised, there would be potential for video livestreaming). In this study, it could only be used by callers who were using a smartphone to make the 999 call. While the CAD showed whether the call was from a landline or mobile phone, it was impossible to determine whether it was a smartphone until the call had been transferred to the HEMS desk/CCD and the caller could be asked this question. In addition, the eligibility often changed at the end of the calls, when, for example, the crew had been dispatched and was due to arrive at the scene within minutes, rendering the evaluation of video livestreaming not possible. These complexities in the fast-moving dispatch environment led to imbalances between the arms where some of the included control arm incidents would likely have been mobile phones not smartphones, and also may have included incidents that could not have used video livestreaming if they had been allocated to intervention. A proposed solution to this is to request a change to NHS Pathways to determine whether the caller is using a smartphone during the triage (though this is likely to be very challenging to implement), and to delay putting the code in for confirming eligibility and transfer of call until towards the end of the NHS Pathways call in both arms.
- We need to consider the most appropriate primary end point for a future definitive trial. Further consideration of speed of appropriate dispatch is needed, together with more distal clinical and health economic end points (e.g. patient outcomes and hospital resources).
- We need to consider the most appropriate design for future research to provide robust evidence but within a context where video livestreaming is rapidly being implemented. This may preclude a RCT design, and thereby we will be considering alternative study designs such as stepped wedge and realist evaluation. The latter will enable a focus on identifying the contextual factors that impact on how and for whom livestreaming works, and so build upon the process evaluation findings of this study and could lead to more generalisable findings across ambulance services with variable models of service delivery (e.g. clinical vs. non clinical dispatchers, NHS Pathways vs. other models of triage).
- Findings from this study in relation to data cleaning and validation required will inform the development of a bespoke study database for a larger definitive study.

- We have learnt that it is complex to determine how to measure the 'appropriateness' of dispatch but did manage to gain clinical consensus on the key areas that require consideration: namely (1) early (< 60 minutes arrival in ED or pre-hospital) clinical interventions; (2) injury pattern/physiology/anatomy; (3) pre-hospital clinical decision-making (e.g. remote assistance from consultant on-call to aid decision-making); and (4) patient disposition and geographical considerations. The algorithms designed by the expert panel were applied reliably to data obtained from medical records but led to some uncertainties that required discussion and further refinement of the algorithms. This requires further testing and validation in future studies to ensure that appropriateness of dispatch is adequately measured.

Patient and public involvement and engagement

- Ensuring diversity of the PPIE group was challenging. Initially all volunteers to join the group were older white men and women who had previous experience of involvement in research within ambulance services or healthcare generally.
- The research team and PPIE lead contacted several ethnic minority groups in an attempt to recruit ethnically diverse PPIE members. We only managed to recruit one member identifying as an ethnic minority with English as a second language. For future projects, we would ensure to start the recruitment process for the PPIE group early (as we did in this study too), consider having a lead from a minority ethnic background, and have a clear strategy to ensure we are maximising efforts to ensure we are representing the views of minority ethnic groups, and other marginalised groups in our research. The research team further tried to increase recruitment of ethnically diverse groups by using social media, contacting ethnic minority groups via e-mail and asking the university networks (such as postgraduate research students) and the EDI team for ideas, none of which led to any further volunteers.

Training: use of video livestreaming and study processes

- Training should be provided face to face (where possible) and should include all staff that may be expected to use video livestreaming in the trial. In addition, having a trial period before the study formally starts where the technology and study processes are piloted would be important to address any operational or training issues.

Information governance

Prior to a future study, we would work closely with the IG departments in any planned study sites to determine how best to balance study requirements with IG policies to build on learning from this study and ensure the best chance of running a future study successfully. In particular, we would seek to gain permission for:

- Allowing video livestreaming to be used by any caller that has access to a smartphone – not just when the call they make is from that smartphone.
- Being able to call back the 999 caller if they are lost in the transfer from the call handler (EMA) to the HEMS dispatcher/CCD, or if the connection with the 999 caller was lost once they had been transferred.
- Being able to attempt recruitment of 999 callers within a wider time frame of the incident, including sending reminders (though see below point on the challenges and lessons learnt here), and by using other methods of recruitment beyond text messages.

Ethical issues

There are several key ethical issues that required consideration for this project and remain relevant for any further research. These included: (1) consent and privacy in relation to the trauma casualties (patients); (2) consent and potential harm (psychological or physical) in relation to the 999 callers; and (3) consent and potential psychological harm in relation to the dispatchers and research paramedics viewing the livestream footage. While the need for informed consent in the pre-hospital setting was necessarily waived due to the nature of the study (likelihood that patients may be unconscious/unable to consent at the time of the event, and that potentially delaying treatment to obtain event would in itself be unethical), where it was possible to ask permission from the casualty/patient, this was part of the script that was used. No footage was recorded, and if any casualty/bystander requested that footage was not streamed, these wishes were adhered to and streaming would cease immediately. In the study, we did not have any such requests, but there were a few incidents where the 999 caller did not want to livestream. We did not obtain sufficient data to fully understand the potential harm to callers or staff/dispatchers (see further below).

Recruitment of 999 callers

We learnt that recruitment of 999 callers was hugely challenging, despite multiple changes to methods and trying different approaches across the main feasibility trial site and observational substudy site. We learnt that changes to text messaging timing and content did not improve recruitment. One measure of harm was post-traumatic stress disorder (PTSD), which cannot be

measured accurately in the immediate aftermath of an event. Our design did involve us attempting to recruit callers 'immediately' after the call, but this was to ask if they would complete a survey 6–8 weeks later. This delay may have caused further attrition. We discussed the challenges with our PPIE, PAG and Steering Committee at various time points during the study and implemented any changes that they suggested. For future research, we would need to prioritise how best to increase recruitment, and this might include (1) increased media and social media campaigns to raise awareness of the study; (2) ensuring the invitation SMS comes from a 'named' source (it was sent via the CAD and just had a number which would have been unknown to callers and so may have aroused suspicion); (3) gaining approval and permissions for a follow-up telephone call; and (4) considering other (non-survey) methods of measuring harm in case the problem was survey-burden (though our challenge was recruiting callers into the study, few of them reached the point of being asked to complete a survey); and (5) considering the use of ecological momentary assessment[24] which would enable 'in the moment' collection of data rather than relying on recall, and could be short questions sent to callers at key time points (e.g. gaining views on use of livestreaming immediately after the call, then checking in with them about their emotional well-being over the coming weeks/months with short questions that are sent by text and require a quick response rather than a longer survey).

Recruitment of emergency operations centre staff for psychological harm survey

- We learnt that it was challenging to find an appropriate comparator site (an ambulance trust that is not using livestreaming nor has plans to introduce so that well-being can be compared and any additional impact of harm from livestreaming be inferred more robustly), and staff groups to give us confidence in our evaluation of the impact of video livestreaming on the staff who use it. This was due to two main challenges, firstly that ambulance services employ different staffing models; and secondly that the landscape in relation to implementation of video livestreaming is fast-changing, and we found that by the time we came to collect data from our comparator site, some aspects of the service had implemented video livestreaming, so were no longer eligible. A different study design may help overcome this, for example, in a stepped wedge design, each site would act as both a control and intervention group (all sites would eventually implement video livestreaming, but the order in which they do it would be randomly determined), or a realist design would ask not 'does it work' but for whom and in which circumstances does it work and how.
- We also learnt about the importance of engaging all staff in the study at an early stage to motivate them to support the study and complete the survey. Offering such engagement activities would have given opportunities for staff to input to study design and operationalisation of implementation at the grant writing stage and beyond would have been beneficial and should be considered in future studies.

Recruitment of patients

- It was challenging to identify and recruit patients, especially once they had been discharged from hospital. The study design required many hospitals to be engaged as potential recruitment sites, but the numbers of patients they might be recruiting could be very small (may be none) and could be spread over many months, which therefore meant it was challenging to keep hospital research staff engaged in the project with this level of unpredictability about their involvement. We need to consider alternative models for recruitment in a future study, together with exploring if the model we used could be improved/enhanced, for example, by providing more comprehensive information to the hospitals about the eligible patients. We will consider the feasibility of having dedicated RPs available to travel to hospitals to support recruitment, and/or learning from other pre-hospital studies where the conveying clinicians have supported initial consent procedures.[25]

What are your aspirations/pre-planned dissemination or discussions to ensure the outcomes of the research are taken forward for implementation by your key stakeholders, partners and target audience/groups?

Our dissemination plan includes:

- The production of a short film aimed at sharing findings with lay members of the public/non-specialist audiences. Ideas and preferences for the film(s) were shared with the PPIE group for suggestions and discussion. Based on this feedback, the research team decided to commission an animation production company to produce the film. At the outset, it was planned to make two short films, one aimed at lay public audience and one for scientific audiences, but we did not require the second film, as the lay film was suitable for any audience. The script, voiceovers and storyboards for the film

were reviewed by all PPIE members, and the film was completed in October 2023 (www.youtube.com/watch?v=EN0mKACpXaQ&t=43s; accessed 3 February 2025).
- The production of a final newsletter to share an overview of our findings and link to our film with patients and the public and all who have registered to receive our newsletters (see *Patient and public involvement and engagement*).
- A joint press release (between participating organisations) to announce the study findings and signpost to outputs/resources (when timing is appropriate for this and in collaboration with NIHR) and a social media [Twitter (X), LinkedIn etc.] strategy to disseminate findings.
- Production of a short briefing about the study has been sent to all ambulance trusts in the UK, and the Director for Acute Care at NHS England, with the link to the film embedded and references to any published papers. The briefing and materials will also be sent to other relevant organisations such as the Association of Ambulance Chief Executives.
- Host a webinar to present the findings from the research and gain input from national and international stakeholders and interested parties. We will use social media and our existing networks to publicise the event (including via our PPIE, PAG and Steering Committee members and their networks).
- Sharing of findings through attendance at conferences, for example, GoodSAM 10 conference (invited speaker, 15 September 2023), and London Trauma Conference (3–6 December 2024). The following have not yet released dates for 2025: College of Paramedics Conference, Ambulance Leadership Forum, Emergency Medical Services Congress, 999 Research Forum Conference. Invited presentation at ISQUA (International Society for Quality in Healthcare, September 2024), and the Royal College of Emergency Medicine annual conference (October 2024).
- Writing and submission of further manuscripts for publication based on data from this study. These will include: (1) the development and validation of the 'appropriateness of dispatch' criteria; (2) how and why video livestreaming 'works' to support dispatch decision-making (based on the qualitative ethnographic data collected as part of this study).

Presentation of findings in informal and internal meetings and seminars such as the Governance Days at Kent, Surrey, Sussex Air Ambulance Charity, and the University of Surrey School of Health Sciences annual seminar for Workforce Organisation and Well-being research; and presentation of the study to Paramedic Science students at the University of Surrey.

Implications for decision-makers

Implications for practice or local service delivery

- While our study provides evidence of acceptability, ease of use and usefulness to both callers and ambulance EOCS, there remains a lack of evidence regarding the effectiveness and cost-effectiveness of using video livestreaming in this setting, and importantly of potential harm to callers and/or staff.
- There is a need for greater understanding of how best to integrate use of video livestreaming with existing and different triage software (NHS Pathways, MPDS) and the CAD systems.
- Reported data from our process evaluation, however, suggest livestreaming improves situational awareness. Dispatchers like being able to see and assess the scene through video streaming, and callers feel reassured by staff being able to see rather than relying on their description alone. There may therefore be increasing pressure from staff (and possibly the public) for greater uptake in the immediate future, meaning a study to better determine implementation and effectiveness is required.
- Ambulance services that are already using video livestreaming – or considering its implementation – need to ensure appropriate governance and monitoring of its use and impact (to ensure it does not risk patient data and staff well-being, and that it is ensuring patient safety) while further evidence is generated to guide this.

Recommendations for policy or practice (justified by research evidence)

- Work should be undertaken to explore barriers to conducting similar research in the pre-hospital setting (such as the IG challenges we faced) to ensure facilitation of important research but with appropriate boundaries.
- Work should also be undertaken to explore barriers and opportunities to public engagement in pre-hospital research and the greater inclusion of minority groups.

Research recommendations

Priorities for research arising from this study include:

1. The follow-on study to this feasibility trial to investigate the effectiveness and cost-effectiveness of using video livestreaming on clinical and economic outcomes (such as speed to appropriate dispatch) for major trauma incidents. This may require an alternative design to a RCT (stepped wedge or realist) due

to the rapid uptake of such technology. The design should incorporate a significant qualitative element to ensure comprehensive evaluation of how, why and for whom livestreaming works.
2. Exploring how best to recruit and retain 999 diverse lay callers/bystanders, including ethnic minorities into pre-hospital setting research. This may require non-traditional research methods to understand barriers and facilitators to recruitment.
3. Investigation of the barriers and facilitators to video livestreaming for lay public 999 callers who have difficulty communicating in English language, and older adults.
4. Investigation of how, why and for whom video livestreaming works in the pre-hospital emergency setting for triage/dispatch to non-trauma or lower acuity events, building on previous research.[21,26,27]
5. Building on the significant research base regarding involving ambulance service staff in research to determine the best way of enhancing their participation in research to increase response rates and engagement in future studies.

Conclusions

This is the first feasibility RCT evaluating the use of video livestreaming for trauma incidents in the real-world setting of an EOC. We have shown that video livestreaming can be successfully implemented, operationalised and evaluated within a RCT design, and that it is acceptable and easy to use by lay public callers and staff. We faced significant challenges in relation to IG restrictions, recruitment of callers and patients, which require further attention for future studies. A further definitive study is supported by the findings we have presented, to be aimed at assessing effectiveness, cost-effectiveness and potential harm. Findings and substantial learning from this study should also be considered in the design of other pre-hospital research studies, especially those using video livestreaming for trauma incidents.

Additional information

CRediT contribution statement

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Andy Fooks: Investigation, Validation.

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Oliver Fitzgerald: Investigation, Validation.

Other contributions

Jane Leng: Patient and public involvement and engagement.

Eva Hogg: Patient and public involvement and engagement.

Yangchhen Yeshi: Patient and public involvement and engagement.

Oliver Bates: Patient and public involvement and engagement.

Glenn Davies: Patient and public involvement and engagement.

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Patient data statement

This work uses data provided by patients and collected by the NHS as part of their care and support. Using patient data is vital to improve health and care for everyone. There is huge potential to make better use of information from people's patient records, to understand more about disease, develop new treatments, monitor safety, and plan NHS services. Patient data should be kept safe and secure, to protect everyone's privacy, and it's important that there are safeguards to make sure that it is stored and used responsibly. Everyone should be able to find out about how patient data is used. #datasaveslives You can find out more about the background to this citation here: https://understandingpatientdata.org.uk/data-citation

Data-sharing statement

All data requests should be submitted to the corresponding author for consideration. Access to anonymised data may be granted following review.

Ethics statement

Favourable ethical opinion was granted on 23 March 2022 by the Health Research Authority (ref: 21/LO/0912). This included approval from the London – Camden and King's Cross Research Ethics Committee (24 January 2022) and NHS Confidentiality Advisory Group (CAG, approval received on 22 March 2022, ref: 22/CAG/0003).

Information governance statement

The University of Surrey and SECAmb are committed to handling all personal information in line with the UK Data Protection Act (2018) and the General Data Protection Regulation (EU GDPR) 2016/679. Under the Data Protection legislation, the University of Surrey is the Data Processor; the University of Surrey or SECAmb (depending on the type of data collected) is the Data Controller and we process personal data in accordance with their instructions. You can find out more about how we handle personal data, including how to exercise your individual rights and the contact details for both the University of Surrey and SECAmb's Data Protection Officers here: www.surrey.ac.uk/information-governance/data-protection; www.secamb.nhs.uk/privacy-statement/.

Disclosure of interests

Full disclosure of interests: Completed ICMJE forms for all authors, including all related interests, are available in the toolkit on the NIHR Journals Library report publication page at https://doi.org/10.3310/EUFS2314

Primary conflicts of interest: Jill Maben was a member of the HSDR Funding Committee from 2019 to 2022.

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This publication presents independent research commissioned by the National Institute for Health and Care Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, MRC, NIHR Coordinating Centre, the Health

and Social Care Delivery Research programme or the Department of Health and Social Care.

This synopsis was published based on current knowledge at the time and date of publication. NIHR is committed to being inclusive and will continually monitor best practice and guidance in relation to terminology and language to ensure that we remain relevant to our stakeholders.

Full list of publications, conference papers, seminars, and so forth, resulting from this study

- Ollis L. The SEE-IT Trial at SECAmb Research: Patient and Public Involvement and Engagement Event 2022, 7 July 2022, Oral Presentation.

- Ollis L and Taylor C. The SEE-IT Trial at the University of Surrey Workforce, Organisation and Wellbeing Monthly Seminar, 12 July 2022.

- Ollis L, Skene SS, Williams J, Lyon R, Taylor C. The SEE-IT Trial: emergency medical services Streaming Enabled Evaluation In Trauma: study protocol for an interventional feasibility randomised controlled trial. *BMJ Open* 2023;**13**:e072877. https://doi.org/10.1136/bmjopen-2023-072877.

- The SEE-IT Group at SECAmb clinical research and education summit: TBI in the prehospital setting, 4 July 2023, Poster Presentation.

- Taylor, C. GoodSAM 10 conference, 15 September 2023, Oral Presentation (invited).

- Taylor C, Ollis L, Lyon RM, Williams J, Skene SS, Bennett K, *et al*. The SEE-IT Trial: emergency medical services Streaming Enabled Evaluation In Trauma: a feasibility randomised controlled trial. *Scand J Trauma Resusc Emerg Med* 2024;**32**:7. https://doi.org/10.1186/s13049-024-01179-0.

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- Taylor C. 26th Annual Trauma Care Conference, 11 March 2024, Oral Presentation.

- Ollis L. College of Paramedics Conference 2024, 21 May 2024, Oral Presentation.

- Ollis L. SECAmb Clinical Research Summit, 11 July 2024, Oral Presentation (invited).

- Williams J. 999 EMS Research Forum Conference, 18 September 2024, Poster Presentation.

- Ollis L. International Society for Quality in Health Care ISQUA, 26 September 2024, Oral Presentation.

- Taylor C. Royal College of Emergency Medicine Annual Scientific Conference, 9 October 2024, Oral Presentation.

Trial registration

This trial is registered as Current Controlled Trials ISRCTN11449333.

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About this synopsis

The contractual start date for this research was in October 2021. This article began editorial review in September 2023 and was accepted for publication in December 2024. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The Health and Social Care Delivery Research editors and publisher have tried to ensure the accuracy of the authors' article and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this article.

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List of supplementary material

Report Supplementary Material 1 Case study of GoodSAM's Instant-On-Scene livestream footage resulting in stand-down of enhanced ambulance care services

Report Supplementary Material 2 Example newsletter: SEE-IT Newsletter Autumn 2022

Supplementary material can be found on the NIHR Journals Library report page (https://doi.org/10.3310/EUFS2314).

Supplementary material has been provided by the authors to support the report and any files provided at submission will have been seen by peer reviewers, but not extensively reviewed. Any supplementary material provided at a later stage in the process may not have been peer reviewed.

Glossary

Advanced Paramedic Practitioners in Critical Care Ambulance service staff who treat the most seriously ill and injured patients.

Cardiopulmonary resuscitation Chest compressions given to a person in cardiac arrest (having a heart attack).

Clinical Research Network Clinical Research Network supports patients, the public and health and care organisations across England to participate in high-quality research, thereby advancing knowledge and improving care. www.nihr.ac.uk/explore-nihr/support/clinical-researchnetwork.Htm

Computer-aided dispatch The software used by ambulance trusts to triage calls and dispatch ambulance resources.

Confidentiality Advisory Group Part of the Health Research Authority process, the Confidentiality Advisory Group is an independent body which you need to apply to if you want to access confidential patient information without patient consent. They provide expert advice on the use of confidential patient information by promoting the interests of patients and public while facilitating the appropriate use of confidential patient information for purposes beyond direct patient care. www.hra.nhs.uk/about-us/committees-and-services/confidentiality-advisory-group/

Consolidated Standards of Reporting Trials A checklist of minimum recommendations for reporting of randomised trials.

Critical care desk The area within the emergency operations centre where the CCPs are dispatched from and from where critical care expertise and support can be sought from the scene of incidents by ambulance crews.

Critical care paramedic A specialist paramedic in critical care.

Dispatcher A member of staff within the ambulance service who dispatches appropriate emergency medical resources to the scene of an incident.

Double-crewed ambulance An emergency ambulance crewed by at least two ambulance service staff who are trained to deliver clinical care at the scene of a medical incident and capable of transporting patients to hospital or another location.

Embedded process evaluation A process evaluation aims to understand if, how and why an intervention works or does not work, that is, video livestreaming, and if/how and why study processes worked or not. It is embedded in the design of the randomised controlled trial to ensure that we can use different types of data to understand how best to implement and evaluate livestreaming.

Emergency medical advisor A member of staff within the ambulance service who finds out the location of the patient/incident, completes an assessment of the patient, provides life-saving instructions (e.g. cardiopulmonary resuscitation) and provides reassurance before emergency medical resources reach the patient/scene. Also known as a 'call taker' or 'call handler'.

Emergency medical services Services which provide urgent or emergency medical help.

Emergency operations centre Receives and triages 999 calls from members of the public and other emergency services, for example, police, fire and coastguard, and co-ordinates dispatch of resources to the scene of incidents.

Expert panel A study-specific group of experts in the field of emergency medicine invited to develop a set of criteria by which the appropriateness of dispatch could be determined.

Feasibility trial A study that asks whether something (in this case, a randomised controlled trial of effectiveness and cost-effectiveness of livestreaming) can be done, and collects the data to inform the design of a future study.

General Data Protection Regulation A set of standards which ensure the fair and proper use of information about people – it is part of the fundamental right to privacy and a way to build trust between people and organisations. It applies to anyone who holds information about people for any business or other non-household purposes. www.gov.uk/government/publications/guide-to-the-general-data-protection-regulation

General Health Questionnaire-12 A 12-item self-report questionnaire used to screen for non-psychotic and minor psychiatric disorders.

GoodSAM's Instant-On-Scene A technology which enables a caller to video livestream from the scene of an emergency to the emergency control centre.

Health Research Authority The regulatory body who ensure that research is ethically reviewed and approved. The Health Research Authority regulates different aspects of health and social care research. www.hra.nhs.uk/

Helicopter emergency medical services Air ambulance medical services, who provide prehospital emergency and critical care to patients via helicopter and/or road, with teams, including emergency medical doctors as well as paramedics.

Impact of Events Scale – Revised A self-report questionnaire used to assess subjective distress and risk of post-traumatic stress disorder caused by exposure to traumatic events.

Intention to treat A method for analysis within randomised controlled trials (where patients are randomly assigned to either control or intervention), where analysis is conducted according to allocation, regardless of whether they received the intended treatment.

International Standard Randomised Controlled Trial Number Primary clinical trial registry recognised by the World Health Organization.

Kent Surrey Sussex Used in this study for Air Ambulance Charity Kent Surrey Sussex.

Medical Priority Dispatch System A dispatch system which allows the categorisation and prioritisation of EMS, is an alternative to NHS Pathways used in this study.

National Institute for Health and Care Research The National Institute for Health and Care Research funds, enables and delivers world-leading health and social care research that improves people's health and well-being, and promotes economic growth. www.nihr.ac.uk/

Observational substudy An observational study involves 'observing' individuals/processes without manipulation or intervention, that is, observing normal practice. A sub-study is a study that sits within a main overarching study. In this study the observational studies sat within and substantiated findings for the main feasibility RCT.

Patient and public involvement and engagement group A group of lay members of the public who ensured that the research project was conducted in line with the interests of patients and the public.

Principal investigator The holder of the research grant and the lead researcher for the research project, with overall responsibility for leading the project from start to dissemination of findings.

Project Advisory Group A group of clinical and methodological experts in the field of research who provided an informal forum for input and support regarding the data collection, analysis and production of research outputs/results.

Qualitative data Data which is descriptive (qualities and characteristics), not numeric and subject to interpretation, for example, interviews, diaries, and observations.

Qualtrics (Provo, UT, USA) Online survey platform which facilitates the design and electronic sharing of questionnaires with participants. www.qualtrics.com/uk/core-xm/surveysoftware/

Quantitative data Data which can be counted or compared on a numeric scale. Used when research is trying to quantify a problem.

Randomised controlled trial A research project where participants (or groups) are randomly assigned to one of two conditions: one (the experimental group) receiving the intervention that is being tested, and the other (the control) not being tested.

Red, Amber, Green rating A traffic light system used to determine progression to a future trial.

Research Ethics Committee The Research Ethics Committee reviews research applications and gives an opinion about whether the research is ethical as part of the overall Health Research Authority approval process. www.hra.nhs.uk/approvals-amendments/what-approvals-do-i-need/researchethics-committee-review/

Research fellow Academic research position under supervision of the principal investigator.

Research paramedic Paramedics who support, deliver and promote research activities.

Scoping review A review (mapping) of the literature on evolving or emerging topics of research, often concerned

with answering multiple or broad research questions and used to identify gaps in current knowledge.

SEENO The code entered into the CAD which signifies if the call was in the intervention arm, the call would have been requested for transfer for live video streaming.

SEESM The code entered into the CAD by dispatchers during the trial to indicate that they were considering the call (incident) as eligible for inclusion in the trial.

SEEYES The code entered into the CAD which requests the call to be transferred for live video streaming (equivalent to SEENO for incidents in the intervention arm).

Silent monitoring When the HEMS dispatchers/CCPs in the EOC silently listen to the conversation between the 999 caller and the EMA to gain more information about the incident.

Steering Committee The role of the Steering Committee is to provide oversight of a project on behalf of the study's sponsor and funder. Members are independent and National Institute for Health Research approved.

World Health Organization The World Health Organization directs and co-ordinates the world's response to health emergencies. They promote healthier lives from pregnancy through old age. www.who.int/

List of abbreviations

APP-CC	Advanced Paramedic Practitioners in Critical Care
CAD	computer-aided dispatch
CAG	Confidentiality Advisory Group
CCD	critical care desk
CCP	critical care paramedic
CONSORT	Consolidated Standards of Reporting Trials
CPR	cardiopulmonary resuscitation
CRN	Clinical Research Network
DCA	double-crewed ambulance
EEAST	East of England Ambulance Service NHS Trust
EMA	emergency medical advisor
EMS	emergency medical services
EOC	emergency operations centre
GHQ-12	General Health Questionnaire-12
HEMS	helicopter emergency medical services
HRA	Health Research Authority
IES-R	Impact of Events Scale – Revised
IG	information governance
ISRCTN	International Standard Randomised Controlled Trial Number
ITT	intention to treat
KSS	Kent Surrey Sussex
LAA	London's Air Ambulance Charity
LAS	London Ambulance Service NHS Trust
MPDS	Medical Priority Dispatch System
NIHR	National Institute for Health and Care Research
PIS	Participant Information Sheet
PAG	Project Advisory Group
PI	principal investigator
PTSD	post-traumatic stress disorder
PPIE	patient and public involvement and engagement
RAG rating	Red, Amber, Green rating
RCT	randomised controlled trial
REC	Research Ethics Committee
RF	research fellow
RP	research paramedic
SECAmb	South East Coast Ambulance Service NHS Foundation Trust
SEE-IT	Streaming Enabled Evaluation In Trauma
SMS	Short Message/Messaging Service (text message)
WHO	World Health Organization

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Appendix 1 CONSORT study flow diagrams and data flow charts

Figures 2–5 have been reproduced from the main results paper.[20]

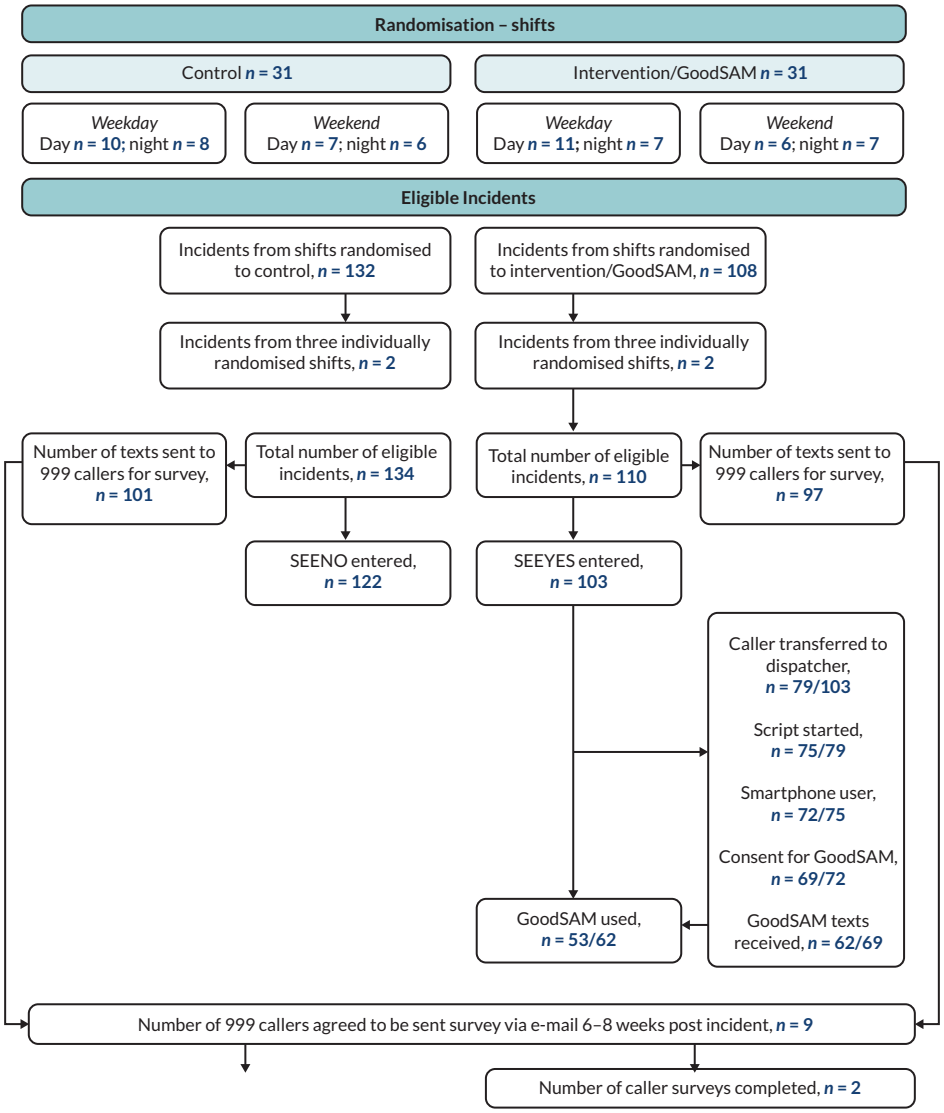

FIGURE 2 CONSORT study flow diagram: randomisation and eligible incident. Reproduced with permission from Taylor *et al.*[20] This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) licence, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/. The figure includes minor additions and formatting changes to the original text.

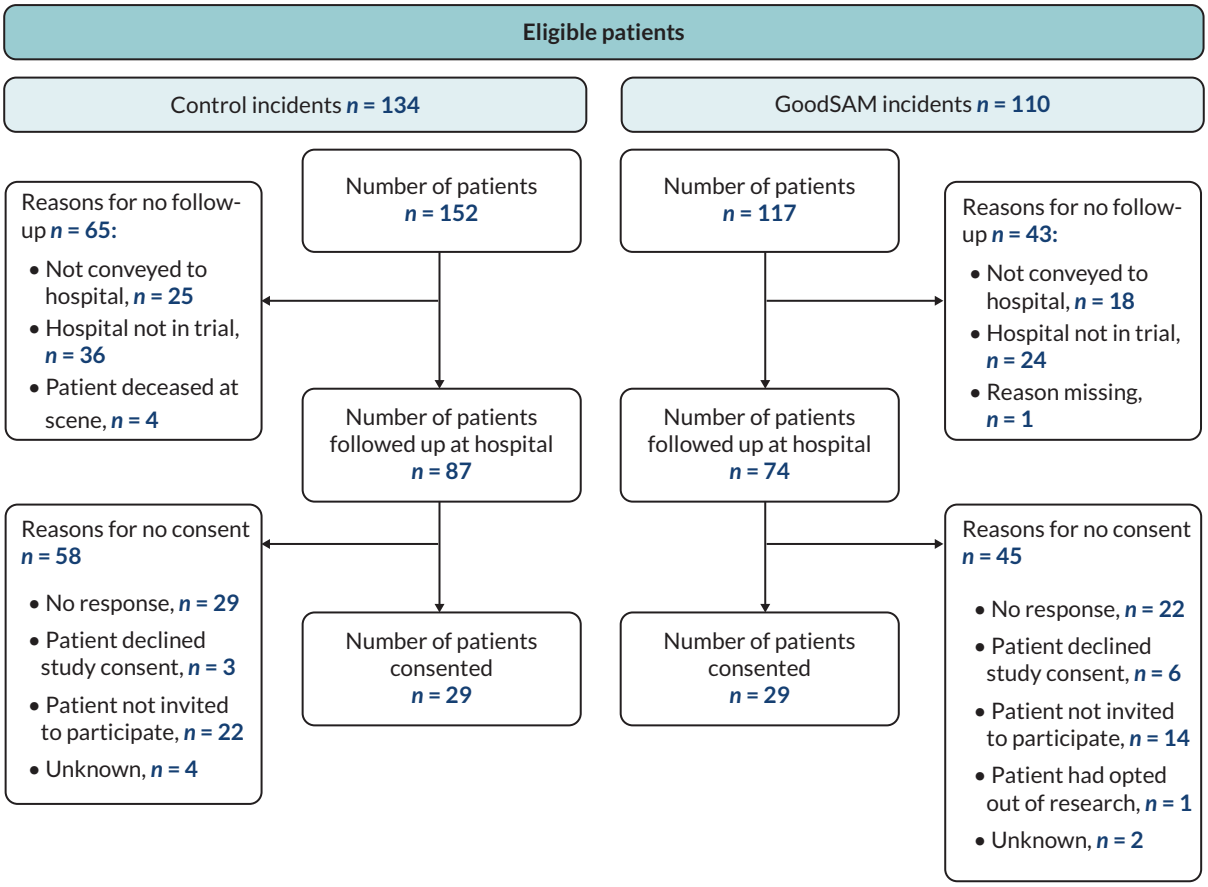

FIGURE 3 CONSORT study flow diagram: patient recruitment. Reproduced with permission from Taylor *et al.*[20] This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) licence, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/. The figure includes minor additions and formatting changes to the original text.

TABLE 7 CONSORT study flow diagram: numbers analysed for each progression criteria

Progression criteria	Number analysed (explanation)
Criteria 1: Percentage of callers with smartphones agreeing and able to activate livestreaming	*N* = 72 (number of callers with smartphones)
Criteria 2: Percentage of requests to activate livestreaming resulting in footage being viewed	*N* = 62 (number of callers where GoodSAM SMS text message was received)
Criteria 3: Proportion of HEMS stand-down due to GoodSAM	*N* = 6 (number of HEMS sends when GoodSAM was used)
Criteria 4: Rates of psychological harm in 999 callers and staff	**Callers** *N* = 4 (number of completed surveys) **Staff** Trial site: *n* = 41 (pre), *n* = 25 (post) Comparison site: *n* = 9 (pre), *n* = 4 (post)

SMS, Short Message Service.

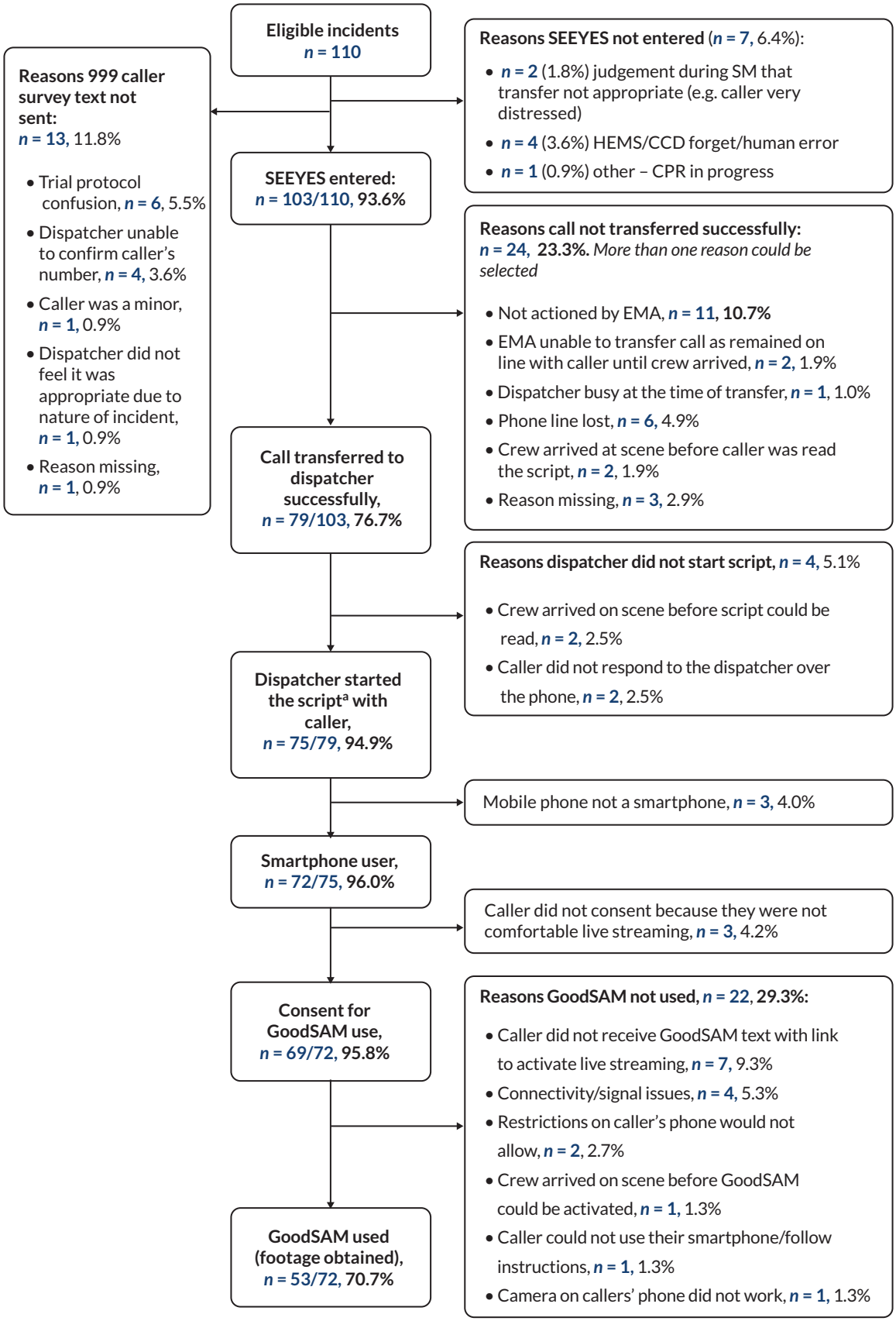

FIGURE 4 Data flow chart (intervention condition).[8] a, a short script checking caller was using a smartphone and was safe and willing attempt livestreaming. Reproduced with permission from Taylor *et al.*[20] This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) licence, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/. The figure includes minor additions and formatting changes to the original text.

This synopsis should be referenced as follows:
Taylor C, Ollis L, Lyon R, Williams J, Skene SS, Bennett K, *et al.* Emergency Medical Services Streaming Enabled Evaluation In Trauma: The SEE-IT Feasibility RCT [published online ahead of print May 28 2025]. *Health Soc Care Deliv Res* 2025. https://doi.org/10.3310/EUFS2314

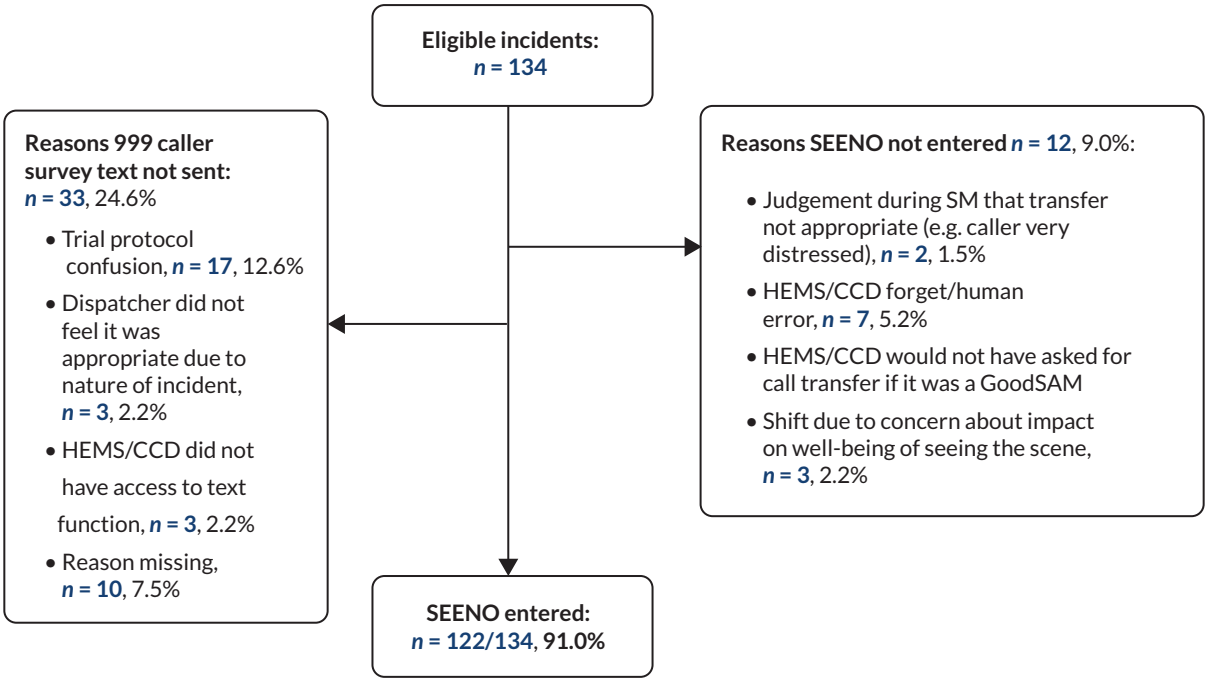

FIGURE 5 Data flow chart (control condition). SM, silent monitoring; SEENO is the code entered to indicate that if the call was in the intervention arm, the call would have been requested for transfer for live video streaming; SEEYES is the code that requests the call to be transferred for live video streaming. Reproduced with permission from Taylor *et al.*[20] This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) licence, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/. The figure includes minor additions and formatting changes to the original text.

Reasons why eligible incidents in the intervention arm did not result in footage obtained and reasons why 999 callers were not sent the text inviting them to participate in the survey. SEEYES is the code entered into the CAD which requests the call to be transferred for livestreaming.

Reasons why eligible incidents in the control arm did not have SEENO entered and reasons why 999 callers were not sent the text inviting them to participate in the survey.

Appendix 2 Health economics analysis report

Emergency medical services Streaming Enabled Evaluation In Trauma: the SEE-IT Trial.
Health Economic Analysis
Authors: Dr Matthew Glover, Dr Oya Eddama, Professor Heather Gage (University of Surrey)
Version 1.4
1 September 2023

Abbreviations

CCP	critical care paramedic
ECP	emergency care practitioner
EOC	emergency operations centre
EOCS	emergency operations centre staff
HEMS	helicopter emergency medical services
KSS	Air Ambulance Charity Kent Surrey Sussex
PLICS	Patient Level Information and Costing System
PSSRU	Personal Social Services Research Unit
RCT	randomised controlled trial
SECAmb	South East Coast Ambulance Service NHS Foundation Trust
SEE-IT	emergency medical services Streaming Enabled Evaluation In Trauma Trial

Introduction

This document presents exploratory analyses for economic outcomes collected in the emergency medical services Streaming Enabled Evaluation In Trauma Trial (SEE-IT) feasibility randomised controlled trial (RCT).

In brief, the SEE-IT Trial was a feasibility RCT with a nested process evaluation, comparing a livestreaming intervention (GoodSAM) to standard care of ambulance dispatch for trauma incidents. In the intervention arm, GoodSAM could be used by 999 callers to livestream incidents to emergency operations centre staff (EOCS), to inform subsequent dispatch decisions. South East Coast Ambulance Service NHSFoundation Trust

(SECAmb) emergency operations centre (EOC) shifts were randomised 1 : 1 to intervention or standard care using a computer-generated randomisation list.

The primary outcome was a decision regarding progression to a definitive RCT based on: percentage of 999 callers agreeable to activate livestreaming; percentage of requests to activate resulting in footage; reduction in air-ambulance stand-down rate or change in dispatch decision; no evidence of increased psychological harm to callers or EOC compared to standard care; and further qualitative data on acceptability and experience.

Secondary outcomes, to collect key data to inform subsequent design and conduct exploratory analysis included: speed of appropriate dispatch; appropriateness of dispatch (determined by expert consensus); stand-down rate; missed jobs; and psychological harm (using IES-R and GHQ).

Aim

The primary purpose of the health economic analysis was to assess the feasibility of gathering data on the resource implications, costs and effects of the dispatch decisions under standard care and when GoodSAM livestreaming intervention is used. This will inform design of a potential future economic evaluation.

Methods

Data sample

Data were collected across shifts randomised in the 6 weeks of the feasibility trial, from July 2022 to November 2022. In the intervention arm, the use of GoodSAM video livestreaming was added to the existing emergency call handling and resource dispatch protocol.

In the data set available for health economic analysis, there were 134 incidents in the control arm and 110 in the intervention arm, involving 152 and 117 participants, respectively.

Healthcare resource use and broader costs

The main healthcare resource use comprised personnel and services dispatched (intervention and control arms), changes to initial response triggered by video streaming (intervention arm), responders on scene (intervention and control arms) and conveyance of patients to hospital.

To compute costs, the time resources were mobile (i.e. travelling to the scene) to whichever time was latest of; time on scene, time leaving scene (or being stood down) and time conveying patients to hospital was used. This gave estimates of the total time different resources spent assigned to, or attending to, a particular incident.

Unit costs

To compare the mean costs of different configurations of resources deployed in the control and intervention arms, unit costs were required at a greater level of granularity than many existing routine sources provide (per unit of time, rather than per incident).

For instance, the National Schedule of NHS costs[28] and associated tariffs separate costs of ambulance services into five categories based on whether a responder attends a scene, treats the patient and conveys: (1) hear and treat (£63); (2) see and treat (£268); (3) treat and (4) convey (£390) and (5) other (£50). This does not distinguish the type of resources involved and is based on an (unknown) distribution of time that resources are deployed.

Unstructured searching of the published literature was performed, focusing on studies of ambulance resources in the UK since 2010, to try and identify sources of more granular data for unit costs. However, the above costs (in different price years) were encountered in several published studies.[29,30]

An additional source of data was identified, which provided ambulance cost data with greater detail: the Patient Level Information and Costing System (PLICS) ambulance data.[31] In addition to the categories described above in the National Schedule of NHS costs, it also compiles activity and costs for types of response vehicles. In the SEE-IT Trial, the majority (c.70%) of resources deployed were double-crewed ambulances (DCAs). Emergency care practitioner (ECP) costs were also available from PLICS and used as proxy for CCPs.

To convert DCA and ECP/CCP costs at incident level into a cost per minute, the mean time that resources were mobile across both arms of the trial was used as denominator.

Neither the National Schedule of Costs nor PLICS detailed costs for HEMS. Additional sources were therefore necessary for HEMS resources. A small contemporary literature was encountered, including a study by Coughlan *et al.* which estimated a cost per mission of a HEMS of £2900 in 2017–8 prices.[32] Similar costs have been cited elsewhere in the academic literature.[33] Contemporary

costs were also sought from Air Ambulance Charity Kent Surrey Sussex (KSS) for both air ambulance and ground vehicles. Cost per hour, inclusive of overheads and operational costs, was provided as £4390 and £1050, respectively (Kent Surrey Sussex Air Ambulance Charity, 2023 n.d., personal communication).

Unit costs used in the exploratory analyses are presented in, in 2021–2 prices. Personal Social Services Research Unit (PSSRU) inflation indices were used where necessary.[34] Intervention costs, road ambulance, CCP and HEMS costs are given per minute.

Intervention costs

The GoodSAM intervention unit cost includes the annual service fee for its use (£40,000) and an assumption regarding the number of calls that would cover (at least 100,000) based on estimates provided by the developer. A HEMS dispatcher (band 4) and CCP (band 7) review unit cost was derived from professional costs detailed in PSSRU costs report.[34] A limited amount of training costs would be incurred when implementing GoodSAM. Guidance was provided during the study but no formalised and consistent training was conducted, making quantifying this cost difficult.

Consequences

The primary consequence of interest was the proportion of incidents with appropriate deployment, based on expert consensus criteria and using data up to 3 months post incident.

Handling missing cost and consequence data

Medical records were only available for a small proportion of total incidents (29 in control and 28 in intervention), and this subsequently affected judgements on appropriateness by the expert panel. Within variable missingness was hard to ascertain based on data, but attempts to minimise were taken during data collection.

Analysis

A cost–consequence framework was adopted to conduct exploratory analysis and assess the feasibility of estimating differences in healthcare resources used during incidents, applying unit costs to estimate total incident costs and estimating proportion of appropriate dispatch decisions.

All analyses were conducted per an intention-to-treat approach, inside the TRE using STATA 16.1 (StataCorp LLC, College Station, TX, USA).

Results

Some limited incident characteristics are summarised in *Table 10* to help understand the nature of incidents which have contributed to resource use and cost data. There were more major trauma tree positive and neurological/brain injuries in the control arm, and more paediatric trauma in the intervention arm. It should be noted that these data were only available for a subsample (c. 20–25%).

Table 11 details the number of resources deployed in each arm across all incidents. There were 116 fewer resources deployed in the intervention arm (333 vs. 217). The mean number of resources per incident was 2.49 and 1.97 in the control and intervention arm, respectively.

The use of GoodSAM video led to seven additional road ambulance dispatches (c. 1 in 20 incidents) and six CPPs (c. 1 in 17 incidents). The number of road ambulances stood down as a result of GoodSAM use was not available (though is unlikely to occur); two CCPs and two HEMS resources were stood down, respectively.

A higher proportion of the first resource arriving on the scene were CCPs in the control arm (25% vs. 17%). Road ambulances were the most often deployed resource, with a higher proportion of resources arriving on scene in the intervention arm being road ambulances (74% vs. 66%). HEMS resources made up a greater proportion of total resources deployed in the control arm compared to the intervention arm (16% vs. 9%).

Mean costs per group, along with mean difference and associated 95% confidence interval (CI) (two-sided), are shown in *Table 12*.

The mean costs of the intervention were £5 per incident. Mean road ambulance costs were similar in the control (£194) and intervention arms (£181). Mean CCP costs were higher in the control arm than the intervention arm (£121 vs. £89). The biggest difference in costs was HEMS resources; mean costs in the control arm were £1087 and £572 in the intervention arm. Total mean costs were £1403 in the control arm and £837 in the intervention arm.

Consequences are summarised as a proportion of inappropriate (under/over-resourced) and appropriate dispatch decisions (see *Table 14*).

Data on appropriateness were only available for a subsample of incidents. A similar proportion of incidents were deemed to have appropriate final resources deployed

to the scene (69% in control; 71% in intervention). At final deployment, more incidents were over-resourced in the control arm (24% vs. 11%) and more incidents were under-resourced in the intervention arm (18% vs. 7%). Means costs were lower in the intervention arm, whether dispatch was under-resourced, appropriate or over-resourced.

No statistical modelling or formal hypothesis testing was conducted, although 95% CI are provided for mean costs.

A summary of the potential impacts of use of GoodSAM by sector and stakeholder is shown in *Table 14*.

Discussion

Exploratory analyses suggest that it is possible to estimate costs of resources dispatched to incidents in the SEE-IT Trial and consequences in terms of appropriateness of dispatch. Differences in the costs of dispatch suggest lower costs in the intervention arm and that the intervention itself forms a negligible proportion of total costs. Cost-effectiveness is likely to be driven by any potential impact of the intervention on dispatches decisions, rather than the cost of acquiring and using the video streaming technology.

A summary of characteristics which might denote severity suggest more serious incidents in the control, which may have impacted the types of resources deployed and time resources were active. However, these data were only available in a sub sample (c. 20–25%).

In this feasibility study, only costs for a 'double-crew ambulance' were applied. In a future study, unit costs for road ambulances could be differentiated further. While most of costs included in the analysis pertain to healthcare payer (NHS costs), HEMS services are often funded primarily via voluntary charitable donations and most accurate unit costs for air ambulances were available from KSS HEMS. The perspective could therefore be considered a societal one, however there are additional societal costs that have not been explored here, for example, other emergency services, economic costs of carriageway disruption.

Additional data collection would be necessary to broaden the scope of costs. The economic impact of carriageways closures is a cost that might be mitigated or increased if HEMS resources deployed are changed by use of GoodSAM. While the mechanism of injury was collected (i.e. road traffic accident) and assumptions could be made based on HEMS dispatch, greater detail on the nature of incidents would be required to estimate costs with any confidence.

In this study, due to design and progression criteria, only limited information was collected from individuals involved in the incidents. Collecting these follow-up data on participants proved difficult in SEE-IT. Improving the ability to gather these will be a crucial part of any attempts to include individual health outcomes in a future evaluation (mortality or health related quality of life) or hospital resources. These data are likely to be the foundation for any longer-term modelling (i.e. quality-adjusted life-years) that could be conducted.

Conclusion

It is feasible to gather data on resource implications and costs associated with deployment of ambulance resources. Additional data collection would be necessary to broaden the analysis. Consideration would be needed in a future study regarding which consequences (effects) to measure and how to ensure sufficient data can be gathered for analyses.

TABLE 8 Healthcare resource use unit costs (£)

Resource use item	Unit cost (per minute)	Source	Notes
Intervention costs		GoodSAM	£40,000 provision of GoodSAM streaming assuming 100,000 calls
Video streaming	£0.07	PSSRU costs 2022	Mean time of call in SEE-IT Trial 6.07 minutes
HEMS dispatcher	£0.62		Band 4 HEMS dispatcher (£37 per hour) and Band 7 CCP (£66 per hour)
CCP review	£1.10		
Road ambulance	£2.68	Ambulance Patient Level Activity and Costing 2019–20 PSSRU costs 2022	All submitters: DCA cost £185. Inflated to 21/22 prices Mean time SECAmb resource mobile in SEE-IT Trial (both arms) 73 minutes (min 4, max 269)
CCP	£3.34	Ambulance Patient Level Activity and Costing 2019–20 PSSRU costs 2022	All submitters: ECP cost £203. Inflated to 21/22 prices Mean time CCP resource mobile in SEE-IT Trial (both arms) 64 minutes (min 4, max 269)

continued

TABLE 8 Healthcare resource use unit costs (£) (*continued*)

Resource use item	Unit cost (per minute)	Source	Notes
HEMS air ambulance	£73.17	KSS	£4390 per hour inclusive of overheads
HEMS road ambulance	£17.50	KSS	£1050 per hour inclusive of overheads

TABLE 9 Selected incident characteristics (participant injuries or incident circumstances)

Characteristic	Control (incidents = 29)	Intervention (incidents = 28)
Major trauma tree positive – # participants (%)	6 (21)	0 (0)
Neurological injury – # participants (%)	3 (10)	2 (7)
Traumatic brain injury – # participants (%)	2 (7)	0 (0)
Paediatric trauma – # participants (%)	2 (7)	3 (10)
Penetrating trauma, limb only – # participants (%)	1 (3)	0 (0)
Fall from height – # participants (%)	3 (10)	3 (10)
Ejected from a vehicle – # participants (%)	1 (3)	0 (0)
Complex isolated open fracture – # participants (%)	2 (7)	2 (7)
Maxillofacial injury – # participants (%)	1 (3)	0 (0)

Note
NB Based on subsample of participants with available medical records.

TABLE 10 Incident level healthcare resource use (levels of dispatch)

	Control incidents = 134		Intervention incidents = 110		Difference	
Resource use item	Number (% of total resources)	Per incident	Number (% of total resources)	Per incident	Number (% of total resources)	Per incident
First resource arriving on scene – number of resources						
Road ambulance	95 (74)	0.71	81 (79)	0.74	−14 (5)	0.03
CCP paramedic	32 (25)	0.24	17 (17)	0.15	−15 (−8)	−0.08
HEMS	1 (1)	0.01	1 (1)	0.01	0 (0)	0
Total	128	0.96	102	0.9	−26	−0.06
Change in resources from video – dispatches						
Road ambulance (%)	N/A		6 (46)	0.05	N/A	
CCP paramedic (%)			7 (54)	0.06		
HEMS			0	0		
Total			13	0.12		

TABLE 10 Incident level healthcare resource use (levels of dispatch) (*continued*)

Resource use item	Control incidents = 134		Intervention incidents = 110		Difference	
	Number (% of total resources)	Per incident	Number (% of total resources)	Per incident	Number (% of total resources)	Per incident
Change in resources from video – stand-down						
Road ambulance (%)	N/A		N/A	N/A	N/A	
CCP paramedic (%)			2 (50)	0.02		
HEMS			2 (50)	0.02		
Total			4	0.04		
Total responder(s) on scene – number of resources						
Road ambulance (%)	206 (66)	1.54	152 (74)	1.38	−54 (9)	−0.16
CCP paramedic (%)	72 (23)	0.54	40 (20)	0.36	−32 (−3)	−0.17
HEMS	36 (11)	0.27	13 (6)	0.12	−23 (−5)	−0.15
Total	314	2.34	205	1.86	−109	−0.48
Resources conveying – number of resources						
Road ambulance (%)	116 (81)	0.87	96 (94)	0.87	−20 (13)	0.01
CCP paramedic (%)	18 (13)	0.13	6 (6)	0.05	−12 (−7)	−0.08
HEMS	9 (6)	0.07	0 (0)	0	−9 (−6)	−0.07
Total	143	1.07	102	0.93	−41	−0.14
Total resources dispatched – number of resources						
Road ambulance (%)	206 (62)	1.54	152 (70)	1.38	−54 (8)	−0.16
CCP paramedic (%)	74 (22)	0.55	45 (21)	0.41	−29 (−1)	−0.14
HEMS	53 (16)	0.4	20 (9)	0.18	−33 (−7)	−0.21
Total	333	2.49	217	1.97	−116	−0.51

TABLE 11 Incident level total healthcare resource use costs (£)

Cost components	Control (SD)	GoodSAM (SD)	Difference (95% CI)
Intervention cost	N/A	5 (13)	
Resource item			
Road ambulance	194 (97)	181 (86)	
CCP	121 (143)	79 (124)	
HEMS	1087 (2041)	572 (1570)	
Total costs (mean, SD)	1403 (2131)	836 (1642)	−566 (−1055 to 78)

SD, standard deviation.

TABLE 12 Cost–consequence (appropriateness of dispatch at incident level)

Cost/consequence	Control (incidents = 29)	Intervention (incidents = 28)	Difference (95% CI)
% inappropriate dispatches – over-resourced (*n*)	24 (7)	11 (3)	−13
% inappropriate dispatches – under-resourced (*n*)	7 (2)	18 (5)	11
% appropriate dispatches (*n*)	69 (20)	71 (20)	2
Mean cost (£) inappropriate dispatches – over-resourced (*n*)	1481 (7)	511 (3)	−970 (−4934 to 2994)
Mean costs (£) inappropriate dispatches – under-resourced (*n*)	591 (2)	224 (5)	−366 (−495 to −238)
Mean costs (£) appropriate dispatches (*n*)	2940 (20)	1755 (20)	−1185 (−3016 to 645)
Total costs (£)	2426	1348	−1078 (−2492 to 337)

Note
NB appropriate is categorised as being neither over/under-resourced. Reproduced with permission from Taylor *et al.*[20] This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) licence, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/. The table includes minor additions and formatting changes to the original text.

TABLE 13 Cost–consequence – potential impacts mapped by sector and stakeholder

Sector	Stakeholder	Potential costs	Potential consequences	SEE-IT exploratory result
Individuals	999 callers		• **Psychological impacts of livestreaming**	• Data not able to be collected
	EOCS/HEMS dispatcher	• **Time spent on call/stream**	• **Psychological impacts of livestreaming**	• No evidence of phycological harm
	Individuals involved in incidents		• **Appropriate dispatch** • **Speed of appropriate dispatch** • Delays in time to conveyance • Long-term health outcomes	• % appropriate dispatch similar between arms • Speed per appropriate dispatch similar between arms
Healthcare Payer	NHS (ambulance trust)	• **Opportunity cost of resources deployed** • **Cost of live-streaming technology** • Downstream healthcare costs	• **Appropriate dispatch** • **Speed of dispatch**	• Mean cost per incident less in intervention arm • Cost of livestreaming technology likely negligible • Limited evidence of differences in dispatch • % appropriate dispatch similar between arms • Speed per appropriate dispatch similar between arms
Healthcare Payer/Societal	Air Ambulance Charity	• **Opportunity cost of resources deployed**	• **Reduced inappropriate dispatch of HEMS**	• GoodSAM may have contributed to small number of HEMS stand-down and costs • HEMS costs lower in intervention arm
Societal	Wider economic impacts	• Impact of carriageway closures		• N/A. Data not available
	Other emergency services	• Opportunity cost of resources deployed		• N/A. Live stream was viewed by ambulance dispatch only

N/A, not applicable.

Note
Costs/consequences in bold were measured in SEE-IT.

Appendix 3 Protocol amendments

Protocol amendments have been summarised within the table below. More details of amendments are found in the protocol, published on the NIHR web page.

TABLE 14 Protocol amendments

REC amendment number	Protocol version no.	Date issued	Details of changes made
N/A	2		• Addition of PIS and consent/assent forms for parents and their children • Addition of consultee declaration form and consultee information sheets, including text in protocol outlining the process for approaching consultees for patients who do not regain capacity to consent • Additional explanations and minor grammatical errors amended in PIS and consent forms for 999 callers and staff • New project title • Addition of exclusion criteria for 999 caller survey due to age restrictions of self-report measures
1	3	28 February 2022	• Addition of 10 NHS organisations (trauma units and major trauma centres) that may need to be included in the study for patient recruitment/data collection • Minor changes to the language of the protocol in relevant places to ensure consistency and clarity. Including edits to the language in the study flow chart of the protocol to ensure the language is correct around priority in ambulance dispatching and escalating/de-escalating resources • The research team added a paragraph explaining that qualitative findings (e.g. interviews and observations) will also be taken into account when reviewing progression to a subsequent definitive trial • Approval for research nurses at the included trauma units/centres to approach casualties/consultees by telephone/post if they are not able to approach them while they are in hospital. In addition, it was added that electronic consent will be acceptable
2	4	18 May 2022	• Addition of one NHS organisation (major trauma centre) that may need to be included in the study for patient recruitment/data collection • Addition of ISRCTN registry number
5	5	21 July 2022	• The trial period was updated from February–July 2022 to June–November 2022. The study end date was changed to 31 July 2023. NIHR approved • The inclusion and exclusion criteria were refined/updated in line with early feasibility testing • Minor update to LAS inclusion criteria (protocol) to ensure only calls where live video streaming is used are eligible for the study • Minor update to protocol as it was not possible to conceal the randomisation from the research paramedics until the start of the shift • The method by which 999 callers were contacted in the main trial was updated. It was not possible to be completed by an EOC administrator so was completed by EOCS through the CAD system • The method by which 999 callers are contacted to take part in the survey in the LAS substudy was updated so that it is clear participants will be phoned to explain the study before receiving a text/e-mail with the survey
6	6	25 August 2022	• Verbal (telephone) consent was added for patients/consultees • Inclusion criteria for the LAS substudy was expanded to also include observations of the critical care advanced paramedic practitioners (APPs, if they consent) • The start and end date for the LAS substudy was updated in the PIS (from May–July to July–October) • In the LAS substudy, a text/e-mail reminder to 999 callers to complete the 999 caller survey was added up to 1 week after the incident occurred • Added approval for the LAS HEMS or APP to asl for permission to share the 999 callers name as well as their phone number with the research paramedic so that they can personalise their messages/calls to them and track who has completed the 999 caller survey so that reminders are only sent to those that were yet to complete the survey • Updated study documents as per changes above

continued

TABLE 14 Protocol amendments (*continued*)

REC amendment number	Protocol version no.	Date issued	Details of changes made
7	7	30 September 2022	• Approval for the research paramedics to record patients' names at the time of the trauma incident, to share with the hospital they are transported to, to aide recruitment
8	7	6 October 2022	• Minor change to the study documents to ensure that the critical care APPs are included in the PIS for the staff interviews in the LAS substudy
9	8	7 November 2022	• Addition of a reminder text to 999 callers in the main trial site, inviting them to participate in the 999 caller survey

APP, advanced paramedic practitioners; ISRCTN, International Standard Randomised Controlled Trial Number; PIS, Participant Information Sheet.