

1 **Accuracy of Nature of Call screening tool in identifying**
2 **patients requiring treatment for Out of Hospital Cardiac**
3 **Arrest**

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38 **Key words:** cardiac arrest, triage, emergency ambulance systems, chain
39 of survival and prehospital care, despatch
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41 **Word count:** Abstract –300 Main paper – 2531 (not including title page,
42 abstract, table, figures or appendices)
43
44

Abstract

Background A new pre-triage screening tool, Nature of Call (NoC), has been introduced into the telephone triage system of UK ambulance services which employ NHS Pathways (NHSP). Its function is to provide rapid recognition of patients who may need immediate ambulance dispatch for Out-of-Hospital Cardiac Arrest (OHCA) and withholding dispatch for other calls whilst further triage is undertaken. In this study, we evaluated the accuracy of NoC and NHSP in identifying patients with potentially treatable or imminent OHCA.

Methods This retrospective, observational study reviewed consecutive calls to a UK ambulance service between October 2016 and February 2017 in which NOC, and then NHSP were applied sequentially. Only those calls for which a corresponding electronic Patient Clinical Record (ePCR) was available were included. Sensitivity and specificity of NOC and NHSP for recognition of an OHCA were determined by comparing allocated priority dispositions with an OHCA Treatment Registry (OHCATR).

Results Of 96,423 calls received, 71,373 were reviewed. For 590 (0.8%) of these calls, the patients received treatment for OHCA. NOC identified 458 OHCATR patients; NHSP identified 467; together they identified 496. NoC captured 29 patients not identified by NHSP; NHSP captured 38 patients not identified by NOC. For NOC sensitivity was 77.6% (95% CI 74.1 to 80.8) and specificity 86.9% (95% CI 86.6 to 87.1). NHSP sensitivity was 79.2% (95% CI 75.7 to 82.2) and specificity 93.4% (93.2 to 93.6). NoC and NHSP combined had a sensitivity of 84.1% (95% CI 80.9 to 86.8) and specificity of 85.3% (95% CI 85.1 to 85.6).

Conclusions NoC and NHSP call categorisation each achieved similar sensitivity for the identification of OHCATR, identifying most of the same patients, but each captured unique patients. Using both methods sequentially improved accuracy. The 16% of OHCATR patients not identified by either method present a challenge to ambulance dispatch systems.

Introduction

Key messages

What is already known on this subject?

- There is evidence that current ambulance telephone triage identifies between 76% and 83% of OHCA.
- NoC is an OHCA screening tool, applied prior to full NHSP triage, which aims to speed up ambulance dispatch for this group. If this benefit is to be realised, NoC must be accurate.

What this study adds?

- In identifying patients on an OHCA treatment registry, the sensitivity of NoC, by itself, is similar to NHSP but allows earlier dispatch of ambulances.
- Accuracy is enhanced when NHSP and NoC are used together.
- NoC and NHSP identify many of the same patients, but each also identifies a unique group.

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82 Emergency ambulance services in the UK have seen year-on-year growth in
83 the numbers of calls received.¹ This is placing increasing pressure on the
84 traditional operating model, whereby most calls trigger the immediate dispatch
85 of ambulance resources. A recent review of ambulance dispatch, the
86 Ambulance Response Programme (ARP),² has led to the introduction of a
87 national policy of only dispatching ambulance resources after telephone triage
88 has concluded ('dispatch on disposition'); specifically, when either a category
89 associated with a priority disposition is allocated or 240 seconds have passed
90 without reaching a priority disposition. The aim of this policy is to increase the
91 efficiency and appropriateness of ambulance care delivery, by taking a more
92 considered approach to the management of lower acuity patients.

93 It is essential that there is minimal delay in attending higher acuity patients
94 who require an immediate response, particularly those who are having, or are
95 in imminent danger of having, an out-of-hospital cardiac arrest (OHCA).

96 Although this ultimately is a small group of patients (only 0.6% of emergency
97 calls are triaged as OHCA and only 8% of these are later confirmed as true
98 OHCA),³ for this group of patients small increases in the time taken to provide
99 interventions may reduce the chances of survival or increase the risk of
100 sustaining life-changing neurological deficit.⁴ A rapid and accurate telephone
101 triage system is therefore vital for identifying those patients in immediate need
102 of treatment.

103 Two telephone triage systems are currently in use by UK ambulance services:
104 NHS Pathways (NHSP) and the Medical Priority Dispatch System (MPDS)
105 (Medical Priority Consultants, Salt Lake City, Utah, USA). The most recent and
106 relevant study of the accuracy of NHSP, regarding the identification of OHCA,
107 estimated sensitivity of 75.9% (95% confidence interval [CI] 74.3 to 77.3) and
108 specificity of 98.6% (95% CI 98.6 to 98.7).⁵ Due to the perceived impact of
109 NHSP on speed of triage, the NHS England ARP has implemented a rapid

110 screening tool at the beginning of NHSP known as Nature of Call (NoC). NoC
111 is primarily a patient safety strategy, intended to support the move to ‘dispatch
112 on disposition’. It aims to do this by hastening the identification of the most
113 urgent cases, so that they are not disadvantaged by the additional time
114 required to complete full triage before dispatch. The ability of this system to
115 accomplish these goals has not yet been evaluated.

116 The aim of this study was to estimate the diagnostic accuracy of NoC in
117 differentiating those who may require treatment for OHCA from all other calls.
118 NoC was evaluated in isolation (in recognition of its role in delaying the
119 dispatch of some ambulances), in comparison with NHSP for the same cohort,
120 and also in combination with NHSP (reflecting their sequential application and
121 interrelated functionality).

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124 **Methods**

125 **Design**

126 A retrospective, observational study was used to assess the diagnostic
127 accuracy of NoC, NHSP and the combination of NoC and NHSP for patients
128 having or at risk of imminent cardiac arrest, between 26 October 2016 and 17
129 February 2017.

130

131 **Setting**

132 South Western Ambulance Service NHS Foundation Trust (SWASFT) is one
133 of 10 NHS ambulance trusts providing emergency medical care for England. It
134 serves one fifth of England. Emergency calls to SWASFT are received by two
135 clinical hubs (North and East/West). At the time of data collection, the hubs
136 employed different triage systems. This study was conducted at the
137 East/West hub, which largely receives calls originating from Cornwall, Devon,
138 Somerset and Dorset, and used NHSP triage. The North hub used the MPDS
139 triage system, which does not use the NoC screening tool. Calls to the North
140 hub were not included.

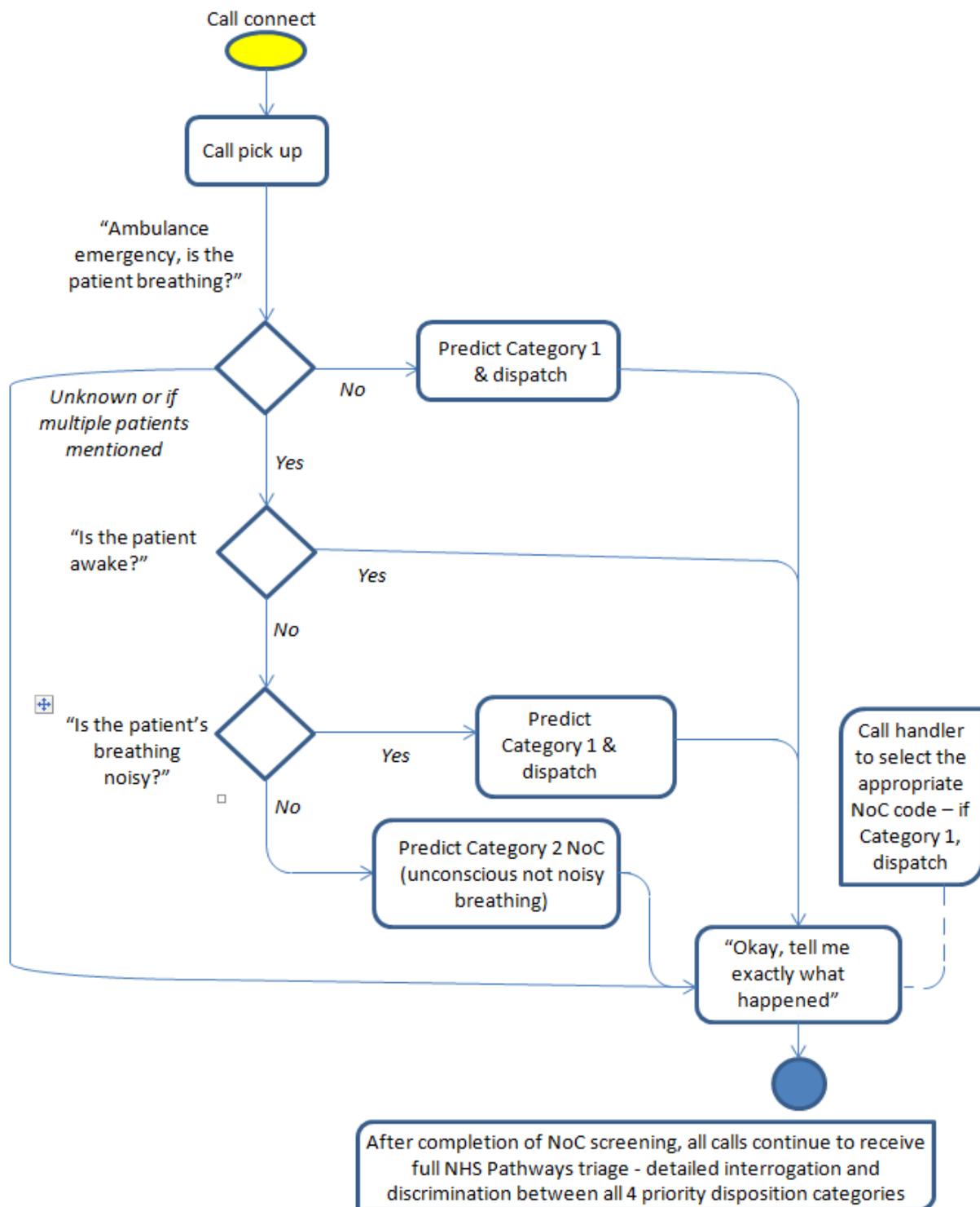
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142 **Intervention**

143 Calls received by the East/West hub first undergo NoC screening. Call takers
144 place each patient into a category from a pre-determined list, based on the
145 answers to questions regarding the patient’s level of consciousness, the
146 quality of their breathing and the nature of their presenting problem and a
147 response category is assigned (Figure 1). After the call has been screened
148 using NOC, more information is taken using NHSP (NHSP version 10.0.08)
149 and another response category is assigned.

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Figure 1 Call process incorporating ‘Nature of Call’ pre-triage questions³



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For both NoC and NHSP, each category is associated with a priority/resource disposition reflecting Department of Health determined levels of acuity/priority (Table 1).

Table 1 Emergency call priority/dispatch dispositions³

NHS England priority/ dispatch disposition	Description
Category 1	Time critical life-threatening event needing immediate intervention and/or resuscitation e.g. cardiac or respiratory arrest; airway obstruction; ineffective breathing; unconscious with abnormal or noisy breathing; hanging. Mortality rates high; a difference of one minute in response time is likely to affect outcome and there is evidence to support the fastest response.
Category 2	Potentially serious conditions (ABCD problem) that may require rapid assessment, urgent on-scene intervention and/or urgent transport. Mortality rates are lower; a difference of an extra 15 minutes response time is likely to affect outcome and there is evidence to support early dispatch.
Category 3	Urgent problem (not immediately life-threatening) that needs treatment to relieve suffering (e.g. pain control) and transport or assessment and management at scene with referral where needed within a clinically appropriate timeframe. Mortality rates are very low or zero; a difference of one hour or more might affect outcome and there is evidence to support alternative pathways of care.
Category 4	Problems that are not urgent but need assessment (face to face or telephone) and possibly transport within a clinically appropriate timeframe.

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Only calls allocated to NoC categories associated with the Category 1 disposition receive immediate ambulance dispatch; all others await NHSP triage (or 240 seconds without triage), before a decision to dispatch an ambulance is made. NoC serves as a single purpose screen to identify OHCA/ imminent OHCA and speed-up dispatch to this group. NHSP provides detailed systematic interrogation and differentiation between all four priority categories.

Participants

Inclusion criteria: Calls were included if they received both NoC and NHSP categorisation, and a corresponding electronic Patient Clinical Record (ePCR) was available. The ePCR is the documentation created by ambulance clinicians detailing each patient episode. Calls from healthcare professionals were excluded because, although they are screened for acuity, their NoC category is routinely recorded as 'Category 4' (table 1).

Data collection

177 Data relating to calls are recorded on internal computer servers using MIS
178 Emergency Systems' Alert C3 computer-aided dispatch software. Consecutive
179 calls which met the inclusion criteria during the period between 26 October
180 2016 (when revised call category definitions were introduced (see appendix 1)
181 and 15 February 2017 were retrospectively reviewed to determine their
182 categorization by each of the two systems. Patient demographics and other
183 data regarding the patient or call characteristics were not analysed.
184

185 **Reference standard**

186 In order to confirm whether or not a call was appropriately categorised by
187 either NOC or NHSP, we used the OHCA Treatment Registry (OHCATR),
188 maintained by SWASFT, which records clinical and demographic data for
189 those patients who receive a resuscitative attempt from the ambulance
190 service.⁶ Presence in this registry was considered a proxy measure for
191 patients who were in immediate or imminent need of treatment for OHCA at
192 the time of the call. The selection of the OHCATR as the reference standard
193 differs from most similar studies, which evaluate the identification of OHCA
194 whether treated or not. The advantage of the OHCATR is that it excludes the
195 high proportion of calls for patients who suffer OHCA, but who do not receive
196 a resuscitative attempt (63%).⁷ In these cases resuscitation is considered
197 futile, typically because OHCA is unwitnessed, or 'do not resuscitate' orders
198 are present.
199

200 **Data Analysis**

201 Sample size was chosen by estimating sensitivity with a suitable degree of
202 precision. Assuming a planning value for sensitivity of 76% (based on
203 previous studies of NHSP), and a desired width of 20% for the 95% CI, a total
204 of 71 cases on the OHCATR were required (calculated using nQuery).
205 Assuming a prevalence of OHCA in emergency calls of 0.3%, and aiming for a
206 95% probability of observing the desired 71 cases, we required almost 29,000
207 calls.⁸

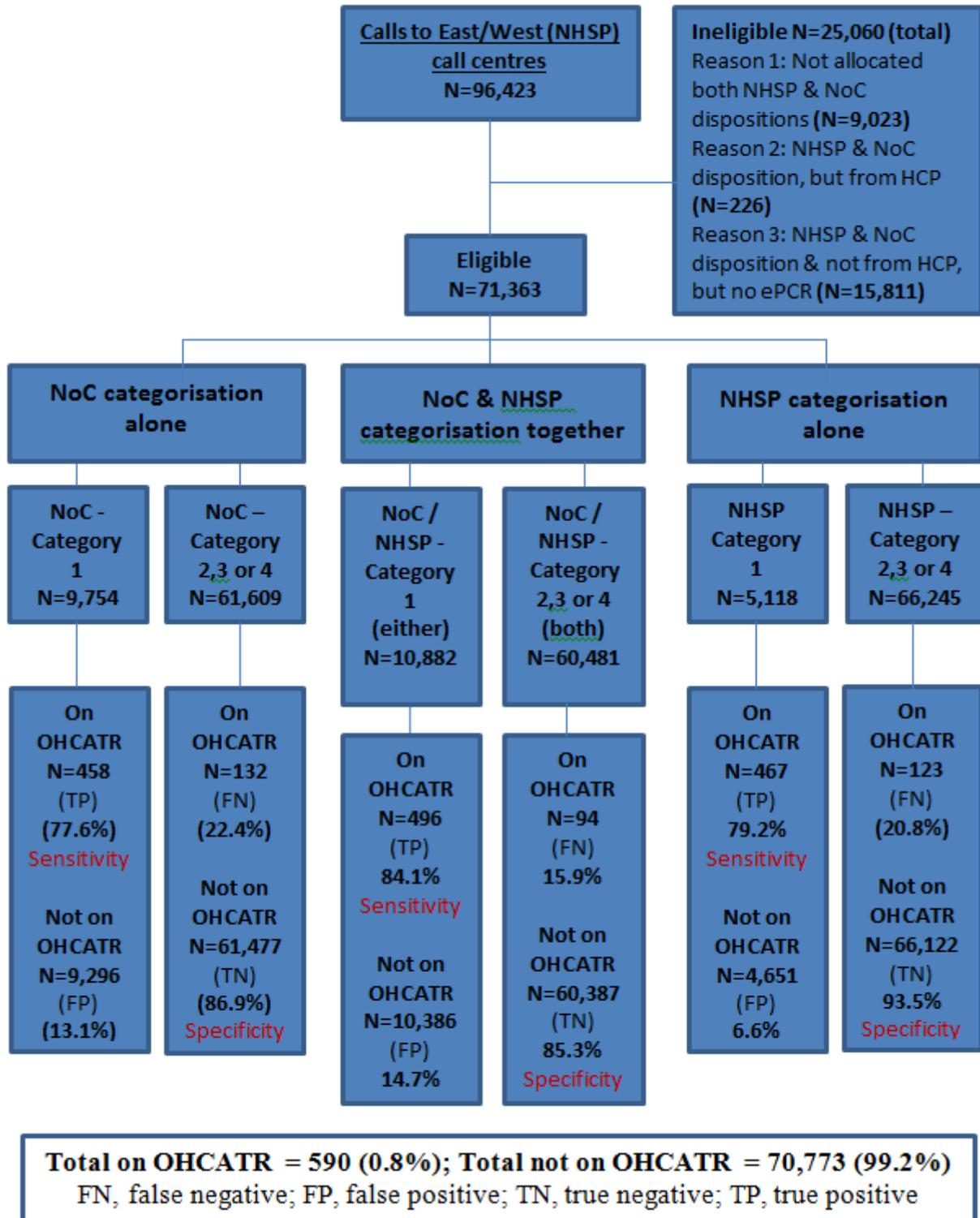
208 NoC and NHSP call categories and OHCATR records were linked by the
209 incident number allocated to each call during the call taking process.
210 Sensitivity and specificity were determined using the following definitions: true
211 positive (patients allocated the Category 1 disposition by NoC, NHSP or both
212 and on the OHCATR); true negative (patients not allocated to Category 1 and
213 not on the OHCATR); false positive (patients allocated to Category 1 and not
214 on the OHCATR); and false negative (patients not allocated to Category 1 and
215 on the OHCATR). Analysis was conducted in Stata v14.0.
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218 **Results**

219 In the four-month period between 26 October 2016 and 15 February 2017,
220 71,363 calls were received by the East/West hub for which there was an
221 associated ePCR. Among these calls, 590 (0.8%) patients were recorded on
222 the OHCATR and 70,773 (99.2%) were not. Sensitivity and specificity are

223 presented for NoC alone, NHSP (post-NoC), and NoC and NHSP combined
 224 (Figure 2).
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Figure 2 Patient flow diagram



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Nature of Call

229 A total of 9,754 eligible calls (13.7%) were allocated to Category 1 by NoC
230 (figure 2). Of these, 458 (4.7%) were on the OHCATR. Of those patients who
231 were not allocated to Category 1 by NoC (61,477), 132 (0.2%) were on the
232 OHCATR.

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234 The sensitivity of NoC (probability of being allocated to Category 1 by NoC, if
235 on the OHCATR) is estimated to be 77.6% (95% CI: 74.0 to 80.9); the
236 specificity (probability of being allocated to Categories 2, 3 or 4 by NoC, if not
237 on OHCATR) is estimated to be 86.9% (95% CI: 86.6 to 87.1).

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239 **NHS Pathways**

240 A total of 5,118 eligible calls (7.2%) were allocated to Category 1 by NHSP
241 (figure 2). Of these, 467 (9.1%) were on the OHCATR. Of those patients who
242 were not allocated to Category 1 by NHSP (66,245), 123 (0.2%) were on the
243 OHCATR.

244

245 *Sensitivity* (probability of being allocated to Category 1 by NHSP, if on the
246 OHCATR)=79.2% (95% CI 75.7 to 82.2). *Specificity* (probability of being
247 allocated to Categories 2, 3 or 4 by NHSP, if not on OHCATR) was estimated
248 to be 93.4% (95% CI 93.2 to 93.6).

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250 **NoC and NHSP combined**

251 A total of 10,882 eligible calls (15.2%) were allocated to Category 1 by NoC or
252 NHSP (Figure 2). Of these, 496 (4.6%) were on the OHCATR. Of those
253 patients who were not allocated to Category 1 by NoC or NHSP (60,481), 94
254 (0.2%) were on the OHCATR.

255

256 *Sensitivity* (probability of being allocated to Category 1 by NoC or NHSP, if on
257 the OHCATR)=84.1% (95% CI 80.9 to 86.8). *Specificity* (probability of being
258 allocated to Categories 2, 3 or 4 by NoC or NHSP, if not on OHCATR)=85.3%
259 (95% CI 85.1 to 85.6).

260

261 Of the 590 patients identified on the OHCATR, 94 (15.9%) were not allocated
262 to Category 1 by either NoC or NHSP. Of the 496 patients who appear on the
263 OHCATR and were allocated a Category 1 disposition by NoC or NHSP, 429
264 (86.5%) were identified by both systems, 38 (7.7%) by NHSP alone and 29
265 (5.8%) by NoC alone.

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268 **Discussion**

269 This study provides evidence that the sensitivity of the Nature of Call (NoC)
270 screening tool and of the NHS Pathways (NHSP) triage system, in identifying
271 patients who require treatment for OHCA, are similar. Therefore, even though
272 NoC requires only a short interaction with callers, it can save time compared
273 to prior standard care while still identifying approximately 80% of those on the
274 OHCATR. These measures of sensitivity for both NoC and NHSP are similar

275 to that of NHSP for OHCA recognition, as reported in a previous study by
276 Deakin *et al* which reported a sensitivity of 75.9%.⁵ Although the performance
277 of NoC, in identifying those requiring treatment for OHCA is similar to that of
278 NHSP triage, 22.4% of OHCATR patients are not allocated Category 1
279 prioritisation by NoC. For these patients ambulance dispatch would have been
280 delayed as NHS Pathways triage proceeded.

281 NoC also achieved a high level of specificity (86.9%); nearly 9/10 of patients
282 who do not receive treatment for OCHA are appropriately allocated lower
283 priority dispositions, meaning that resources can be prioritised to those most
284 in need. NOC specificity was slightly lower than NHSP in this study, and also
285 lower than that determined by Deakin *et al* (98.6%).

286 Although the application of NoC does not result in the appropriate
287 categorisation of all OHCATR patients, it does not operate in a vacuum.
288 Subsequent NHSP triage provides a more accurate safety net. This study
289 evaluated the combined performance of NoC and NHSP as they are used in
290 practice. Combined sensitivity is a relatively high 84.1% (whilst maintaining
291 85.3% specificity). Therefore, although recognition by NoC should facilitate
292 very rapid dispatch, subsequent recognition by NHSP may identify additional
293 OHCATR patients (a further 6.4%). It is however important to recognise that
294 4.9% of those on the OHCATR were only identified by NoC. Therefore, NoC
295 informed dispatch to Category 1 calls should not automatically be revised to
296 reflect NHSP triage. This performance compares well with OHCA identification
297 by the other triage system widely used in the UK (MPDS): sensitivity 76.7%,
298 specificity 99.2%.⁹

299 As call triage and ambulance dispatch are interconnected, the results of this
300 study are relevant to changes to ambulance dispatch, introduced by the
301 Ambulance Response Programme (ARP). In the past, the impact of any failure
302 of triage systems to identify the highest priority patients was mitigated by a
303 policy of rapid ambulance dispatch to almost all calls. The ARP is intended to
304 enable more selective dispatch, based on call triage. This approach increases
305 reliance on triage accuracy. Our data suggest NoC is fulfilling its intended
306 patient safety function reasonably well, both as an OHCA sieve and in
307 identifying OHCA in conjunction with subsequent NHSP triage. This is an
308 appropriate response to the problem, as it does not in itself prohibit (and may
309 facilitate) rapid ambulance dispatch to the highest acuity calls compared to
310 NHSP alone or MPDS triage. However, because no triage system is perfect,
311 the ARP's introduction of 'dispatch on disposition', including efforts to avoid
312 dispatch altogether for some low acuity calls, will expose a small group of
313 OHCA patients to the risk of having an ambulance delayed which may have
314 been routinely dispatched under the previous dispatch system.

315

316 **Limitations**

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318 The impact of prehospital treatment, either in preventing or treating OHCA
319 may be expected to be influenced by speed of response. A rapid response will
320 make the aversion of OHCA more likely and a delayed response will increase

321 the likelihood that commencing resuscitation will be considered futile. Neither
322 of these groups are recorded on the OHCATR. We suspect that each scenario
323 is rare, but cases are difficult to identify. A future study may benefit from an
324 analysis of dispatch to OHCA patients, such as times to dispatch and numbers
325 of ambulances dispatched to Category 1 calls, before and after NoC was
326 introduced. Retrospective, observational accuracy studies are limited in their
327 ability to compare causative links between telephone triage/ ambulance
328 dispatch systems and clinical outcomes. There is therefore a pressing need
329 for prospective trials in this field.

330

331 **Conclusions**

332 Our data suggest that, compared to NHSP alone, triage by NoC and NHSP
333 together offers improved accuracy for identifying OHCA calls, while providing
334 rapid dispatch for most of these patients. However, sufficient safety-netting
335 must be built into dispatch systems to ensure that failure to rapidly respond to
336 high-acuity patients is 'acceptably' rare.

337

338 **Footnotes**

339

340 **Ethics:** The University of Southampton granted ethics approval for this study
341 on 1 March 2017.

342

343 **Funding:** There is no funding to report.

344

345 **Competing interests:** There are no competing interests for any author.

346

347 **Contributorship:** JG conducted and submitted the study. All authors drafted
348 or revised this manuscript and approved the final version.

349

350 **Acknowledgement:** We would like to acknowledge Sue Tuckett, recent
351 Clinical Lead for SWASFT, for her advice regarding NoC (and her role in its
352 creation).

353

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Appendix 1 Nature of Call (NoC) descriptors as used by South Western Ambulance Service NHS Foundation Trust October 2016 to November 2017

Code	Description	New Setting
BLE1	Bleeding catastrophic	Category 1
BRE1	Breathing Probs (NotAlert/Ineff)	Category 1
CHO	Choking	Category 1
CONS	Operation Consort	Category 1
DRO	Drowning/Water incident	Category 1
FIT	Fitting	Category 1
PLATO	PLATO	Category 1
RED1	Arrest / Peri-Arrest	Category 1
UNC	Unconscious (NOT Noisy Breathing)	Category 1
ESCL	Escalation	Category 1
OTH	Other Service	Category 1
PESCL	Psiam Emergency Declared	Category 1
CSDPR	CSD PURPLE response escalation	Category 1
CVA	Stroke/Neurological	Category 2
CSDRT	CSD RED TRANSPORT Escalation	Category 2
CHE	Chest Pain/Cardiac Prob/Back Pain (Upper)	Category 2
COL	Collapse (Breathing Normally)	Category 2
DEAT	Death unexpected all ages	Category 2
TRAM	Trauma Major	Category 2
CSDRR	CSD RED response escalation	Category 2
OD	Overdose	Category 3
S136	Section 136	Category 3
TPLANT	Transplant Service	Category 3
PEAMB	Psiam Emergency Ambulance Required	Category 3
CSDAT	CSD AMBER TRANSPORT Escalation	Category 3
AIR	Air Incident	Category 3
ALCO	Alcohol Related	Category 3
ALL	Allergic Reaction	Category 3
BLE	Bleeding (Specify..)	Category 3
BOMB	Bomb Threat	Category 3
BRE	Breathing Problems (Alert)	Category 3
CBRN	CBRN	Category 3
CHEM	HAZCHEM	Category 3
CON	Concern For Welfare	Category 3
DIA	Diabetic Probs	Category 3
EDEC	Death expected <18	Category 3
ELEC	Electrocution/Shock	Category 3
ENV	Heat/Cold Exposure	Category 3
EXPL	Explosions	Category 3

FALU	Fall Injuries Unknown	Category 3
FIRE	Fire Persons Reported	Category 3
FLOO	Flooding	Category 3
HEA	Headache	Category 3
MAJ	Major Incident Standby / Declared	Category 3
MARC	Marine Incident on Coast	Category 3
MAT	Maternity	Category 3
MED	Medical	Category 3
MUL	Multiple Casualty Event	Category 3
RAIL	Rail Incident	Category 3
RRED	Running Red	Category 3
RTC	RTC	Category 3
RTCR	RTC Roll Over	Category 3
SHOO	Firearms	Category 3
STAB	Stabbing	Category 3
SUIC	Suicide	Category 3
AMPDS	Continue AMPDS Triage	Category 3
CSDAR	CSD AMBER RESPONSE Escalation	Category 3
ABDO	Abdominal/Flank Pain (Lower)	Category 4
ASS	Assault / Domestic	Category 4
BAC	Back Pain (Lower)	Category 4
BUR	Burns	Category 4
EDEA	Death expected >18	Category 4
FALL	Fall Non-Injury	Category 4
FISB	Fire Request To Standby	Category 4
HCP	HCP	Category 4
MARS	Marine Incident at Sea	Category 4
TRA	Trauma	Category 4
CSDGT	CSD GREEN TRANSPORT Escalation	Category 4
EYE	Eye Problems	Category 4
INFO	Information Only	Category 4
MEDM	Medical Minor	Category 4
MEN	Mental Health	Category 4
SOC	Social	Category 4
CSDGR	CSD GREEN Response	Category 4

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