Article title: '*She's sort of breathing*': what linguistic factors determine call-taker recognition of agonal breathing in emergency calls for cardiac arrest?

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Word count: 2997 (excluding title, abstract, keywords, references, table, figures)
Word count of the abstract: 198
Number of tables: 1
Number of figures: 3

Funding
This work has been supported by an NHMRC Partnership Project between Curtin University and St John Ambulance Western Australia (APP1076949 'Improving ambulance dispatch to time-critical emergencies').

'*She's sort of breathing*': what linguistic factors determine call-taker recognition of agonal breathing in emergency calls for cardiac arrest?

Abstract

Background: In emergency ambulance calls, agonal breathing remains a barrier to the recognition of out-of-hospital cardiac arrest (OHCA), initiation of cardiopulmonary resuscitation, and rapid dispatch. We aimed to explore whether the language used by callers to describe breathing had an impact on call-taker recognition of agonal breathing and hence cardiac arrest.

Methods: We analysed 176 calls of paramedic-confirmed OHCA, stratified by recognition of OHCA (89 cases recognised, 87 cases not recognised). We investigated the linguistic features of callers' response to the question "*is s/he breathing?*" and examined the impact on subsequent coding by call-takers.

Results: Among all cases (recognised and non-recognised), 64% (113/176) of callers said that the patients were breathing (*yes*-answers). We identified two categories of *yes*-answers: 56% (63/113) were plain answers, confirming that the patient was breathing ("*he's breathing*"); and 44% (50/113) were qualified answers, containing additional information ("*yes but gasping*"). Qualified *yes*-answers were suggestive of agonal breathing. Yet these answers were often not pursued and most (32/50) of these calls were not recognised as OHCA at dispatch.

Conclusion: There is potential for improved recognition of agonal breathing if call-takers are trained to be alert to any qualification following a confirmation that the patient is breathing.

Keywords

Out-of-hospital cardiac arrest; recognition; agonal breathing; emergency medical services; dispatch; emergency calls; communication; conversation analysis

Introduction

During emergency medical calls, after determining whether the patient is conscious, call-takers ask callers whether the patient is breathing, and/or whether the patient is breathing normally. Breathing assessment is a challenging task for callers[1] as well as for call-takers,[2] but it is commonly used to help identify time-sensitive emergencies such as out-of-hospital cardiac arrest (OHCA). A reflexive breathing pattern referred to as 'agonal breathing'[3, 4] can sometimes be observed in the first few minutes after cardiac arrest.[5, 6] Agonal breathing presents a window of opportunity as it indicates that OHCA has recently occurred and therefore there is a higher likelihood of survival[7, 8] if cardio-pulmonary resuscitation (CPR) is started immediately. The paradox[9] is that lay rescuers often mistake agonal breathing for effective breathing and thus OHCA patients can be incorrectly assessed as breathing[10, 11], thereby delaying any resuscitation attempt.

The question of whether the patient is breathing is binary and seeks to elicit a "yes" or "no" answer. However, callers often volunteer additional information about the patient's breathing ("*yes but barely*"). Previous research has identified common descriptors[3, 8, 12] These are typically integrated into the dispatch protocols used by Emergency Medical Services. For example, the Medical Priority Dispatch System (MPDS)[14] lists the following terms as indicators of ineffective/agonal breathing: "barely breathing", "can't breathe at all", "fighting for air", "gasping for air", "just a little", "making funny noises", "not breathing", and "turning blue/purple".

However, even with such descriptors in place, agonal breathing remains a major barrier to the recognition of OHCA at dispatch and thus delays initiation of bystander-CPR[11, 16–18] Interpreting what callers say is not just a matter of which keywords are said, but also of the overall context of their answers. This study aimed to determine whether the type of sentence used by callers in response to the question "*Is s/he breathing?*" had an impact on call-taker recognition of agonal breathing and thus, identification of OHCA.

Methods

Data collection

We retrospectively analysed a random selection of emergency medical calls received by St John Ambulance Western Australia (SJA-WA) between 1 January 2014 and 31 December 2015 for paramedic-confirmed OHCA that occurred in Perth. A flowchart for the data collection is presented in Fig. 1. As detailed in the over-arching study protocol,[19] there were 3513 OHCA cases attended by SJA-WA paramedics during the study period. Of those, 1382 cases met the following initial criteria: non-traumatic OHCA in adults (≥14 years old) where the paramedics attempted resuscitation, no impediment to paramedic attendance, incidents with a single OHCA patient, OHCA not witnessed by paramedics, and cases for which the dispatch data were available. Due to the detailed analysis involved, we were unable to examine every call, thus a randomly selected subset was used. The cases meeting the initial criteria were listed in a randomised order (using Microsoft Excel 2013). We worked through this list sequentially until reaching the target of 200 cases: 100 calls in which cardiac arrest was recognised by the call-taker and 100 calls in which cardiac arrest was not recognised by the call-taker. This stratification by OHCA recognition was necessary because non-recognition is rarer (estimated <15% for the study period), and yet, these cases provide invaluable insight as to what linguistic factors can negatively impact dispatch. We excluded the following: cases in which the patient was unequivocally conscious, the caller was not a lay bystander, the caller was not on scene, the caller and/or call-taker was not a native speaker of English, and calls with very poor sound quality.

After listening to the 200 randomly selected calls, we excluded a further 12 calls: 7 calls because the call-takers did not ask the question "*is s/he breathing?"*; 3 calls because the call-takers asked two protocol questions at the same time ("*and he's not awake and not breathing is that right?*"); and 2 calls because the call-takers asked the question in a negative format ("*and he's not breathing at all?*"). Closer inspection of the electronic Patient Care Records led

to the exclusion of 12 cases because OHCA was paramedic-witnessed. Consequently, this study was conducted on 176 calls.

Dispatch protocol

During the study period, SJA-WA used the MPDS (version 12.1.3), implemented with the ProQA software.[20] Calls start with a case entry sequence, with the following steps: after confirming (1) the address and (2) telephone number of the emergency, the call-taker (3) delivers the prompt "*okay, tell me exactly what happened*", and asks the questions (4) "*Are you with the patient now?*", (5) "*How old is s/he?*", (6) "*Is s/he awake?*", and (7) "*Is s/he breathing?*". Based on the caller's answers, the call-taker assigns the call to one of 32 Chief Complaints, representing the primary nature of the patient's emergency. Depending on the MPDS protocols for specific Chief Complaints, further questions about breathing may be asked after case entry, e.g. "*is s/he breathing normally?*" in the case of chest pain. This study focuses on initial breathing assessment during case entry, i.e. how callers responded to item (7) "*is s/he breathing?*" Fig. 2 summarises the overall structure of calls using the MPDS.

Analysis of dispatch data

We retrieved the following data from ProQA for each of the 176 calls:

1. **Breathing status** entered by call-takers, chosen from four possible options (breathing, not breathing, ineffective, unknown).
2. **OHCA recognition**: we considered that OHCA was recognised at dispatch in the presence of at least one of the following elements: (a) The dispatch code indicated cardiac arrest, (b) MPDS protocol steps for CPR were taken, (c) Two Priority 1 ("lights and siren") paramedic-staffed ambulances were dispatched, as SJA-WA automatically allocate dual responses to suspected cardiac arrest cases.

Initial breathing assessment is the first opportunity to recognise OHCA. However, OHCA can also be recognised later in the call[16] for patients initially coded as breathing.

Additionally, we investigated the timing of the **breathing sequence**. The breathing sequence is defined as the pair formed by the call-taker's question ("*is s/he breathing?*") and the caller's response (e.g., "*no*"). It can include a third turn,[21, 22] i.e., an additional utterance expanding or closing the sequence after the caller's response (e.g., "*okay so not breathing*"). Two measures of timing were taken:

1. Time to breathing sequence (from call start to call-taker's question),
2. Duration of breathing sequence (from call-taker's question to caller's response, or to third turn if present).

Linguistic analysis

The calls were transcribed following the methodology of Conversation Analysis.[23] We coded caller response to the question "*is s/he breathing?*" using a coding scheme[24] developed for a cross-linguistic study of question-answer pairs.[25] Caller response was classified into two categories (response type):

1. **Answers** directly addressed the terms of the question. Answers could be a confirmation ("*she is*") or a disconfirmation ("*no*"). We refer to confirming answers globally as *yes*-answers, and to disconfirming answers as *no*-answers.
2. **Non-answer responses** did not directly address the terms of the question ("*I don't know*").

Additionally, we coded caller answers as **qualified answers** if they contained any words modifying them ("*but gasping"*, "*sort of"*), and as **plain answers** otherwise.

Statistical analysis

We used logistic regression to analyse the relationship between response type and OHCA recognition. Time measures were summarised as medians and interquartile ranges (IQR). The Mann–Whitney U test was used to compare the differences in medians by group (OHCA recognised vs. not recognised) for continuous variables (time). A *p*-value <0.05 was considered statistically significant.

Ethics

Approval for the study was granted by the Human Research Ethics Committee of Curtin University (HR128/2013) and the SJA-WA Research Advisory Group.

Results

Among all cases (recognised and non-recognised), the breathing question received an answer in 89% (157/176) of calls and a non-answer response in 11% (19/176) of calls (see Appendix A for examples). Among the 157 calls where the response was categorised as an 'answer', more callers gave a *yes*-answer (113 calls) than a *no*-answer (44 calls). Thus, 64% (113/176) of the patients were initially reported by callers as breathing (Table 1). OHCA was recognised in 28% (32/113) of calls with a *yes*-answer, 95% (42/44) of calls with a *no*-answer, and 79% (15/19) of calls with a non-answer response.

Callers often volunteered additional details: 32% (51/157) of answers to the breathing question were qualified (Table 1). Qualification was found in 44% (50/113) of *yes*-answers. Most of these qualified *yes*-answers (32/50) were composed of two parts: a response particle (*yes*/*yeah*/*yep)* and/or partial repeat (*s/he is*), as well as a qualification of this confirmation of breathing ("*but gasping*"). Some qualified *yes*-answers (18/50) solely expressed the qualification ("*only just*"), yet logically implying a confirmation of breathing. In these qualifications, callers described problematic aspects of the patients' breathing: questioning its very presence ("*yep just*"), difficulty ("*yes but she's battling*"), irregularity ("*uh intermittently*"), abnormal depth ("*very- faint noises*"), unusual sounds ("*yes he's snoring*"), or mentioning another symptom causing them concern ("*breathing he's a bit grey*"). Only 2% (1/44) of *no*-answers were qualified ("*no he's not really he's got a little breath here and there but that's-*").

Despite the fact that qualified *yes*-answers were suggestive of agonal breathing, they were treated similarly to plain *yes*-answers. Call-takers entered in ProQA that the patient was breathing after 94% (47/50) of qualified *yes*-answers and 94% (59/63) of plain *yes*-answers.

OHCA was subsequently recognised in 22% (14/63) of calls with a plain *yes*-answer and in 36% (18/50) of calls with a qualified *yes*-answer. The odds of OHCA recognition were not significantly higher following a qualified *yes*-answer rather than a plain *yes*-answer (Odds Ratio 1.96; 95% Confidence Interval 0.86-4.57; *p*=0.11).

Overall, the median time to the breathing sequence was 56 seconds (IQR 44-72) from call start, and the median duration of the breathing sequence was 5 seconds (IQR 3-10). The median duration of the breathing sequence was significantly shorter (p<0.001) in calls where OHCA was not recognised (median 4 seconds, IQR 3-7) than in calls where OHCA was recognised (median 7 seconds, IQR 4-12).

Discussion

This study identified an important area for improvement in emergency medical call-taking. In a dispatch system using the MPDS with known descriptors of agonal breathing, we found a substantial number of missed opportunities to recognise agonal breathing. When callers gave a plain *yes*-answer ("*she is*"), there was little reason to suspect cardiac arrest from this response alone. However, there is considerable room for improvement for calls in which callers gave a qualified *yes*-answers ("*yes gasping*"). These answers, found in 37% (32/87) of non-recognised OHCA cases, were suggestive of agonal breathing. Yet, in 94% of cases they were interpreted by call-takers as confirmations that the patient was breathing, and their use did not significantly increase the odds of OHCA recognition. As the calls were stratified for OHCA recognition, our results are not representative of the whole population of OHCA cases. However, our study design enabled us to identify qualified *yes*-answers as a problem category requiring further attention.

We argue that, on top of the challenge of recognising agonal breathing, call-takers also faced a linguistic difficulty. The descriptors of agonal breathing typically appeared in sentences confirming breathing, often right next to the word "yes". This linguistic environment was inherently ambiguous, as qualified *yes*-answers confirmed that the patient was breathing while undermining this confirmation at the same time. It is unreasonable to expect lay callers to know that agonal breathing is not effective breathing. However, a lay caller will typically realise that the patient's breathing is not normal. It is thus logical that they would describe it as a *type* of breathing[8]. Therefore, we should expect callers to describe agonal breathing as a confirmation ("*yes but he's gasping*") rather than a disconfirmation ("*no he's gasping*", invented example).

A linguistic perspective can explain in part the mismatch that we identified between what callers said and how it was treated by call-takers. Research on spontaneous conversation has identified a social preference for confirming answers to questions: it is much more common for speakers to answer "*yes*" after polar questions ("yes-no questions") than to answer "*no*". A study conducted on 10 languages[25] found that between 72% (in English[26]) and 88% (in Korean[27]) of polar questions were answered with a confirmation. This is explained as a preference for agreement between two speakers interacting,[28, 29] in an effort to promote social solidarity. In the context of cardiac arrest, our findings suggest that lay callers only

report the patient as not breathing when they are sure of their assessment (rightly or wrongly). If they have doubts, they tend to report the patient as breathing, but qualify this confirmation. Our results suggest that this is typically where descriptions of agonal breathing fall, which seems to negatively impact on recognition.

Our results on timing suggest a mismatch between the linguistic complexity of caller answers and their interpretation at dispatch. In our data, the breathing sequence was completed in mere seconds (median 5 seconds). This is positive news from the point of view of dispatch efficiency, but raises questions regarding dispatch accuracy. A previous study on the MPDS[30] found that the median time to establish the patient's age was 5.5 seconds (IQR 3-9). Given how important breathing assessment is for OHCA recognition, it is troubling that, during case entry, the same amount of time is devoted to the patient's age and their breathing status. Our result that the median duration of the breathing sequence was 3 seconds shorter in calls where OHCA was not recognised suggests the importance of taking enough time to listen to caller responses, and especially to what may follow the words "*yes*" or "*s/he is*".

Outside of their professional role, call-takers would be less likely to be misled into thinking in terms of absolute "yes" and "no" answers. If they proposed marriage to their partner who responded "*yes, sort of*", they would probably assign meaning to the qualification and not consider the answer as a clear and resounding "yes". But because dispatch protocols are necessarily structured as decision trees, call-takers are on the lookout for "yes-or-no" answers, and thereby tempted to indiscriminately interpret any "*yes*" answer as indeed a "yes". This is illustrated in Extracts 7 and 8 in Appendix A: in both instances, the call-taker did not treat the caller's response as satisfying, and pursued a "yes-or-no" answer.[31]

Call-taker training targeted at agonal breathing has been shown to increase OHCA recognition and the frequency of telephone-CPR.[2, 32] We recommend, based on our retrospective analysis of initial breathing assessment in OHCA calls, that call-takers be trained to be attentive to any qualifications following a breathing confirmation, whether callers say or imply "yes". Future research is needed to prospectively test the effects on dispatch accuracy of implementing this recommendation. It would also be valuable to compare how lay callers describe the patient's breathing in OHCA calls to other calls.

As previously recommended in the literature,[18] our results emphasise the importance of listening to the details of what callers say. In their commentary[33] about recent changes to the MPDS (version 13.0), Clawson & Patterson discussed how a second-party caller (a bystander) may say the words "can't breathe" to describe ineffective breathing, but the same words coming from a first-party caller (the patient) who is able to utter them are more appropriately described as breathing with difficulty, rather than breathing ineffectively. Our study provides further support to the notion that linguistic context matters.

Emergency ambulance telephone calls represent something of a black box in terms of research on prehospital care for OHCA. While the literature has identified the need to focus on communication difficulties during calls,[10, 30, 34] relatively little is known about what specific aspects of the dialogue between callers and call-takers impact dispatch accuracy and

timeliness. Data-driven, observational studies can contribute to the identification of "hurdles",[35] i.e., common communication difficulties experienced at certain points during the calls. Rather than defining a priori what the difficulties are, a linguistic analysis of what is said during the calls, and how it is said, can provide valuable insight into the difficulties that are actually encountered, and how to resolve them. Following this preliminary step, the hypotheses generated can then be tested prospectively. Our observational study contributes to the first part of this process, in generating the hypothesis that a certain aspect of the language used by callers is challenging for call-takers during initial breathing assessment, which seems to negatively impact dispatch performance.

A caveat of our study is the assumption that the patients had already arrested before the start of the call. By definition of our cohort, all patients were confirmed by paramedics as having arrested at the time of their arrival at the scene, however, some patients may have arrested in the interval between the start of the call and when paramedics arrived. We sought to minimise this possibility by excluding cases in which there were unequivocal signs that the patient was still conscious (as evidenced through their voice being heard during the call).[19] Another caveat of this study is that it was conducted on a sample of calls stratified by OHCA recognition. Though our sample size of 176 calls stands in the upper range of previous studies analysing the dialogue between caller and call-taker in OHCA calls (e.g., 21 calls,[10] 47 calls,[30] 82 calls,[18] 100 calls,[12] 267 calls[36]), it does not preclude potential issues of representativeness.

Conclusion

Analysing a sample of emergency ambulance calls stratified by recognition of OHCA, this study identified a problem with call-taker interpretation of breathing status, resulting in potential delays in cardiac arrest response time. When asked whether the patient was breathing, lay callers often responded with words typically associated with agonal breathing, such as "gasping". Yet, call-takers overwhelmingly considered these answers as confirmations that the patient was breathing. We argue that the linguistic format of these qualified breathing confirmations ("*yes but gasping*") was challenging for call-takers because of their inherent ambiguity. We propose that dispatch performance could be improved if call-takers spent more time assessing breathing status and were trained to listen closely for any qualification that callers express when they report the patient as breathing. This is irrespective of whether "yes" is said or implied, as this is how lay callers typically describe agonal breathing.

Appendix A. Extracts from the calls.

Plain *yes*-answer

Extract 1 (SJA021)

1 CT: and he's breathing?
2 C: (.) yeah.

Extract 2 (SJA362)

1 CT: is he breathing.
2 C: he is.

Qualified *yes*-answer

Extract 3 (SJA336)

1 CT: he's breathing?
2 C: yes but u:h laboured.

Extract 4 (SJA505)

1 CT: and is he breathing.
2 C: (.) barely.

***No*-answer**

Extract 5 (SJA279)

1 CT: is he breathing.
2 C: NO:.

Non-answer response

Extract 6 (SJA162)

1 CT: is he breathing?
2 C: (.) I don't know.

Pursuing a yes-or-no answer

Extract 7 (SJA247)

1 CT: now is he brea⌈thing ⌉.
2 C: ⌊please ⌋.
3 (.) I don't think so.
4 CT: (.) is he breathing or not.
5 I need a yes or a no.
6 C: ((SOBS))
7 CT: (.) is he NOT sir or is he?
8 C: *I don't think so*

Extract 8 (SJA493)

1 CT: is he breathing?
2 C: ye:s.
3 sort of.
4 CT: (.) okay.
5 yes or no is he breathing.
6 C: (..) u:::h yes.

Transcription conventions

CT:	speaker identification: call-taker
C:	speaker identification: caller
(.)	very short pause
(..)	short/medium pause
:	lengthening
[ ]	overlap with following turn
⌊ ⌋	overlap with previous turn
?	final rising intonation
.	final falling intonation
WORD	louder volume, shouted segment
°word°	lower volume, whispered segment
word	segment said sobbing
((SOBS))	non-linguistic sound or anonymised content

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Legend to figures

Fig. 1. Data collection flowchart.

Fig. 2. Overall structure of calls with the Medical Priority Dispatch System.

Fig. 1. Data collection flowchart.

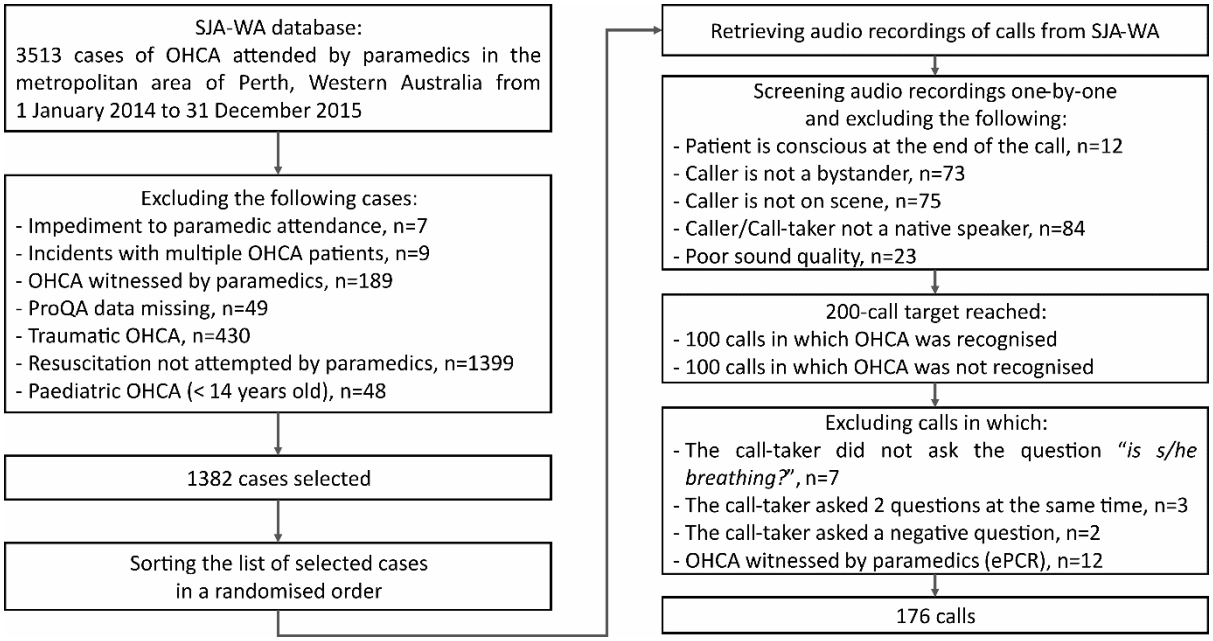

Fig. 2. Overall structure of calls with the Medical Priority Dispatch System.

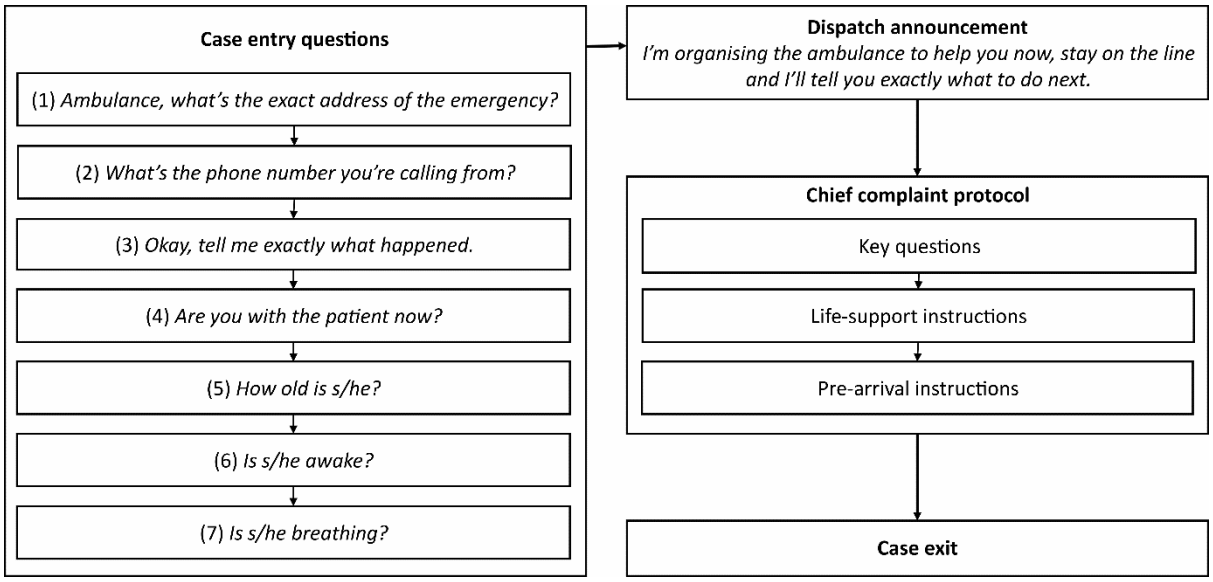

Table 1.

Caller response type in reply to the question "*is s/he breathing?*" by breathing status entered by call-takers.

A. **All calls (irrespective of whether OHCA was recognised by the call-taker or not)**					
	Breathing: Yes	Breathing: No	Breathing: Ineffective	Breathing: Unknown	Total
Yes-answer	106	2	3	2	113
Plain	59	1	1	2	63
Qualified	47	1	2	0	50
No-answer	4	39	1	0	44
Plain	4	39	0	0	43
Qualified	0	0	1	0	1
Non-answer/no response	8	11	0	0	19
Total (column)	118	52	4	2	176
B. **Calls in which OHCA was recognised by the call-taker**					
	Breathing: Yes	Breathing: No	Breathing: Ineffective	Breathing: Unknown	Total
Yes-answer	28	2	2	0	32
Plain	12	1	1	0	14
Qualified	16	1	1	0	18
No-answer	2	39	1	0	42
Plain	2	39	0	0	41
Qualified	0	0	1	0	1
Non-answer/no response	4	11	0	0	15
Total (column)	34	52	3	0	89
C. **Calls in which OHCA was not recognised by the call-taker**					
	Breathing: Yes	Breathing: No	Breathing: Ineffective	Breathing: Unknown	Total
Yes-answer	78	0	1	2	81
Plain	47	0	0	2	49
Qualified	31	0	1	0	32
No-answer	2	0	0	0	2
Plain	2	0	0	0	2
Qualified	0	0	0	0	0
Non-answer/no response	4	0	0	0	4
Total (column)	84	0	1	2	87