The continuous quality improvement project for telephone-assisted instruction of cardiopulmonary resuscitation increased the incidence of bystander CPR and improved the outcomes of out-of-hospital cardiac arrests

The Continuous Quality Improvement Project for Telephone-Assisted Instruction of Cardiopulmonary Resuscitation Increased the Incidence of Bystander CPR and Improved the Outcomes of Out-of-Hospital Cardiac Arrests

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Review: In 2007, the Ishikawa Medical Control Council initiated the Continuous Quality Improvement (CQI) project for telephone-assisted cardiopulmonary resuscitation (telephone-CPR), which included instruction on chest-compression-only CPR, education on how to recognise out-of-hospital cardiac arrests (OHCAs) with agonal breathing, emesis and convulsion, recommendations for on-line or redialling instructions, and feedback from emergency physicians. This study aimed to investigate the effect of this project on the incidence of bystander CPR and the outcomes of OHCAs.

Materials and Methods: The baseline data were prospectively collected on 4995 resuscitation-attempted OHCAs, which were recognised or witnessed by citizens rather than emergency medical technicians during the period of February 2004 to March 2010. The incidence of telephone-CPR and bystander CPR, as well as the outcomes of the OHCAs, were compared before and after the project.

Results: The incidence of telephone-CPR and bystander CPR significantly increased after the project (from 42% to 62% and from 41% to 56%, respectively). The incidence of failed telephone-CPR due to human factors significantly decreased from 30% to 16%. The outcomes of OHCAs significantly improved after the projects. A multiple logistic regression analysis revealed that the CQI project is one of independent factors associated with one-year (1-Y) survival with favourable neurological outcomes (odds ratio = 1.81, 95% confidence interval = 1.20-2.76).

Conclusions: The CQI project for telephone-CPR increased the incidence of bystander CPR and improved the outcome of OHCAs. A CQI project appeared to be essential to augment the effects of telephone-CPR.

Keywords: Telephone-CPR; Continuous quality improvement; Cardiopulmonary resuscitation; Dispatcher; Emergency medical service; Out-of-hospital cardiac arrest

INTRODUCTION

Currently, medical control (MC) for the emergency medical service system (EMS) is active in Japan. However, MC, including education, is mainly targeted to emergency medical technicians (EMTs) and is rarely targeted to dispatchers in Japan. Since February 2004, the Ishikawa MC Council has requested that fire departments collect the reasons why dispatchers failed to provide telephone-assisted instruction on cardiopulmonary resuscitation (telephone-CPR). Telephone-CPR has been shown to increase the incidence of bystander CPR and is expected to improve the outcomes of out-of-hospital cardiac arrests (OHCAs) [1-5].

There are no special qualifications or authorisations required for fire department staff to be dispatchers in Japan. Some dispatchers have no experience as EMTs. An educational program for dispatchers has not been established. In some fire departments, the actual condition of the OHCA patient, discovered by EMTs during a post-arrival interview, is not relayed back to the dispatchers.

In March of 2007, the Ishikawa MC Council initiated the Continuous Quality Improvement (CQI) project for telephone-CPR. The project included the following: 1) a standardized manual for instruction on chest-compression-only CPR (CC-only CPR), 2) education on how to recognise OHCAs with agonal breathing [6,7], emesis [8] and convulsion [9,10], 3) recognition of an impending cardiac arrest [11], 4) recommendations for on-line or redialling instructions for patients with impending cardiac arrest [12,13], 5) instructions on the use of a cellular phone as a communication device at the scene [14], and 6) feedback from emergency physicians and EMT supervisors to dispatchers.

The purpose of this study was to investigate the effects of the CQI project on the incidences of telephone-CPR and CPR before EMT arrival. This study also investigated the effects of the project on the time factors and outcomes of individuals experiencing an OHCA that was recognised or witnessed by citizens and not witnessed by EMTs.

METHODS

The data were collected in accordance with the national guidelines of ethics for epidemiological surveys [15]. This study has been approved by the review board of the Ishikawa Medical Control Council.

Populations and setting

The Ishikawa prefecture encompasses a snowfall area of 4,186 km^2 and has a resident population of 1,170,000. The prefecture is divided into four administrative regions: one central or urban region and three semi-rural or rural regions. Sixty-two percent of the residents are located in the central (urban) region, which has an area of 1,432 km^2. The age of the population is more advanced in rural regions (28.5% vs. 20.3% over the age of 65).

EMTs resuscitate patients experiencing an OHCA according to the protocol developed by the Ishikawa Medical Control Council, which is based on the guidelines of the American Heart Association and the Japan Resuscitation Council. The paramedics are authorised to perform the following procedures during the resuscitation: (1) use a semi-automated external defibrillator, (2) use a supra-pharyngeal airway and (3) the infusion of Ringer's lactate. Since July 2004, specially trained paramedics have been permitted to insert tracheal tubes under limited indication criteria [16], and since April 2006, they have been permitted to administer intravenous adrenaline. The EMTs are not permitted to terminate resuscitation in the field. All resuscitation-attempted victims are transported to hospitals. EMS changes over time are summarised in Fig. 1.

CQI project for telephone-CPR

Since February 2004, telephone-CPR has been conducted by all fire departments (Fig. 1), and the reasons why dispatchers failed to attempt the telephone-CPR have been recorded prospectively (Fig. 3). Our CQI project was based on the prior analysis of the reasons for failure followed by planning and preparing for the project's implementation. Our project was implemented in March 2007 and is presently being continued. The project consists of the following: 1) enforcement of a uniform telephone-CPR manual for CC-only CPR, 2) a standard educational approach on how to detect and recognise OHCAs with agonal breathing [6,7], emesis [8] and anoxic seizure [9,10] as well as an impending cardiac arrest [11], 3) behaviour modification for dispatchers, and 4) conferences between EMTs and dispatchers to resolve discrepancies in their information. The telephone-CPR manual states the following. 1) Telephone-CPR may be initiated by obtaining other information about the situation and events suggestive of cardiac arrest, even when a caller is not able to judge whether an OHCA victim is responsive or breathing normally. 2) When snoring, vomiting and abnormal motions are preferentially described by the caller, a dispatcher should ask for evidence of agonal breathing, emesis or regurgitation and anoxic seizures associated with cardiac arrest. For example, "Is the victim unresponsive, unconscious, or breathing abnormally?" and "Has the victim vomited (or moved abnormally) before becoming unresponsive (or pale)?" or "Are you only seeing the vomitus on the victim's face or floor?" 3) A dispatcher should request that the caller redial them via a mobile or wireless phone when they are not beside the OHCA victim. 4) A dispatcher should request that the caller redial them if they notice any changes in the patient with impending cardiac arrest, or the dispatcher should call back the caller periodically, when there are sufficient resources.

New programs were introduced in prefectural school, and simulation trainings for dispatchers in fire departments were included in the educational approach. Telephone-CPR quality was evaluated in all OHCAs by emergency physicians and EMT supervisors, and their evaluations, including an appreciative comment, were given as feedback to the dispatchers.

Patient data

Baseline data were collected prospectively by fire departments for 4995 resuscitation-attempted OHCAs that were witnessed or recognised by citizens rather than EMTs from 1 February 2004 to 31 March 2010. The collected data were based on the Utstein template [17,18] and included the patient's backgrounds, arrest witness, causes of arrest (presumably cardiac or not), bystander CPR, initial cardiac rhythm, estimated time of collapse, times of the initiation of CPR by bystanders and EMTs, and EMT arrival on the scene, sustained return of spontaneous circulation (SROSC), one-month (1-M) survival, one-year (1-Y) survival and 1-Y survival with a favourable neurological outcome, as determined by the Pittsburgh cerebral performance category (CPC) [19]. The SROSC is defined as the continuous presence of palpable pulses for more than 20 min [17,18]. The survival rate at 1-Y was defined as the patient being alive in a hospital at 1-Y or as the patient being alive and discharged from the hospital to a home or to a care or rehabilitation facility within 1-Y. One-year survival with a favourable neurological outcome was defined as a CPC of one (good recovery) or two (moderate disability) in patients without any neurological disturbance before the arrest event and when the best CPC was equal to the pre-arrest category in patients with neurological disturbance. The primary end point was 1-Y survival with a favourable neurological outcome. The secondary end points were SROSC, 1-M survival and 1-Y survival.

When telephone-CPR was not attempted during an OHCA, the causes of failure were analysed by reviewing voice recordings and/or dispatch reports as well as the EMT's interview records for callers. Supervisors and emergency physicians involved in the project classified the reasons for failure into two categories: unpreventable factors related to the callers and the scenes and preventable human factors related to the dispatchers.

We compared the incidences of telephone-CPR and CPR before EMT arrival as well as the outcome of OHCAs between two time periods: before (1 February 2004 to 28 February 2007) and after the initiation of the project (1 March 2007 to 31 March 2010).

Statistical analysis

We analysed the data using JMP ver. 7 for Windows (SAS institute, Cary, NC). The chi-squared test with and without a Pearson's correction was applied for the univariate analyses. The Kruskal-Wallis test was used for non-parametric comparisons. We used a multiple logistic regression analysis to identify the factors associated with outcome. In all analyses, $P < 0.05$ was considered significant.

RESULTS

Incidence of CPR following telephone-CPR before and after the project

As shown in Fig. 1, the CQI project significantly increased the incidence of CPR following telephone-CPR from 24% to 42%. Regardless of whether CPR was initiated either under one's own initiative or following telephone-CPR, the incidence of CC-only CPR as a CPR method significantly increased after the project. Annual changes in the incidence of CPR before EMT arrival are shown in Fig. 2. Although the incidence of CPR before arrival has been continuously increasing, the increase appeared to be augmented by the project. As demonstrated in Fig. 3, the project significantly increased the incidence of telephone-CPR from 42% to 62%. Telephone-CPR was not attempted in some cases with impending cardiac arrest. The project decreased the incidence of failed attempts due to preventable human factors from 30% to 16% when the impending cardiac arrest was included in the preventable cause and from 25% to 12% when the impending arrest was independently categorised.

Background and management of OHCA patients before and after the CQI project (Table 1 and Fig. 1)

As shown in Table 1, there were differences in the background and characteristics of OHCA patients between the two time periods. The incidence of a presumed cardiac aetiology was significantly higher before the project (52% vs. 48%), and the patient's age was higher after the project (76 vs. 78). Witnessed OHCAs of a presumed cardiac aetiology and with a shockable initial rhythm more frequently occurred at the patient's home after the project (47% vs. 68%). Advanced CPR procedures including tracheal intubation (6% vs. 14%) and adrenaline administration (0.3% vs. 6%) were more frequently performed after the project.

As shown in Fig. 1, the incidence of CPR before EMT arrival was 41% before the project and increased to 56% after the CQI (Odds ratio = 1.75, 95% confidence interval = 1.57-1.96). Citizens more frequently used CC-only CPR after the project (67% vs. 83%).

Time factors and prognoses of OHCAs before and after the CQI project (Fig. 2 & Table 1)

As shown in Fig. 2, the incidence of SROSC and 1-Y survival with favourable neurological outcomes appeared to be augmented after the project, though a small drop in the incidence of SROSC was observed in the fiscal year term of 2009 having a larger number of OHCAs.

As shown in Table 1, the interval between the call and the initiation of CPR (by citizens or EMTs, whichever was performed first) significantly decreased after the project when analysed for all OHCAs. The interval between the witnessing or recognition of cardiac arrest and the call significantly increased after the project. For all OHCAs given CPR before EMT arrival, the interval between the call and CPR initiation by citizens was significantly reduced. The interval between the call and EMT arrival at the scene significantly increased after the project when analysed for all OHCAs. The incidence of 1-Y survival with a favourable neurological outcome was significantly improved after the project (1.9 % vs. 2.8 %, $p = 0.0443$) when analysed for all OHCAs. For the witnessed OHCAs with a presumed cardiac aetiology, having an initial shockable rhythm, the incidence of 1-Y survival (22.8 % vs. 35.7 %, $p =$

0.0243) and 1-Y survival with a favourable neurological outcome (16.3 % vs. 27.8 %, $p = 0.0276$) were significantly improved after the project.

Subcategorised comparisons of outcomes between the two time periods for OHCAs managed without prehospital advanced cardiac life support (ACLS) procedures (Fig. 4)

Because tracheal intubation and adrenaline administration have been shown to affect the outcomes of OHCAs [16,20-23], we analysed the effect of the project on the outcomes of OHCAs managed prior to hospital arrival without tracheal intubation or adrenalin administration. As shown in Fig. 4, we found a significant improvement in the outcomes of OHCAs after the project.

Elucidation of factors related to 1-Y survival with favourable neurological outcomes in all OHCAs (Table 2)

A multiple logistic regression analysis following a univariate analysis revealed that the CQI project is one of the independent factors related to 1-Y survival with favourable neurological outcomes. Decreased age, a witnessed cardiac arrest, cardiac arrests with a presumed cardiac aetiology, a shockable initial rhythm, a shorter response time and a shorter interval between the witnessing or recognition of cardiac arrest and a telephone call were other independent factors associated with favourable 1-Y survival. Adrenaline administration was an independent factor related to unfavourable 1-Y survival, while tracheal intubation was an independent factor that was not associated with favourable 1-Y survival.

DISCUSSION

Telephone-CPR has the potential to improve the frequency of bystander CPR [1-5]. To enhance the beneficial effect of telephone-CPR and reduce the "barriers" to telephone-CPR, educational approaches aimed at dispatchers and citizens are necessary [24-29]. Although teaching dispatchers to understand and recognise bystander descriptions of agonal respiration in patients with OHCA have been reported to result in a significant increase in the incidence of telephone-CPR [24,29,30], the effects of education on survival after OHCA have not been reported. To the best of our knowledge, this study is the first study to demonstrate the efficacy of the educational approach with the CQI project.

Our CQI project was based on the analysis of reasons why dispatchers failed to initiate telephone-CPR; presumably due to "cognitive bias", some callers interpret "snoring" breathing sounds, abnormal body motion and vomitus on the face or the floor as a "vital" sign of OHCA victims and preferentially describe them to a dispatcher. For example, "She/he is unhealthy but is snoring, moving or vomiting". This may interfere with a dispatcher's proper recognition of cardiac arrest and may lead to "no further exploration" by the dispatcher because snoring, abnormal motion or convulsions, and emesis are common symptoms of acute illnesses other than cardiac arrest [31,32]. These failures may

be minimised by teaching dispatchers that agonal breathing, anoxic convulsions and emesis or regurgitation often occur in OHCA patients [8-10,27-29]. We also realised that dispatchers frequently fail to attempt telephone-CPR for OHCAs that are witnessed after the emergency call. Although the telephone-CPR in these cases may be difficult, a dispatcher in fire departments with sufficient resources may attempt it by recognising prearrest signs and symptoms [11] and by redialling the caller periodically.

The incidence of CPR before EMT arrival was significantly increased after the project (Fig. 1). The increased frequency of CPR before EMT arrival is mainly due to the increased incidence of CPR performed following telephone-CPR (Fig. 2) and the decreased failure of telephone-CPR attempts due to preventable human factors related to the dispatchers (Fig. 3).

The time factors related to citizen-performed CPR were also improved by this project. The interval between the call and the initiation of CPR significantly decreased after the project. For OHCAs given CPR before EMT arrival, the interval between the call and CPR by citizens was significantly reduced. These favourable changes in time factors appear to be due not only to the increased incidence of citizen-performed CPR but also to the increased incidence of CC-only CPR because instruction on CC-only CPR accelerates the initiation of CC [12,33].

Some of the other time factors related to survival, including the intervals between the recognition or witnessing of cardiac arrest and the call and between the call and EMT arrival on the scene were significantly prolonged after the project. These unfavourable changes were not related to the CQI project and may be attributed to the increased age of the patients [34] and an increased number of dispatches in our region. Despite these unfavourable changes, a univariate analysis revealed that the outcomes of OHCAs were significantly improved after the project, even when subgroups of OHCAs and witnessed OHCAs with a presumed cardiac aetiology with a shockable initial rhythm were analysed independently (Table 1). A small decline of SROSC incidence was observed in the fiscal year beginning in February 2009 (Fig. 2). In this term, we had a larger number of OHCAs, and the interval between the call and the arrival on the scene was significantly prolonged, presumably due to unusually heavy snowfall in this winter.

The use of ACLS, including tracheal intubation and adrenaline administration, has been shown to affect the outcome of OHCAs [16,20-23]. We compared the outcomes between the two time periods for OHCAs managed prior to hospital arrival without prehospital ACLS procedures because the incidence of ACLS was higher after the project. We showed that the CQI project improved the outcome of OHCAs. We further confirmed the effect of the CQI project in all OHCAs using a multiple logistic regression analysis, which included all prehospital factors related to 1-Y survival. While tracheal intubation was not an independent factor associated with a favourable 1-Y survival, adrenaline administration was a

potent independent factor related to unfavourable 1-Y survival. These effects of ACLS procedures were carefully interpreted because the procedures were performed only by specially trained paramedics in Japan.

The risk of bystander CPR for patients not in cardiac arrest needs to be considered [35-38]. In this study, we did not determine how frequently telephone-CPR was attempted on patients who were not in cardiac arrest [39]. At present, no complications associated with telephone-CPR have been reported to the Ishikawa MC Council. We are now conducting surveillance of our telephone-CPR system and have reported the preliminary results of this analysis [40].

Limitations

Because this study was not randomised and not conducted in an on-off manner, the results of the outcome analysis might therefore be a result of coincidence. The CQI project was initiated shortly after the EMT protocol changed, according to the 2005 Consensus (C2005), and the improvement of patient management by EMTs, particularly the quality of chest compressions, may have influenced the outcome of OHCAs. However, starting in April 2003, the quality assurance of patient care by EMTs has been a main issue addressed by our MC Council.

CONCLUSIONS

The CQI project for telephone-CPR initiated shortly after the implementation of C2005 increased the incidence of CPR before EMT arrival and improved the outcomes of OHCAs in our community having the standard Japanese EMS system. These observations suggest that a CQI project is essential to improve the outcome of telephone-CPR.

CONFLICT OF INTEREST STATEMENT

We have no conflicts of interest to disclose.

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Figure legends

Figure 1　Changes in the EMS protocol and the incidence of CPR following telephone-CPR before and after the CQI project.
"CPR performed without telephone-CPR" means that CPR was performed by citizens on their own initiative despite the absence of telephone-CPR either before or after an emergency call. Percentage values for CC-only CPR are expressed as a fraction of the total number of CPR cases for the "CPR performed without telephone-CPR" and "CPR performed following telephone-CPR" groups.

Figure 2　Annual changes in the incidence of CPR prior to EMT arrival and patient outcomes.
The number of OHCA dispatches are shown in numeric values. The interval between the call and EMT arrival on the scene (response time) is shown as a median (25-75%) value.

Figure 3　Incidences of telephone-CPR and failure due to preventable factors before and after the CQI project.
All percentage values are expressed as a fraction of all OHCAs.

Figure 4　Subcategorised comparisons of the outcomes between the two time periods for OHCAs managed without prehospital ACLS procedures.
★ significant difference between the two times periods (using a chi-squared test with and without Person's correction.)

Start of medical control & EMT protocol according to G2000

April, 2003

Analyze reasons why dispatchers failed to attempt telephone-CPR

Feb, 2004

Tracheal intubation by qualified paramedics

July, 2004

EMT protocol change according to C2005

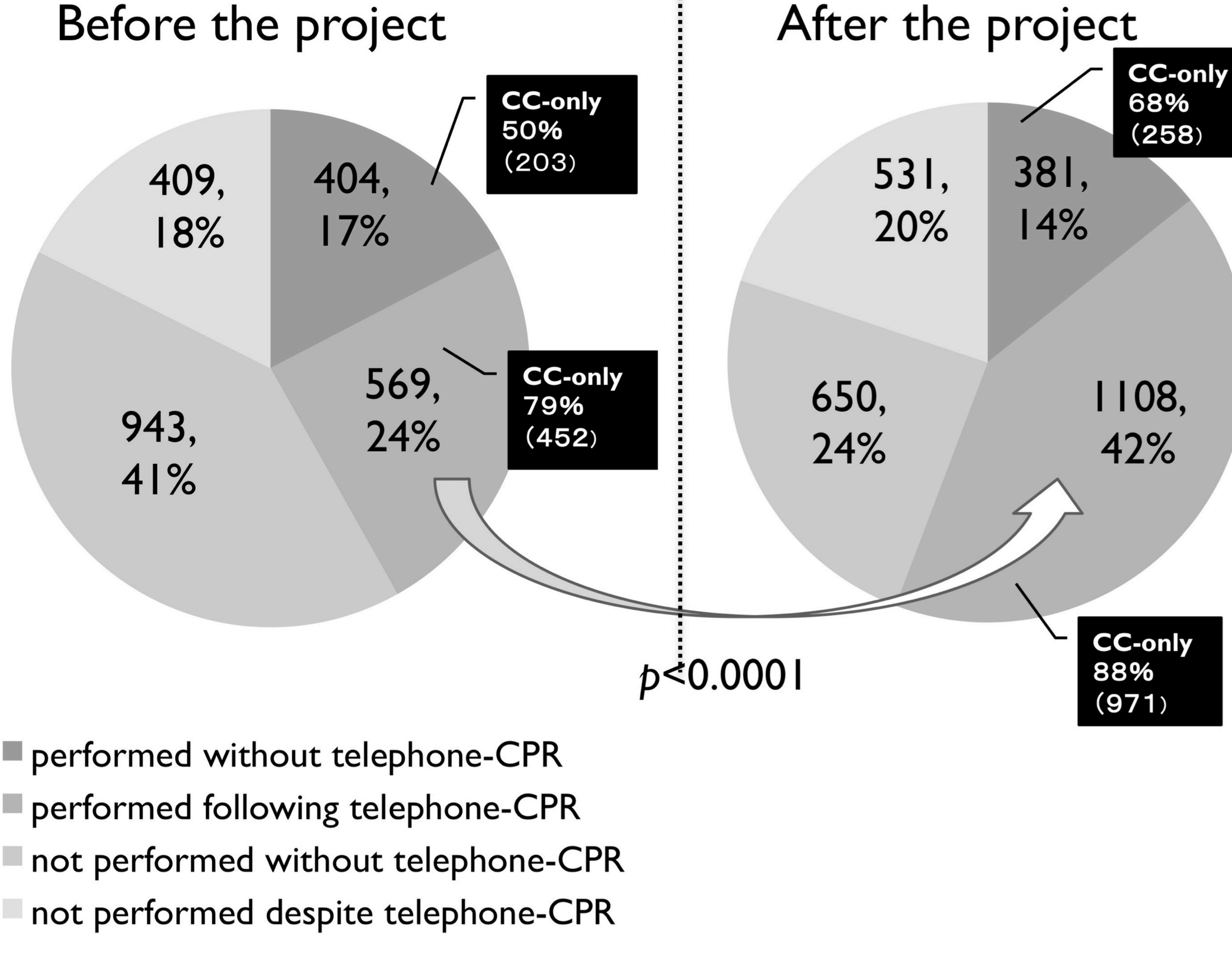
June, 2006

CQI project for telephone-CPR

March, 2007

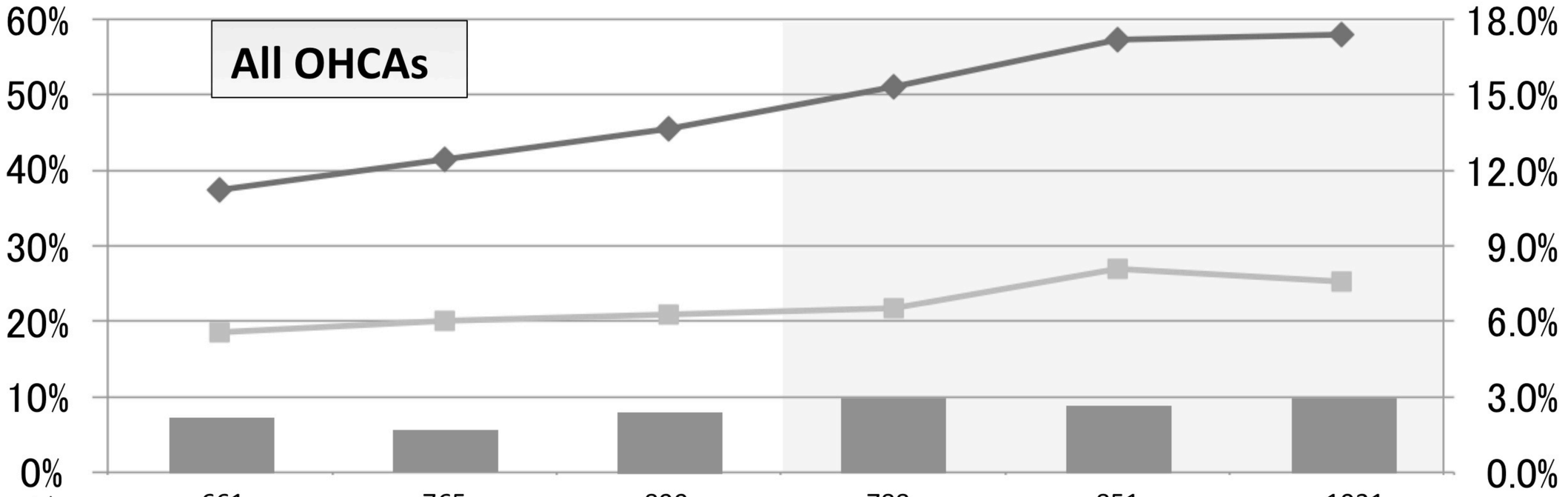
Adrenalin administration by qualified paramedics

April, 2006

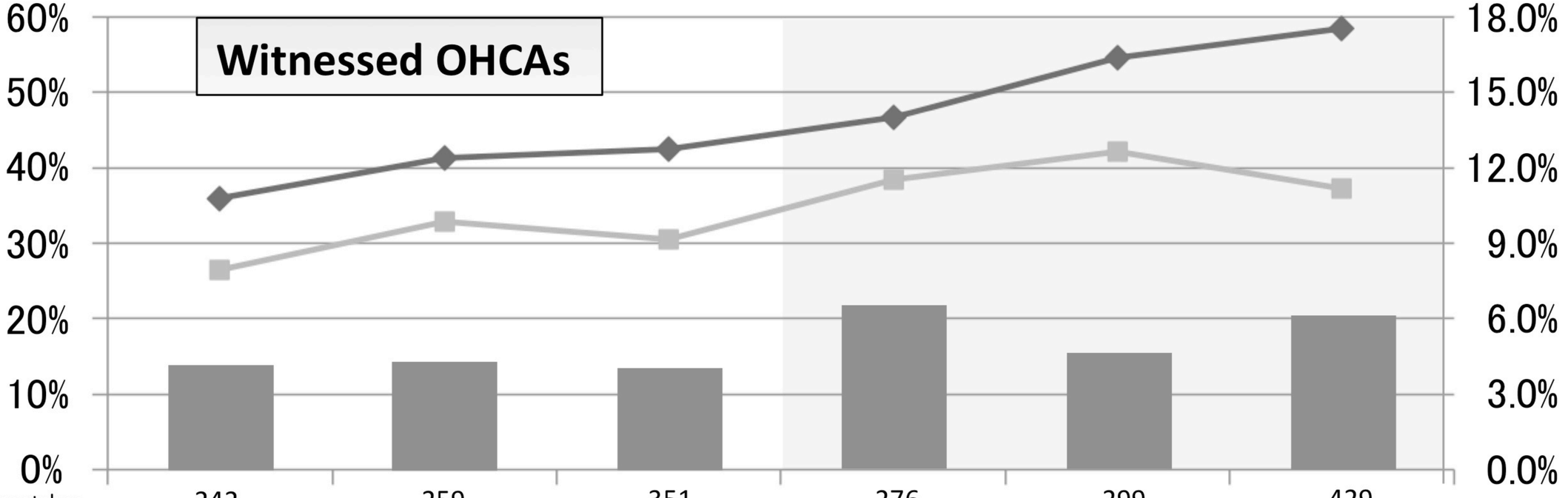


Line graph

Bar graph



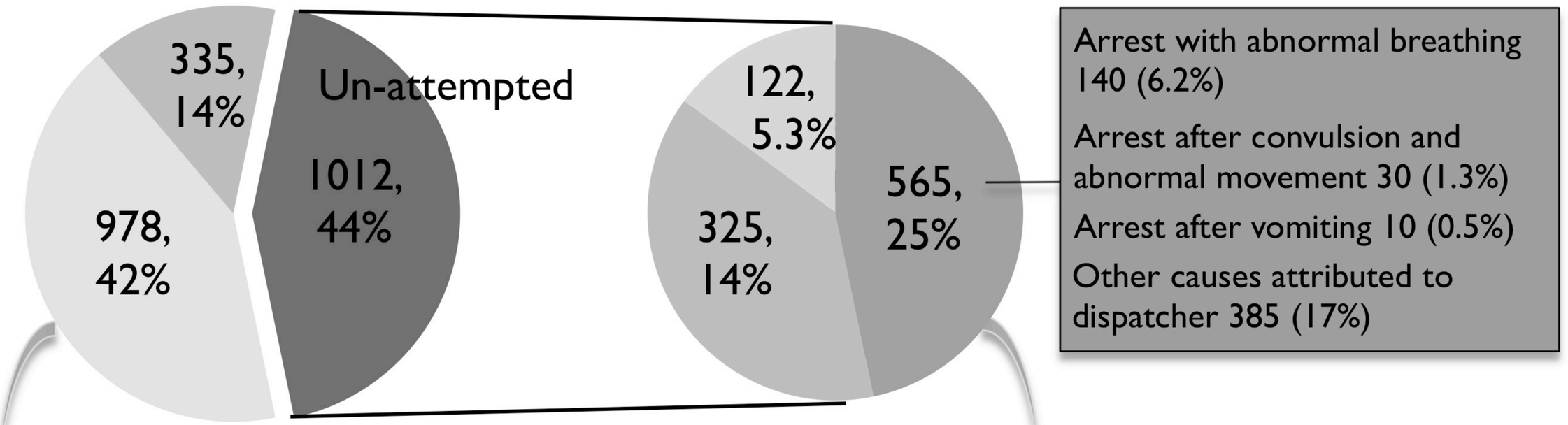
Number of dispatches	661	765	899	788	851	1031
Response time (min), Median (25-75%)	7 (5-10)	7 (5-10)	8 (6-10)	7 (6-10)	7 (6-10)	8 (6-10)



Number of dispatches	242	259	351	276	299	429
Response time (min), Median (25-75%)	7 (5-11)	7 (5-9)	8 (6-10)	7 (6-10)	7 (6-10)	8 (6-10)
	2004.2.1−	2005.2.1−	2006.2.1−	2007.3.1−	2008.3.1−	2009.3.1−

◆ CPR before EMT arrival ■ SROSC Bar graph 1-Y survival with favourable neurological outcomes

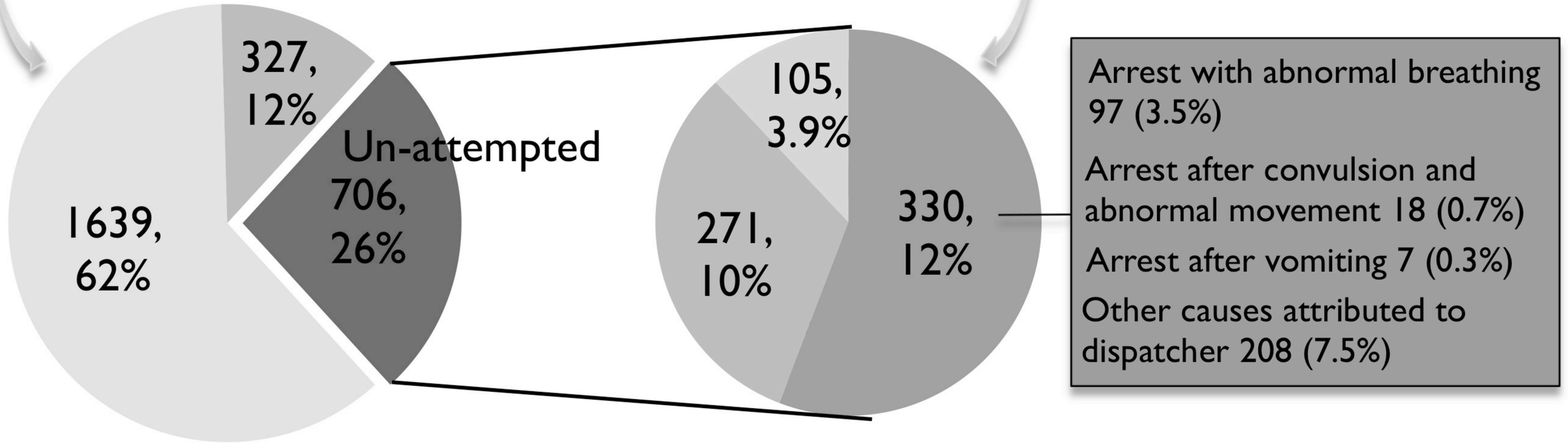
Before the project



p <0.01

p <0.05

After the project



- Telephone-CPR was not attempted as a bystander had already initiated CPR
- Telephone-CPR attempted
- Preventable factors
- Unpreventable factors
- Arrest after call (impending cardiac arrest)

All OHCAs (N=4356)

30%
20%
10%
0%

shockable initial rhythm
SROSC
1-M
1-Y
1-Y with favourable neurological outcomes

Witnessed OHCAs with a presumed cardiac aetiology and shockable initial rhythm (N=230)

60%
40%
20%
0%

shockable initial rhythm
SROSC
1-M
1-Y
1-Y with favourable neurological outcomes

before the project
after the project

Table 1 Background, time factors and management of OHCAs before and after the CQI project

Background, characteristics and management	All OHCAs			Witnessed OHCAs with a presumed cardiac aetiology with a shockable initial rhythm		
	Before the project (N = 2325)	After the project (N = 2670)	*p*	Before the project (N = 23)	After the project (N = 126)	*p*
Arrest - witnessed, % (N)	37% (852)	38% (1004)	*p*=0.4846	-	-	undefined
Aetiology - presumably cardiac, % (N)	**52% (1199)**	**48% (1269)**	***p*=0.0044**	-	-	undefined
Location - Home, % (N)	66% (1537)	67% (1796)	*p*=0.3862	**47% (58)**	**68% (86)**	***p*=0.0007**
Sex - male, % (N)	60% (1402)	59% (1583)	*p*=0.4666	81% (99)	74% (93)	*p*=0.2090
Age, y median (25%-75%)	**76 (63-84)**	**78 (65-85)**	***p*<0.0001**	63 (55-72)	64 (54-75)	*p*=0.4808
Region - central (urban), % (N)	47% (1096)	50% (1326)	*p*=0.0751	60% (74)	54% (68)	*p*=0.3233
Tracheal intubation, % (N)	**6% (143)**	**14% (367)**	***p*<0.0001**	4% (5)	8% (10)	*p*=0.1949
Adrenalin, % (N)	**0.3% (8)**	**6% (166)**	***p*<0.0001**	**0% (0)**	**6% (7)**	***p*=0.0018**
Call to CPR by citizens, min median (25%-75%) N	**1 (-1-2) N=973**	**0 (-1-1) N=1489**	***p*<0.0001**	0.5 (-1-2) N=66	0.5 (0-2) N=80	*p*=0.4707
Call to first CPR*, min median (25%-75%)	**5 (1-8)**	**2 (0-8)**	***p*<0.0001**	3 (0-7)	2 (0-7)	*p*=0.8577
Call to arrival at patient, min median (25%-75%)	**7 (6-10)**	**8 (6-10)**	***p*=0.0069**	7 (5-9)	8 (6-9)	*p*=0.2356
Witness/recognition to call, min median (25%-75%)	**2 (1-5)**	**3 (1-6)**	***p*<0.0001**	**1 (0-2)**	**2 (1-3)**	***p*=0.0125**
Duration of transportation, min median (25%-75%)	**8 (5-12)**	**9 (6-13)**	***p*=0.0014**	9 (6-13)	9 (5-12)	*p*=0.9538
1-Y survival, % (N)	3.2% (74)	4.2% (112)	*p*=0.0595	**22.8% (28)**	**35.7% (45)**	***p*=0.0243**
1-Y survival with favourable neurological outcome, % (N)	**1.9% (45)**	**2.8% (75)**	***p*=0.0443**	**16.3% (20)**	**27.8% (35)**	***p*=0.0276**

* first CPR: CPR by citizens or EMTs, whichever was performed first.

Table 2 Factors related to 1-Y survival with a favourable neurological outcome for all OHCAs

Factors	Survivors (N = 120)	Nonsurvivors (N = 4875)	Unadjusted odds ratio (95% C.I.) for survival or *p* value	Adjusted odds ratio (95% C.I.) for survival by multiple logistic regression
Patient's age, median (25%-75%)	63 (52-76)	77 (64-85)	*p*<0.0001	0.97 (0.96-0.98)
Sex - male, % (N)	66% (79)	60% (2906)	1.31 (0.89-1.91)	1.24 (0.80-1.57)
Location - home, % (N)	58% (70)	67% (3263)	0.69 (0.48-1.00)	0.96 (0.64-1.46)
Region - central, % (N)	58% (69)	48% (2353)	1.45 (1.01-2.09)	1.05 (0.69-1.59)
Arrest - witnessed, %(N)	78% (94)	36% (1762)	6.38 (4.12-9.90)	3.36 (2.10-5.53)
Aetiology - presumably cardiac, %(N)	73% (87)	49% (2381)	2.76 (1.84-4.14)	1.32 (0.81-2.17)
Initial rhythm - shockable, %(N)	58% (69)	6.5% (317)	19.45 (13.31-28.43)	9.32 (5.84-15.00)
CPR before EMT arrival, %(N)	59% (71)	49% (2391)	1.51 (1.04-2.18)	1.24 (0.69-2.12)
Call to arrival at patient, min median (25%-75%)	6 (5-8)	8 (6-10)	*p*<0.0001	0.88 (0.83-0.93)
Witness/recognition to call, min median (25%-75%)	2 (1-3)	2 (1-5)	*p*<0.0001	0.93 (0.90-0.98)
Call to first CPR*, min median (25%-75%)	2 (0-6)	4 (0-8)	*p*=0.0016	0.98 (0.92-1.00)
Duration of transportation, min median (25%-75%)	9 (5-14)	8 (5-13)	*p*=0.5973	1.00 (1.00-1.02)
CQI project, %(N)	63% (75)	53% (2595)	1.46 (1.01-2.13)	1.81 (1.20-2.76)

* first CPR: CPR by citizens or EMTs, whichever was performed first.