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The Dispatcher Assisted Resuscitation Trial: Indirect Benefits of Emergency Research

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Abstract

Objective—Conduct of emergency research under waiver of consent produces special challenges. Moreover, the act of performing research may have unintended effects, potentially beneficial or detrimental. The Dispatcher-Assisted Randomized Trial (DART) was designed to compare 2 types of dispatcher cardiopulmonary (CPR) instruction, but not intended to affect the proportion of arrest victims that received bystander CPR. We sought to determine whether odds of receiving bystander CPR were higher during DART than during the periods before and after.

Methods—We conducted an observational cohort study of 8,626 adults who suffered non-traumatic out-of-hospital cardiac arrest prior to emergency medical services (EMS) arrival in greater King County, Washington, between January 1, 1999, and December 31, 2011. Bystander CPR status was assessed through review of dispatch recordings and EMS reports to classify any bystander CPR (any B-CPR), and further categorized as bystander CPR with or without dispatcher assistance (DA-CPR and B-CPR, no DA). We used multivariable logistic regression to evaluate odds of B-CPR before, during, and after DART.

Results—The proportions receiving any B-CPR were 52% before DART (1817/3468), 59% during DART (2093/3527), and 54% after DART (885/1631). Compared to the period *before* DART, odds of receiving any B-CPR were higher *during* DART (OR=1.35, 95% CI = 1.23–1.49), but no different after (OR=1.10, 0.98–1.24). Compared to the before period, odds of DA-CPR were higher during DART (OR=1.79, 1.59–2.02) but no different after (OR=0.94, 0.80–1.10).

Conclusions—Odds of bystander CPR were higher during the trial, an increase related to higher likelihood of DA-CPR. The finding suggests a possible indirect community-wide benefit due to the interventional trial.

Keywords

cardiac arrest; waiver of consent; ethics; Hawthorne effect; epidemiology

Introduction

The challenge of balancing risk to an individual patient with potential benefit to the population as a whole is a fundamental challenge in research involving human subjects. The challenge is especially formidable when the research involves vulnerable populations who cannot provide informed consent. This circumstance is present in interventional resuscitation trials where potential participants are in need of time-sensitive, emergency treatments and cannot provide consent.¹

Beyond the intended benefit of the knowledge gained by the conduct and analysis of the intervention, the act of performing research may have unintended effects, potentially beneficial or detrimental. Henry Landsberger coined the term “the Hawthorne Effect” in 1958 to describe short-term improvements in productivity that occurred when electric factory workers were actively observed during a trial of different lighting conditions.² Since then, the phenomenon of improvement under observation has been observed in a variety of conditions from blood glucose control among insulin-dependent diabetics³ to hand hygiene among inpatient medical providers.⁴ Unintended negative consequences, including ethical consequences, have also been described.^{5, 6} The potential for research to cause harm—such as injury related to study drugs or protocols, or loss of autonomy—has notorious historic precedent in experiments such as the Tuskegee Syphilis Study.⁷ Protecting individuals from this potential for harm underpins our current system of research oversight.^{8, 9}

We used the Dispatcher Assisted Resuscitation Trial (DART) to evaluate how emergency research might indirectly influence resuscitation care. The DART study was designed specifically to compare two types of dispatcher CPR instruction (chest compression alone versus chest compression plus rescue breathing).¹⁰ The trial was *not* designed to influence whether bystander CPR was initiated more or less often; the criteria for providing such instructions did not change over time, rather just the content of the instruction; however, we hypothesized that the trial may influence dispatcher behavior in a manner that would increase arrest identification and provision of CPR instruction, and in turn increase the proportion who received bystander CPR. Consequently, we conducted a retrospective cohort study to determine whether bystander CPR was more frequent during the DART study compared to periods before and after the trial.

Methods

Study design, setting, and population

We performed a retrospective cohort study of adult subjects who suffered non-traumatic out-of-hospital cardiac arrest prior to emergency medical services (EMS) arrival in greater King County, Washington, between January 1, 1999, and December 31, 2011. The institutional review board at the University of Washington approved the study. Data were obtained under waiver of informed consent. To best investigate whether the interventional study potentially influenced the provision of bystander CPR, we included a period for investigation that spanned before, during, and after the DART study. The current study excluded arrest victims for whom bystander CPR was not possible, so we specifically excluded those persons who

suffered their arrest after EMS scene arrival. We also excluded persons <18 years of age, and those who had an arrest due to trauma, drowning, or asphyxiation.

The study community is a metropolitan region of approximately 1.2 million persons residing in urban, suburban, and rural areas. Persons access EMS by calling 9-1-1 to contact an emergency medical dispatcher. EMS response is two-tiered. The first tier is firefighter emergency medical technicians trained in basic life support and equipped with automated external defibrillators. The second tier is paramedics trained in advanced life support including rhythm interpretation, medication administration, and endotracheal intubation. The EMS system personnel follow the American Heart Association guidelines for resuscitation.

Data collection

Since 1976, King County EMS has maintained a registry of every EMS-treated cardiac arrest.¹¹ The registry uses dispatch, EMS, hospital, defibrillator, and death certificate records to collect information using the Utstein template for cardiac arrest.¹²

The primary exposure variable of interest was the time period stratified according to before, during, or after the DART study. The DART study was conducted in King County between June 1, 2004, and September 30, 2009, and the DART study time period serves as the intervention period for this comparison.¹⁰ Briefly, DART was a large multi-site randomized trial of dispatcher-assisted CPR instruction comparing instruction for chest compressions alone with instruction for compressions plus rescue breathing (www.clinicaltrials.gov, NCT00219687). It was funded in part by the Laerdal Foundation. Patients were eligible if the call taker determined the patient was unconscious and not breathing normally and bystander CPR was not under way. These same criteria were used before and after the DART study to identify cases of suspected cardiac arrest. If the caller was willing to undertake CPR, a randomization envelope containing CPR instructions was opened during the DART study. Dispatchers attempted to exclude patients with arrest due to trauma, drowning, or asphyxiation (from choking, strangulation, or suffocation), as well as patients who were under 18 years of age or had do-not-resuscitate status. Subjects were enrolled in the DART study under a waiver of informed consent. Dispatchers routinely provided adult CPR instruction that included chest compression plus rescue breathing prior to DART, a comparable distribution of chest compression alone and compression plus rescue breathing during DART, and chest compression alone after DART.

The primary outcome of the current study was the provision of bystander CPR. Bystander CPR is collected as a core Utstein element. Data are abstracted from the EMS report, which includes a check box reporting who initiated CPR. This approach to ascertainment was consistent throughout the study interval. Bystander CPR status was classified as any bystander CPR (any B-CPR), coded as “yes”, “no”, or “unknown”. For the purposes of classification throughout the study, a bystander is considered any person *without* an on-the-job duty to respond. For example, an on-duty police officer who responds and provides CPR would not be considered bystander CPR. Conversely an off-duty medical provider who performs CPR prior to arrival of on-the-job professional rescuers would be considered bystander CPR. Any bystander CPR included bystander CPR with dispatcher assistance or bystander CPR without dispatcher assistance. Based on all available pre-hospital

documentation, abstractors further categorized B-CPR as bystander CPR with dispatcher assistance (DA-CPR) or bystander CPR without dispatcher assistance (B-CPR, no DA).

Statistical methods

We used descriptive analyses to compare characteristics and outcomes across the three study periods (pre-DART, DART, and post-DART). We fit multivariable logistic regression models to evaluate the odds of any B-CPR before, during, and after the DART study. We also evaluated whether the odds varied by type-specific B-CPR. Models were adjusted for age, sex, location of arrest, whether arrest was witnessed, cardiac vs. non-cardiac aetiology, initial presenting rhythm, responding aid unit, and call dispatch center. A p-value of < 0.05 was considered significant. For clarity, ORs are presented comparing the period before DART (reference period) to the periods during and after. We also compared odds of receipt of CPR *during* DART to the period after DART.

Results

Of 10,828 subjects who suffered out-of-hospital cardiac arrest and were treated by EMS, 1208 were excluded because the arrest occurred after EMS arrival, 352 were excluded because they were less than 18 years of age, and 642 were excluded because the arrest was due to trauma, drowning, or asphyxiation, leaving 8,626 arrest cases for investigation (Figure 1). Characteristics of the cohort are summarized in Table 1. Subjects were 66 years old on average and predominantly male (63%). The majority of arrests were cardiac in aetiology (66%). Most occurred at home (70%), and about half were witnessed. Patient and arrest circumstances were similar across the study periods.

Overall, the proportion of arrest cases that received bystander CPR was 52% before DART (1817 of 3468 cases), 59% during DART (2093 of 3527 cases), and 54% after DART (885 of 1631 cases). The proportion of arrests that received bystander CPR with dispatcher assistance was 18% before DART (634 of 3468 cases), 28% during DART (1004 of 3527 cases), and 18% after DART (296 of 1631 cases). During the DART period, roughly 40% of the individuals who were included in this analysis were enrolled in the DART intervention; the 1421 cases enrolled in DART represented about 58% of the 2465 cases that were apparently eligible for DART during the study years, given the additional inclusion criterion for study enrollment that unassisted CPR was not already ongoing at the time of the call.

When compared to the period before DART, odds of receiving any bystander CPR were higher during DART (OR=1.33, 95% CI = 1.21–1.46, $p<0.0001$) than before, and no different after the trial ended (OR=1.08, 0.96–1.21, $p = 0.21$). Similarly, compared to the period before DART, the odds of receiving dispatcher-assisted bystander CPR were higher during the trial (OR=1.78, 1.59–1.99, $p<0.0001$) but no different after (OR=0.99, 0.85–1.15, $p = 0.91$). (Table 2).

When adjusted for age, sex, location of arrest, whether arrest was witnessed, cardiac vs. non-cardiac aetiology, initial presenting rhythm, responding aid unit, and call dispatch center, estimates were similar. Odds of receiving any bystander CPR were higher during DART (OR=1.35, 95% CI = 1.23–1.49, $p < 0.0001$) than before, and no different after the trial

ended (OR=1.10, 0.98–1.24, $p = 0.11$). Similarly, compared to the period before DART, the odds of dispatcher-assisted CPR were higher during the trial (OR=1.79, 1.59–2.02, $p<0.001$) but no different after (OR=0.94, 0.80–1.10, $p = 0.45$). Compared to the period during DART, odds of receiving any B-CPR were lower after DART (adjusted OR=0.82, 95% CI = 0.72–0.92), p -value=0.001, odds of receiving B-CPR (no DA) were 1.30 (95% CI 1.2–1.5, $p<0.0001$), and odds of receiving DA-B-CPR were 0.53 (95% CI 0.45–0.61, $p<0.0001$)

Discussion

In this observational cohort study, odds of receiving bystander CPR were higher during a trial of dispatcher CPR instruction than compared to the periods before and after the trial. The higher rate during the DART study seems to be largely attributable to a higher likelihood of receiving CPR with dispatcher assistance.

Sudden unexpected cardiac arrest is a major public health challenge claiming hundreds of thousands of lives each year annually in the US.¹³ Although there is a basic understanding of the health services strategies required for successful resuscitation, survival is poor in many communities.¹⁴ This set of circumstances provides for real opportunities to improve public health if advances in treatment can be realized. An important strategy that can inform improvements in care is clinical trials, which provide the highest level of evidence to guide treatment when performed properly.¹⁵ To date, there have been relatively few trials in resuscitation in part because of the challenges of consent and the concern for risk related to these types of trials.

In the current investigation, however, we actually observe an indirect and positive association possibly related to community-based emergency research. The finding that the proportion that receive bystander CPR increased during the trial and then decreased again after completion of the trial helps support the interpretation that the study itself was responsible for the increase as opposed to other temporal changes related to bystander CPR. The other finding that provides additional support for this interpretation is that the increase and then decrease of bystander CPR appears to be largely attributable to dispatcher-assisted CPR.

If DART increased CPR among cardiac arrest patients, then there is high likelihood that the study also increased bystander CPR among those not in arrest for whom CPR provides no clear benefit. Fortunately, serious injuries in this circumstance due to CPR are quite infrequent.¹⁶ Thus added risk due to an increase in bystander CPR related to the trial is minimal for those not in arrest.

In light of the findings of the current study, one could suggest that the DART study should be ongoing regardless of completing the *a priori* comparison given the net benefit to increase the absolute proportion who receive bystander CPR by 10%. Efforts associated with the study could have raised dispatcher awareness and participation. Although dispatcher CPR is included in annual training, the DART study itself provided unique training specific to the trial. Moreover each dispatcher station was supplied with randomization envelopes that could have served as a visual reminder of the study and the potential for cardiac arrest. There

is evidence that participation in a resuscitation research network that regularly conducts interventional randomized trials has been associated with a temporal improvement in EMS care and clinical outcome, even though the study interventions themselves to date have not affected outcome. The challenge in the study community currently—now that the trial is completed—is to achieve the higher CPR rates in a system that already programmatically emphasizes dispatcher CPR. To this point, an interventional trial may not be required but rather simply the general appreciation that care and outcome is being measured can produce improvement. At the provider level, clinical documentation is improved when paramedics are aware they are being observed for quality improvement initiatives.¹⁷ At the community level, temporal improvements in arrest outcomes have been associated with community-based registries implementing specific programmatic initiatives, without the specific conduct of interventional trials.¹⁸

This study has limitations. There is potential for bystander CPR to be misidentified or incorrectly transcribed by EMS providers. Importantly, EMS field providers were not specifically informed of the DART study or its start or completion. To help guard against ascertainment bias that might influence the results, we used a uniform definition and abstraction approach to define bystander CPR. The rates of bystander CPR *without* dispatcher assistance were actually lower during the DART period; therefore, it is reasonable to ask whether cases were simply “shifted” from the bystander CPR without dispatcher assistance category to the dispatcher-assisted bystander CPR category by zealous 9-1-1 dispatchers without improvement in overall bystander CPR rates. The increase in overall bystander CPR rates during the study period argues against this possibility. This analysis did not quantify whether higher rates of bystander CPR were associated with higher survival or with other outcomes. Survival from out-of-hospital cardiac arrest is a complex measure that depends on many factors and was not the intended outcome of the current study. The current study is observational and so cannot definitively exclude the potential that unrecognized secular influences may have contributed to the results. Given the ever-increasing multimedia opportunities to learn CPR and the transition to simpler compression-alone CPR instruction after the DART study, we might have expected that bystander CPR would have continued to increase—rather than decrease—during the period after DART if secular trends were a pervading influence. The current study includes only one of the three sites that originally participated in DART because of data and personnel resources. The King County EMS system and dispatch centers are mature and train annually on dispatcher arrest recognition and provision of bystander CPR instruction. Regular training would likely attenuate the relationship between DART study and bystander CPR rates as dispatchers routinely receive some education. In other communities with less frequent dispatcher training, one might anticipate a larger increase in awareness and performance that could translate to an even bigger (beneficial) influence related to such an intervention study.

In conclusion, the findings from the current investigation suggest a measurable community-wide benefit from resuscitation research protocols above and beyond the intended intervention effect. Specifically, the DART study appears to have had an indirect consequence of increasing bystander CPR rates compared to before and after time periods. These results should be considered by stakeholders involved in resuscitation—investigators,

regulatory groups and review boards, funding organizations, and citizens—as they may influence perspective on the potential value of such comparative research.

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Fig. 1.
Study flow diagram showing participant eligibility

Table 1

Baseline characteristics of cardiac arrest study subjects, overall and stratified by whether their arrest occurred before, during, or after a community-wide randomized controlled trial comparing cardiopulmonary resuscitation protocols in King County, Washington

	Overall n = 8626	Before n = 3468	During n = 3527	After n = 1631
Age, years (SD)	66.4 (16.7)	67.4 (16.4)	65.9 (16.8)	65.7 (17.1)
Age in men, years (SD)	65.2 (16.3)	65.8 (16.2)	64.9 (16.4)	64.5 (16.3)
Age in women, years (SD)	68.5 (17.3)	70.1 (16.5)	67.4 (17.6)	67.6 (18.2)
Sex, % male (n)	63 (5431)	63 (2187)	63 (2217)	63 (1027)
Location of arrest				
% Home (n)	70 (6078)	68 (2375)	71 (2518)	73 (1185)
% Nursing home (n)	18 (1580)	20 (687)	17 (616)	17 (277)
% In public (n)	11 (968)	12 (406)	11 (393)	10 (169)
Arrest witnessed? % yes (n)*	47 (4031)	47 (1635)	46 (1636)	47 (760)
Presumed cardiac etiology, % (n)	66 (5703)	69 (2392)	64 (2256)	65 (1055)
Initial rhythm				
% VF (n)	29 (2536)	32 (1109)	29 (1009)	26 (418)
% PEA/other non-shockable (n)	26 (2228)	22 (779)	27 (969)	29 (480)
% Asystole (n)	45 (3861)	46 (1579)	44 (1549)	45 (733)
Dispatch call center				
% Center 1 (n)	57 (4954)	57 (1971)	57 (2007)	60 (976)
% Center 2 (n)	40 (3435)	41 (1405)	40 (1415)	38 (615)
% Center 3/4 (n)	3 (237)	3 (92)	3 (105)	2 (40)

* Includes cardiac arrest during or after call to 911, but prior to arrival of emergency medical services

SD: standard deviation

VF: ventricular fibrillation

PEA: pulseless electrical activity

Table 2

Odds ratios (ORs) and 95% confidence intervals for receipt of cardiopulmonary (CPR) resuscitation instruction before, during, and after a community-wide randomized controlled trial comparing CPR protocols in King County, Washington (n = 8626)

Total cases		Any B-CPR			B-CPR (no DA)			DA-B-CPR		
	n	n	OR (95% CI)	p-value	n	OR (95% CI)	p-value	n	OR (95% CI)	p-value
<i>Unadjusted</i>										
8626										
Before	3468	1817	Reference		1183	Reference		634	Reference	
During	3527	2093	1.33 (1.21–1.46)	<0.0001	1089	0.86 (0.78–0.95)	0.004	1004	1.78 (1.59–1.99)	<0.0001
After	1631	885	1.08 (0.96–1.21)	0.213	589	1.10 (0.97–1.23)	0.162	296	0.99 (0.85–1.15)	0.909
<i>Adjusted*</i>										
8614										
Before	3458	1810	Reference		1178	Reference		632	Reference	
During	3525	2092	1.35 (1.23–1.49)	<0.0001	1088	0.88 (0.79–0.98)	0.023	1004	1.79 (1.59–2.02)	<0.0001
After	1631	885	1.10 (0.98–1.24)	0.107	589	1.18 (1.04–1.35)	0.011	296	0.94 (0.80–1.10)	0.453

Any B-CPR: any bystander CPR; B-CPR (no DA): bystander CPR without dispatcher assistance; DA-B-CPR: dispatcher-assisted bystander CPR Before period: 1/1/1999–5/31/2004. Study period: 6/1/2004–9/31/2009. After period: 10/1/2009–12/31/2011.

* Models are adjusted for age, sex, location of arrest, whether arrest was witnessed, cardiac vs. non-cardiac etiology, initial presenting rhythm, responding aid unit, and call dispatch center; differences in sample size are due to missing covariate data

A p-value of < 0.05 was considered significant.

For clarity, ORs are presented comparing before DART to during and after. Additionally, compared to the period *during* DART, odds of receiving any B-CPR were lower after DART (adjusted OR=0.82, 95% CI = 0.72–0.92), p-value=0.001, odds of receiving B-CPR (no DA) were 1.3 (95% CI 1.2–1.5, p<0.0001), and odds of receiving DA-B-CPR were 0.53 (95% CI 0.45–0.61, p<0.0001).