Out-of-hospital cardiac arrests occurring in southern Ontario health care clinics

Bystander cardiopulmonary resuscitation and automated external defibrillator use

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ABSTRACT

OBJECTIVE To determine the proportion of public-location out-of-hospital cardiac arrests (OHCAs) that occur in health care clinics and to describe bystander cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) use during these episodes.

DESIGN Our study was a retrospective cohort study of 679 nontraumatic OHCAs recorded in the Resuscitation Outcomes Consortium Epistry–Cardiac Arrest database.

SETTING Out-of-hospital medical clinics and other public locations in Toronto, Ont, and the surrounding municipal regions of Hamilton, Durham, York, Peel, Simcoe, and Muskoka.

PARTICIPANTS A total of 679 consecutive patients suffering nontraumatic OHCAs of presumed cardiac cause in public locations.

MAIN OUTCOME MEASURES The proportion of public-location cardiac arrests occurring in medical clinics and the occurrence of bystander CPR and bystander use of AEDs.

RESULTS Twenty-two of the 679 public-location cardiac arrests occurred in health care clinics (3.2%, 95% confidence interval 1.9% to 4.6%). Bystander CPR occurred more often in health care clinics (73% of episodes in clinics compared with 46% in other public places, $P=.02$), but there was no statistically significant difference in AED use between groups. Twenty-seven percent of those suffering cardiac arrests in health care clinics did not receive any bystander CPR, and more than 90% did not have AEDs applied.

CONCLUSION Although the response to cardiac arrest in out-of-hospital medical clinics is superior to the response to those arrests that occur in other public settings, it remains suboptimal. Increasing CPR training among staff and improving access to AEDs in medical clinics might improve the response to OHCA in medical clinics and ultimately improve outcomes for patients.

EDITOR'S KEY POINTS

- Sudden cardiac arrests sometimes occur in ambulatory health care clinics. In many of these cases, bystanders witness the cardiac arrests and the patients have shockable initial cardiac arrest rhythms, suggesting an opportunity for successful resuscitation with early intervention.
- Unfortunately, this study demonstrated that nearly a third of patients suffering cardiac arrest in clinics did not receive bystander cardiopulmonary resuscitation before paramedics arrived, and 91% of these patients did not have automated external defibrillators applied.
- Because only a small number of cardiac arrests occur in medical clinics, this study is limited by its small sample size. Nonetheless, it is likely that many of those who suffer cardiac arrests in medical clinics could be saved if cardiopulmonary resuscitation and automated external defibrillator use were more common in these settings.

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Arrêts cardiaques hors d'un hôpital survenant dans des cliniques de santé du sud de l'Ontario

Ressuscitation cardiorespiratoire et utilisation du défibrillateur externe automatique par les personnes présentes

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RÉSUMÉ

OBJECTIF Établir la proportion des arrêts cardiaques extra-hospitaliers (ACEH) qui surviennent dans des cliniques de santé et décrire les manœuvres de ressuscitation cardiorespiratoires (RCR) et l'utilisation du défibrillateur externe automatique (DEA) durant ces épisodes.

TYPE D'ÉTUDE Étude de cohorte rétrospective de 679 ACEH tirés de la base de données *Ressuscitation Outcome Consortium Epistry-Cardiac Arrest*.

CONTEXTE Cliniques médicales extra-hospitalières et autres lieux publics de Toronto et des municipalités avoisinantes d'Hamilton, Durham, York, Peel, Simcoe et Muskoka, Ont.

PARTICIPANTS Un total de 679 patients consécutifs ayant présenté un ACEH non traumatique de cause vraisemblablement cardiaque dans des lieux publics.

PRINCIPAUX PARAMÈTRES ÉTUDIÉS La proportion des arrêts cardiaques des lieux publics survenant dans des cliniques médicales et les cas où les personnes présentes ont utilisé la RCR ou le DEA.

RÉSULTATS Sur 679 arrêts cardiaques dans des lieux publics, 22 sont survenus dans des cliniques médicales (3,2%, intervalle de confiance à 95% 1,9% à 4,6%). Les manœuvres de RCR par les personnes présentes étaient plus fréquentes dans les cliniques médicales (73% des épisodes dans les cliniques comparé à 46% dans d'autres lieux publics, $P=,02$), mais il n'y avait pas de différence significative entre les groupes pour l'utilisation du DEA. Parmi ceux qui ont eu un arrêt cardiaque dans des cliniques médicales, 27% n'ont pas reçu de CPR par les personnes présentes et plus de 90% n'ont pas subi de manoeuvres à l'aide d'un DEA.

CONCLUSION Même si la réponse aux arrêts cardiaques dans les cliniques médicales extra-hospitalières est supérieure à celle observée quand l'arrêt survient dans d'autres lieux publics, elle demeure sous-optimale. Une formation en RCR accrue pour le personnel et un meilleur accès au DEA dans les cliniques médicales pourraient améliorer la réponse aux ACEH et ainsi améliorer les issues pour les patients.

POINTS DE REPÈRE DU RÉDACTEUR

- Il arrive parfois qu'un arrêt cardiaque subit survienne dans des cliniques de soins ambulatoires. Dans plusieurs de ces cas, des personnes s'en aperçoivent et le patient présente des rythmes d'arrêt cardiaque susceptibles de répondre à des chocs, laissant croire qu'une intervention précoce aurait des chances de succès.
- Malheureusement, cette étude a montré que près du tiers des patients présentant un arrêt cardiaque dans une clinique n'ont pas reçu des manœuvres de ressuscitation par les personnes présentes avant l'arrivée des ambulanciers et que chez 91% de ces patients, on n'a pas utilisé le défibrillateur externe automatique.
- Comme peu d'arrêts cardiaques surviennent dans des cliniques médicales, la portée de cette étude est limitée par la petitesse de son échantillon. Il est néanmoins probable que plusieurs de ceux qui présentent un arrêt cardiaque dans des cliniques médicales pourraient être sauvés si on utilisait plus souvent la RCR et le DEA à ces endroits.

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Out-of-hospital cardiac arrest (OHCA) is a considerable public health problem. The North American incidence of cardiac arrest treated by emergency medical services (EMS) is estimated to be 52.1 per 100 000 people each year. Only 8.4% of these patients survive to hospital discharge.[1] Early bystander cardiopulmonary resuscitation (CPR) and defibrillation are independently associated with 3-fold improvements in the odds of survival after OHCA.[2-4] Survival to hospital discharge of greater than 70% has been demonstrated for patients with witnessed ventricular fibrillation OHCA who receive prompt CPR and defibrillation from trained lay people.[3] The beneficial effect of these interventions is very time-sensitive. The probability of survival falls 7% to 10% per minute of delay between collapse and defibrillation without CPR and 3% to 4% per minute when CPR is provided. Even under ideal conditions in an urban Canadian setting, it can be 5 or 6 minutes after a 911 call before EMS personnel equipped with defibrillators arrive on scene.[5]

Many who suffer sudden OHCA develop symptoms hours before the event.[6] These symptoms might prompt a visit to a family practice office or other out-of-hospital ambulatory care setting. A study from Windsor, Ont, found that 6.1% (20 of 329 in 6 years) of all cardiac arrests in public locations occurred in community medical clinics.[7] Investigators from Sweden observed that 13.3% (18 of 135 in 8 years) of all OHCAs occurring in public buildings happened in general practitioners' offices.[8] These OHCAs occurring in medical clinics provide an opportunity for an optimized response because personnel with medical training and resuscitation equipment should be in proximity. Recommendations for health care clinic emergency preparedness, which includes CPR training for clinic employees in all clinics and automated external defibrillators (AEDs) for high-risk clinics,[9,10] have been published, but the preparedness of Canadian out-of-hospital health care clinics for sudden cardiac arrest is unclear. Also, the characteristics of OHCAs occurring in Canadian health care clinics and the resuscitative efforts of clinic bystanders have not been well described in the literature. Among episodes of OHCA occurring within the Toronto RESCuNET study region of Southern Ontario, we sought to determine the proportion of public-location OHCAs occurring in health care clinics and to describe the bystander response to cardiac arrest, including the occurrence of bystander CPR and deployment of AEDs.

METHODS

This was a retrospective cohort study using the Resuscitation Outcomes Consortium Epistry database, which prospectively captures detailed EMS and patient data from OHCAs occurring in 11 North American sites.[11] This study analyzed data from the Toronto RESCuNET, which is the University of Toronto's regional coordinating centre of this consortium. The catchment area includes the municipalities of Toronto, Hamilton, Durham, York, Peel, Simcoe, and Muskoka, with an approximate population of 8.8 million in both urban and rural settings. The methods for this database have been described in detail elsewhere.[12] Dispatch, EMS, and patient data are abstracted from ambulance call reports and uploaded into the database by trained data abstractors. *Health care clinic* was defined in this study as any out-of-hospital location patients visited for medical assessment, diagnostic procedures, or treatment. *Automated external defibrillator use* was defined as application of AED pads onto the chest of the patient, regardless of whether a shock was delivered.

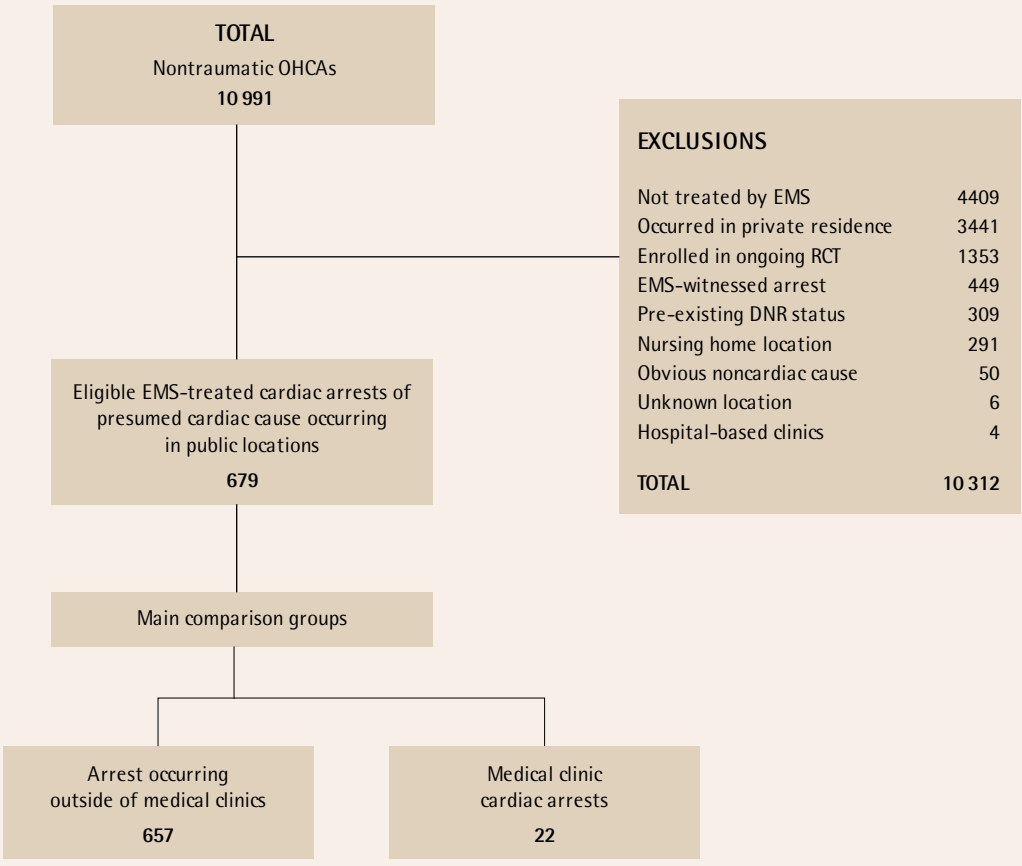
We included patients with nontraumatic OHCAs of presumed cardiac cause occurring in public locations, with treatment initiated by EMS between January 1, 2006, and April 30, 2008. Episodes occurring in nursing homes or hospital-based clinics, those witnessed by EMS personnel, those in which pre-existing do-not-resuscitate orders were identified, or those in which patients were enrolled in Resuscitation Outcomes Consortium randomized controlled trials, were excluded.

Proportions were compared using χ^2 testing. Continuous variables were compared with Student *t* tests. Multiple logistic regression was used to explore the association between cardiac arrest location (health care clinic vs other public place) and the probability of bystander CPR and AED use. Odds ratios (ORs) were adjusted for age, sex, witness status, and EMS response interval. A *P* value of .05 or less was considered statistically significant. This study was approved by the Sunnybrook Health Sciences Centre research ethics board. At the time of undertaking this work, our research program (and the database) was housed at Sunnybrook.

RESULTS

A total of 10 991 nontraumatic OHCAs occurred during the study period. Of these, 679 satisfied our criteria for inclusion (**Figure 1**). Twenty-two of the 679 public-location cardiac arrests occurred in health care clinics (3.2%, 95% confidence interval [CI] 1.9% to 4.6%) (**Table 1**). Among those episodes in which the specific type of clinic could be determined, 82.4% (14 of 17) occurred in physician offices. The remainder occurred in chiropractic, audiology, and dentistry offices. Bystander CPR occurred more often during medical clinic cardiac arrests than during cardiac arrests occurring in other public places (72.7% vs 45.7%, *P*=.02). Use of AEDs was infrequent, with no statistically significant difference between medical clinic cardiac arrests and cardiac

Figure 1. Derivation of the study cohort



DNR—do not resuscitate, EMS—emergency medical services, OHCA—out-of-hospital cardiac arrest, RCT—randomized controlled trial.

arrests occurring in other public places (9.1% vs 7.5%, $P=.68$). Adjusted ORs for bystander CPR (OR 2.42, 95% CI 0.83 to 6.63) and AED use (OR 1.21, 95% CI 0.26 to 5.92) suggested higher use in medical clinics, but had wide CIs and were not statistically significant. Of those who suffered OHCAs in clinics, 27.3% (6 of 22) did not receive any bystander CPR and 90.9% (20 of 22) did not have AEDs applied.

DISCUSSION

To our knowledge, this is the first report describing cardiac arrest characteristics and bystander responses for OHCAs occurring in health care clinics. We analyzed 22 of these episodes within our region over the 28-month study period, representing 3.2% of all public-location OHCAs. Many of these cardiac arrests were witnessed and the patients had shockable initial rhythms, suggesting an opportunity for successful resuscitation with early intervention. Although bystander resuscitation efforts occurred more often in clinics than in other public locations, almost a third of those in the clinic group did not receive any bystander CPR, and 91% did not have AEDs applied.

This study is limited by a small sample size and by retrospective data collection. Our findings will require validation in larger samples from other geographic areas. Despite this, we believe our observations are valuable for generating hypotheses, highlighting potential deficiencies in health care clinic medical emergency preparedness, and justifying further investigation. Our data derived from a research-quality population-based database, enrolling consecutive cases of OHCA over a large geographical region serving a population of 8.8 million; they should therefore be representative. Unfortunately, information about bystander demographic characteristics, bystander CPR training status, and AED availability at the site of cardiac arrest were not available to the paramedics at the time of the cardiac arrest and,

Table 1. Univariate analysis of demographic features, cardiac arrest characteristics, and outcomes among 679 patients with cardiac arrest occurring in a public place

CHARACTERISTIC	ALL CASES N = 679	PUBLIC N = 657	MEDICAL CLINIC N = 22	*P* VALUE
Mean (SD) age, y	61.7 (16.4)	61.7 (16.0)	63.0 (26.4)	.81*
Male, %†	82.7	83.2	68.2	.12
Initial rhythm, n (%)‡				
• VF, VT, AED shock	312 (46.0)	304 (46.3)	8 (38.1)	.34
• PEA, asystole, no shock	340 (50.1)	329 (50.1)	11 (52.4)	.34
Witnessed arrest, n (%)	386 (56.8)	368 (56.0)	18 (81.8)	.02
Bystander CPR, n (%)	316 (46.5)	300 (45.7)	16 (72.7)	.02
AED use, n (%)	51 (7.5)	49 (7.5)	2 (9.1)	.68
AED shock, n (%)	38 (5.6)	36 (5.5)	2 (9.1)	.35
Survival, n (%)				
• ROSC	184 (27.1)	177 (26.9)	7 (31.8)	.63
• Survival to hospital discharge§	95 (17.4)	91 (17.2)	4 (23.5)	.51

AED—automated external defibrillator, CPR—cardiopulmonary resuscitation, PEA—pulseless electrical activity, ROSC—return of spontaneous circulation, VF—ventricular fibrillation, VT—pulseless ventricular tachycardia.

*This *P* value was generated with a Student *t* test. All other *P* values were derived from χ^2 testing.

†Data on sex were available for 676 patients.

‡Data on initial rhythms were available for 678 patients.

§Data on survival to hospital discharge were available for 546 patients.

therefore, are not in our data set. A comparison of these variables in the clinic and nonclinic groups might provide potential explanations for the differences we have observed.

Low rates (between 15% and 30%) of lay person bystander CPR in out-of-hospital settings have been well documented in several past studies from various parts of the world.[13] Our bystander CPR rate of 46% in the nonclinic arrests occurring in public settings is higher than the 15% to 30% reported in other studies. This is probably because we only included cardiac arrests in public settings, where the chance of bystander CPR is known to be higher than in private settings. Cardiac arrests that occur in private settings are twice as common as those in public settings and are more likely to be unwitnessed and have fewer bystanders present.[14]

Although we observed a significantly higher proportion of patients receiving bystander CPR in the clinic setting (73%), more than a quarter of the patients in health care clinics did not receive this life-saving intervention. Possible explanations could include a lack of CPR training for office staff, failure to recognize cardiac arrest, fear of harming the patient, fear of legal liability, or fear of contracting an infectious disease from mouth-to-mouth ventilation. Some of these potential barriers have been identified in surveys of lay people gauging their willingness to perform CPR.[13,15] The relevance of these potential barriers to the health care clinic setting is unclear. Our data do not allow an analysis of the specific potential barriers that prevented delivery of resuscitation in the clinic cases.

Although the difference between comparison groups was not statistically significant, we observed that the first recorded cardiac arrest rhythm was shockable in more than a third of clinic OHCAs. Very early (less than 3 minutes) bystander AED use for shockable rhythms has been associated with doubled survival in this group when compared with later use (after 3 minutes).[3] Because bystander AEDs were applied in less than 10% of cases in our cohort, rhythm determination was usually delayed until EMS arrival. The true incidence of a shockable rhythm closer to the onset of cardiac arrest and the full potential effects of AEDs in medical clinic cardiac arrest remain unclear.

Enforced regulations pertaining to minimum emergency equipment and training in health care clinics do not exist in Ontario and most other jurisdictions across Canada. The College of Physicians and Surgeons of Ontario provides guidelines for medical emergency preparedness in clinics, which stress the importance of trying to match the risk profile of the clinic to the type of emergency equipment available within the office, but these are not evidence-based or enforced.[16] Health care clinics should be prepared to handle a variety of medical emergencies including sudden cardiac arrest. Cardiac arrest is a particularly time-sensitive emergency that demands immediate intervention to maximize chance of survival. Our study highlights an opportunity to improve the care of patients suffering cardiac arrests within out-of-hospital health care clinics. At a minimum, all clinic staff should be trained and ready to provide CPR and apply an AED. Future work in this area should be directed toward identifying barriers to CPR training and AED placement in medical clinics, and the development of cost-sharing methods to allow group CPR training

and AED application to occur for staff from adjacent offices.

Conclusion

In a select area of southern Ontario serving a population of 8.8 million, approximately 3% of all public-location cardiac arrests occurred in a health care clinic setting. Bystander CPR was more likely to occur when the event occurred in a health care clinic than if it occurred in another public location. However, more than a quarter of patients who suffered OHCA in a health care clinic did not receive bystander CPR and very few had AEDs used. Future work should explore opportunities to improve this response and potentially improve survival through increasing CPR training and access to AEDs among health care clinic staff.

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Contributors

All of the authors participated in the study design, analysis and interpretation of the results, and drafting of the manuscript, and have read and approved the final manuscript.

Competing interests

Dr Morrison has received unrestricted research grants from a number of defibrillator manufacturers, including Zoll and Phillips Medical, for the conduct of clinical trials of cardiac arrest.

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References

1. Nichol G, Thomas E, Callaway CW, Hedges J, Powell JL, Aufderheide TP, et al. Regional variation in out-of-hospital cardiac arrest incidence and outcome. *JAMA* 2008;300(12):1423-31. Erratum in: *JAMA* 2008;300(15):1763.
2. Stiell IG, Wells GA, Field B, Spaite DW, Nesbitt LP, De Maio VJ, et al. Advanced cardiac life support in out-of-hospital cardiac arrest. *N Engl J Med* 2004;351(7):647-56.
3. Valenzuela TD, Roe DJ, Nichol G, Clark LL, Spaite DW, Hardman RG. Outcomes of rapid defibrillation by security officers after cardiac arrest in casinos. *N Engl J Med* 2000;343(17):1206-9.
4. Holmberg M, Holmberg S, Herlitz J. Effect of bystander cardiopulmonary resuscitation in out-of-hospital cardiac arrest patients in Sweden. *Resuscitation* 2000;47(1):59-70.
5. Stiell IG, Wells GA, Field BJ, Spaite DW, De Maio VJ, Ward R, et al. Improved out-of-hospital cardiac arrest survival through the inexpensive optimization of an existing defibrillation program: OPALS study phase II. Ontario Prehospital Advanced Life Support. *JAMA* 1999;281(13):1175-81.
6. Müller D, Agrawal R, Arntz HR. How sudden is sudden cardiac death? *Circulation* 2006;114(11):1146-50. Epub 2006 Sep 4.
7. Fedoruk JC, Currie WL, Gobet M. Locations of cardiac arrest: affirmation for community Public Access Defibrillation (PAD) program. *Prehosp Disaster Med* 2002;17(4):202-5.
8. Engdahl J, Herlitz J. Localization of out-of-hospital cardiac arrest in Goteborg 1994-2002 and implications for public access defibrillation. *Resuscitation* 2005;64(2):171-5.
9. Sempowski IP, Brison RJ. Dealing with office emergencies. *Can Fam Physician* 2002;48:1464-72.
10. Toback SL. Medical emergency preparedness in office practice. *Am Fam Physician* 2007;75(11):1679-84.
11. Davis DP, Garberson LA, Andrusiek DL, Hostler D, Daya M, Pirrallo R, et al. A descriptive analysis of emergency medical service systems participating in the Resuscitation Outcomes Consortium (ROC) network. *Prehosp Emerg Care* 2007;11(4):369-82.
12. Morrison LJ, Nichol G, Rea TD, Christenson J, Callaway CW, Stephens S, et al. Rationale, development and implementation of the Resuscitation Outcomes Consortium Epistry–Cardiac Arrest. *Resuscitation* 2008;78(2):161-9. Epub 2008 May 13.
13. Abella BS, Aufderheide TP, Eigel B, Hickey RW, Longstreth WT Jr, Nadkarni V, et al. Reducing barriers for implementation of bystander-initiated cardiopulmonary resuscitation. *Circulation* 2008;117(5):704-9. Epub 2008 Jan 14.
14. Swor RA, Jackson RE, Compton S, Domeier R, Zalenski R, Honeycutt L, et al. Cardiac arrest in private locations: different strategies are needed to improve outcome. *Resuscitation* 2003;58(2):171-6.
15. Vaillancourt C, Stiell IG, Wells GA. Understanding and improving low bystander CPR rates: a systematic review of the literature. *Can J Emerg Med* 2008;10(1):51-65.
16. College of Physicians and Surgeons of Ontario. *Safe and effective office-based practices.* Toronto, ON: College of Physicians and Surgeons of Ontario; 2009. Available from: **http://cpso.on.ca/policies/guidelines/default.aspx?id=1990&terms=emergency+preparedness.** Accessed 2009 Feb 9.