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ABSTRACT

Aims: There are large differences between emergency medical systems, which may account for variability in outcomes. We seek to compare prehospital organizations, response modes, patient characteristics and outcomes after out-of-hospital cardiac arrest, between France and Canada, and discuss the need for the first European-North American prehospital research network on out-of-hospital cardiac arrest.

Methods: Preliminary comparative description of data drawn from two nation-wide, population-based, Utstein-style prospectively implemented registries for out-of-hospital cardiac arrest in France and Canada (France: RéAC, Canada: CanROC), covering approximately 80 million people, and soon to be participating in an international research network in 2020.

Results: Since creation, 103,722 cases were included in France and approximately 99,317 in Canada. Data used in this work were drawn from 2011 to 2016, and comprised around 33,688 adult, non-traumatic, treated cases in Canada, and 55,358 in France, leading to estimated incidence rates of 75,3/100,000 inhabitants in France and 83/100,000 in Canada. In both countries, out-of-hospital cardiac arrest predominantly occurred in male patients, in their late sixties, at home, of presumed cardiac aetiology. Bystander cardiopulmonary resuscitation was provided in half of the cases. First assessed cardiac rhythm was shockable in 16% (France) vs. 22% (Canada). Professional resuscitation was attempted in 82% (France) and 60% (Canada). Prehospital organizations and response modes differed in the constitution of responding teams (France: physician-led advanced life support, Canada: trained paramedics), in response time intervals (call to first professional responders' arrival at scene 6.5 min (interquartile range IQR [5.2-8.3]) (Canada) vs. 10 min [7-15] (France)), in on-scene interventions, type of referral at hospital (France: systematic bypass of emergency department, tertiary hospital first, Canada:

occasional bypass, mainly closest hospital first), and in outcomes (overall survival at hospital discharge in France: 5%, vs. Canada: 11%).

Conclusion: Despite similarities in some out-of-hospital cardiac arrest Utstein variables, several differences exist between French and Canadian prehospital systems, and ultimately, between outcomes. The creation of the ReACanROC research network will facilitate the conduction of further analyses to better understand predictors of this variability.

INTRODUCTION

Outcomes after out-of-hospital cardiac arrest (OHCA) greatly vary upon countries, territories and communities, with overall survival at hospital discharge, in emergency medical system (EMS)-treated cases, ranging from 0% to 31% (aggregate 6,7% to 8,4%) (1). While these differences can be in part accounted for by Utstein variables within the chain-of-survival, additional variability remains (1,2).

Emergency medical services (EMS) systems in Canada and France demonstrate significant differences in terms of organizations and practices (3,4). Response modes range from: physician-led ambulances, critical care or advanced life support-trained paramedics, basic life support-trained paramedics, fire fighter first responders, or emergency medical responders/technicians. The EMS fleet composition, response times, access to bystander cardiopulmonary resuscitation (CPR), external defibrillation, airway control, and drug administration of these different units may affect outcomes (5–7). Further variation exists within other countries based on population density and geography (8), resulting in decreased access to advanced prehospital care and prolonged response times in rural and remote locations (9), therefore leading to possible inequities in access to urgent and critical care (10).

Access to prehospital care does not only vary on a large geographic scale, it varies at community- and facility levels as well. While response times are logically longer in high-rise buildings (11) or in large/complex facilities (such as train stations) (12–14), leading to poorer outcomes after OHCA, they also appear to be delayed in rural areas (15), socioeconomically deprived areas (16), or in areas with predominantly non-white populations (17). The association between low socioeconomic status, access to critical interventions, and patient outcomes remains poorly understood. Some authors have suggested that poorer outcomes may be the result of

lower bystander presence and participation (18), lower availability of automatic external defibrillators (19), more frequent accessibility constraints to EMS providers (20), or population growth and urbanization rates (21). Further, as the socioeconomic status of a given territory is a dynamic process that evolves with time, the ability of EMS to evolve in a corresponding time and space is unclear.

The dynamic associations between prehospital organizations, response modes, geographic and socioeconomic predictors of incidence and survival after OHCA therefore need to be further explored (22). Because in-depth comparisons between service delivery and outcomes of systems with differing prehospital configurations and geo-socio-economic landscape will help to identify areas for care improvement, we sought to describe and compare available, preliminary, aggregate data between OHCA registries in France and Canada, to illustrate the need for the creation of the first international Europe-North America research network on OHCA.

METHODS

Settings

We are creating ReACanROC, an international research network between two nation-wide, population-based, Utstein-style prospectively implemented registries for EMS-assessed OHCA in France and Canada: RéAC (*Registre électronique des Arrêts Cardiaques*, data from 2011, France), and CanROC (*Canadian Resuscitation Outcomes Consortium*, previously ROC Epistry, data from 2005 in Ontario (the OPALS communities organized from Ottawa; the former Rescu (now R3) communities organized from Toronto) and in British Columbia urban communities)), covering approximately 80 million people (fig.1). CanROC was created in 2016 after the ROC funding was discontinued. CanROC is currently expanding to include all provinces in Canada.

Over 87% of the 350 French prehospital mobile medical teams (MMT) participate in the RéAC registry (n=305), covering a total population of 60 million inhabitants in 82 out of 96 regions on mainland. MMT provide advanced life support (ALS), while first responders (firefighters) provide basic life support (BLS). Nation-wide, MMT's density is 0.7/100.000 inhabitants (min. 0.2, max. 2.4) (23), and firefighters units' density is 10 (min. 8, max. 20) (24). National response time goal metrics recommend MMT to arrive at scene within 30 minutes after receiving the call. There are no such nation-wise objectives for firefighters' units. Every OHCA case included in RéAC is a case for which an MMT is dispatched for assessment.

Of 40 EMS agencies (Ontario: 39, British Columbia (BC): 1) involved in CanROC, 150 EMS units currently participate in the OPALS site, and 98 in the Toronto site. BC has a single province-wide EMS system, which includes dispatch, ground response and interfacility transfer/critical care primarily staffed by paramedics. Out of the 746 EMS units in BC, 172 BLS and 36 ALS ambulances participate in CanROC. The total population covered by CanROC registry is 20 million people. Every caregiver that participates in the chain-of-care of OHCA patients can implement the CanROC registry. In Ontario and British Columbia, goal metrics for EMS response times in urban areas are 6-9 minutes for OHCA. Every OHCA patient who is treated by an EMS team is eligible for inclusion in CanROC.

Detailed rationales and implementations of both ReAC and CanROC, and other epidemiology results, can be found in previously published articles (2,25–27).

Data

We used preliminary, available, aggregate data drawn from the RéAC (nation-wide) and CanROC historical sites (ex-ROC Epistry: British Columbia and Ontario) registries. Both RéAC and CanROC are Utstein-style based. They record a broad range of variables, of which core elements and time events are synthesized in table 1.

In Canada, data from 2011 to 2016 were drawn from the Canadian sites of the North-American ROC Epistry, comprising 8 sites in United States of America and 3 in Canada. CanROC now aggregates data from its former ROC sites and data drawn by its current sites from 2016 to date. Because ReACanROC will only use French and Canadian datasets, and in order to ensure comparability between the two countries, no data that were drawn from the previous ROC American sites were used in this article.

For standardization and comparability purposes, and due to ongoing regulatory processes, we used data drawn between 2011 and 2016, for all cases recorded in RéAC and Canadian sites of ex-ROC/CanROC.

Categorical variables are reported as numbers and percentages, and continuous variable are reported as median with interquartile range ([Q1-Q3]).

RESULTS

Since creation, 103,722 patients were included in RéAC, and 99,317 in CanROC sites. The number of patients analyzed in this article (adult, non-traumatic, EMS-treated) was 55,358

(France) and 33,688 (Canada), leading to estimated incidence rates of 75,3/100,000 (France) and 83/100,000 (Canada).

France and Canada have globally comparable populations of patients suffering OHCA (male patients, median age in the mid-sixties, suffering at-home OHCA, mostly from presumed cardiac aetiology, often witnessed by a non-professional bystander, with a non-shockable initial rhythm). In contrast, France and Canada present with different geography, EMS systems, practices and outcomes (table 2). Notable differences include: the proportion with professionally attempted resuscitation varied from 60% (Canada) to 82% (France); response time intervals (from call to arrival at scene) for BLS and ALS varied from 6.5 min [5-8.5] and 7 min [5-10] (Canada) to 10 min [7-15] and 20 min [20-28] (France); initially attempted resuscitation was discontinued prior to transportation to hospital in 79% (France) and 45% (Canada) of the cases; and both overall survival rates and neurological status in survivors at hospital discharge varied within wide ranges (survival 5% (France) vs. 11% (Canada), favourable neurological status (cerebral performance category (CPC) ≤ 2) 84% (France) vs. 92% (Canada).

The definitions of the Utstein core elements were very similar between the two registries, except for the definition of presumed cardiac aetiology, hence ensuring good comparability of data used for the present work (table 1).

DISCUSSION

Main results

Preliminary comparison of data drawn from RéAC and CanROC highlighted several differences in prehospital system organizations, care delivery, practices and outcomes. Detailed analyses,

conducted on full and merged datasets from creation to date, are required in order to identify possible reasons to explain differences in outcomes, and to gain further insight into the optimal EMS configuration for OHCA management. One of the core questions that needs to be explored is why a system with physician-led triage and advanced life support, and systematic emergency department (ED) bypass towards catheterization laboratory and intensive care unit, presents with overall survival apparently over two times poorer than a system without prehospital physicians (5% vs. 11%), and in which ED bypass is inconsistent. Another question is to what extent regional variations occur within, and between, each country. Higher rates of attempted resuscitation, exploration of the definitions of presumed cardiac causes or other systematic differences in aetiology, longer EMS response times, lower socioeconomic status, or higher variability in geographic and temporal OHCA incidence rates may account for such inequities, and represent key objectives for the future ReACanROC network.

Implications for future work

The ReACanROC network will be set during 2020. Once the datasets are merged and fully explorable, ReACanROC will be the first Europe-North America research network on OHCA. It will help to better understand the differences in outcomes between the countries and territories, and their associations with geographic, socioeconomic and EMS system-related factors. Because we suspect that several of the differences between France and Canada, and *in extenso* between systems of either type (e.g. physician- or paramedic-led), will rely on predictors that are not purely technical, we seek to perform observational studies (including propensity matched analyses), comparative effectiveness analyses (including simulation modeling), and subsequently international randomized clinical trials focusing on new practices and organizations.

Limitations

This preliminary work has limitations. First, because the ReACanROC network is not created yet, and because the present work was aiming at discussing the need for its creation, we did not have full access to merged and homogenized datasets, but only to aggregate data; hence we were neither able to perform statistical tests of hypothesis, nor to describe, quantify, or address missing data between the two datasets. Nevertheless, every core Utstein elements and time events are mandatory for each registry, in order to reduce the amount of missing data, and to ensure sufficient data quality.

Second, as depicted in previous works, the variability we are discussing may be related to the quality, exactitude or definition of the variables recorded in each of the registries (28). Despite using the Utstein template, each of the registries sometimes uses some specific categories for core elements, and also different optional variables. Such differences warrant systematic comparison of both datasets, which will be provided in future works.

Finally, comparing health systems is complex and must take into account a broad range of variables that do not appear here, or are not collected by any of our registries (29).

CONCLUSION

France and Canada present with differences in EMS systems organization and care delivery, and ultimately in outcomes after OHCA. The creation of ReACanROC, the first Europe-North America research network on OHCA, will aim, first, at comparing the structure of each dataset, and second, at further exploring structural, demographic, geographic, and socioeconomic predictors of survival.

Conflicts of interest

The Authors declare none.

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References

1. Sasson C, Rogers MAM, Dahl J, Kellermann AL. Predictors of Survival From Out-of-Hospital Cardiac Arrest: A Systematic Review and Meta-Analysis. Circ Cardiovasc Qual Outcomes. 2010 Jan;3(1):63–81.

2. Okubo M, Schmicker RH, Wallace DJ, Idris AH, Nichol G, Austin MA, et al. Variation in Survival After Out-of-Hospital Cardiac Arrest Between Emergency Medical Services Agencies. JAMA Cardiol. 2018 Oct 1;3(10):989.

3. Symons P, Shuster M. International EMS Systems: Canada. Resuscitation. 2004 Nov;63(2):119–22.

4. Adnet F, Lapostolle F. International EMS Systems: France. Resuscitation. 2004 Oct;63(1):7–9.

5. Wengenmayer T, Staudacher DL. Need for speed in out-of-hospital cardiac arrest. Resuscitation. 2019 Sep;S0300957219305945.

6. Chocron R, Loeb T, Lamhaut L, Jost D, Adnet F, Lecarpentier E, et al. Ambulance density and outcomes after out-of-hospital cardiac arrest: insights from the Paris - sudden death expertise centre registry. Circulation. 2018 Dec 4;(ahead of pub.).

7. Grunau B, Kawano T, Dick W, Straight R, Connolly H, Schlamp R, et al. Trends in care processes and survival following prehospital resuscitation improvement initiatives for out-of-hospital cardiac arrest in British Columbia, 2006–2016. Resuscitation. 2018 Apr;125:118–25.

8. Yasunaga H, Miyata H, Horiguchi H, Tanabe S, Akahane M, Ogawa T, et al. Population density, call-response interval, and survival of out-of-hospital cardiac arrest. Int J Health Geogr. 2011;10(1):26.

9. Alanazy ARM, Wark S, Fraser J, Nagle A. Factors Impacting Patient Outcomes Associated with Use of Emergency Medical Services Operating in Urban Versus Rural Areas: A Systematic Review. Int J Environ Res Public Health. 2019 May 16;16(10):1728.

10. Brooks SC. Bystander CPR: Location, location, location. Resuscitation. 2013 Jun;84(6):711–2.

11. Drennan IR, Strum RP, Byers A, Buick JE, Lin S, Cheskes S, et al. Out-of-hospital cardiac arrest in high-rise buildings: delays to patient care and effect on survival. Can Med Assoc J. 2016 Apr 5;188(6):413–9.

12. Karch SB, Graff J, Young S, Ho CH. Response times and outcomes for cardiac arrests in Las Vegas casinos. Am J Emerg Med. 1998 May;16(3):249–53.

13. Heidet M, Mermet É, Vaux J, Jérémie R, Audureau É, Marty J. Simulated EMS response times until patients located in public train stations: A geospatial model to improve on-foot accessibility. Resuscitation. 2018 Oct;131:e3–5.

14. Silverman RA, Galea S, Blaney S, Freese J, Prezant DJ, Park R, et al. The "vertical response time": barriers to ambulance response in an urban area. Acad Emerg Med Off J Soc Acad Emerg Med. 2007 Sep;14(9):772–8.

15. Mell HK, Mumma SN, Hiestand B, Carr BG, Holland T, Stopyra J. Emergency Medical Services Response Times in Rural, Suburban, and Urban Areas. JAMA Surg. 2017 Oct 1;152(10):983.

16. Hsia RY, Huang D, Mann NC, Colwell C, Mercer MP, Dai M, et al. A US National Study of the Association Between Income and Ambulance Response Time in Cardiac Arrest. JAMA Netw Open. 2018 Nov 30;1(7):e185202.

17. Fosbøl EL, Dupre ME, Strauss B, Swanson DR, Myers B, McNally BF, et al. Association of neighborhood characteristics with incidence of out-of-hospital cardiac arrest and rates of bystander-initiated CPR: implications for community-based education intervention. Resuscitation. 2014 Nov;85(11):1512–7.

18. Castra L, Genin M, Escutnaire J, Baert V, Agostinucci J-M, Revaux F, et al. Socioeconomic status and incidence of cardiac arrest: a spatial approach to social and territorial disparities. Eur J Emerg Med. 2019 Jun;26(3):180–7.

19. Griffis HM, Band RA, Ruther M, Harhay M, Asch DA, Hershey JC, et al. Employment and residential characteristics in relation to automated external defibrillator locations. Am Heart J. 2016 Feb;172:185–91.

20. DeRuyter NP, Husain S, Yin L, Olsufka M, McCoy AM, Maynard C, et al. The impact of first responder turnout and curb-to-care intervals on survival from out-of-hospital cardiac arrest. Resuscitation. 2017 Feb;

21. Ro YS, Shin SD, Song KJ, Lee EJ, Kim JY, Ahn KO, et al. A trend in epidemiology and outcomes of out-of-hospital cardiac arrest by urbanization level: A nationwide observational study from 2006 to 2010 in South Korea. Resuscitation. 2013 May;84(5):547–57.

22. Starks MA, Schmicker RH, Peterson ED, May S, Buick JE, Kudenchuk PJ, et al. Association of Neighborhood Demographics With Out-of-Hospital Cardiac Arrest Treatment and Outcomes: Where You Live May Matter. JAMA Cardiol [Internet]. 2017 Aug 30 [cited 2017 Sep 18]; Available from: http://cardiology.jamanetwork.com/article.aspx?doi=10.1001/jamacardio.2017.2671

23. Observatoires régionaux des urgences - FHP-MCO [Internet]. [cited 2019 Nov 18]. Available from: http://www.fhpmco.fr/2016/12/27/observatoires-regionaux-urgences/

24. l'Intérieur M de. Les statistiques des services d'incendie et de secours. Édition 2018. [Internet]. http://www.interieur.gouv.fr/Publications/Statistiques/Securite-civile/2017. [cited 2019 Nov 18]. Available from: http://www.interieur.gouv.fr/Publications/Statistiques/Securite-civile/2017

25. 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 Aug;78(2):161–9.

26. Hubert H, Tazarourte K, Wiel E, Zitouni D, Vilhelm C, Escutnaire J, et al. Rationale, Methodology, Implementation, and First Results of the French Out-of-hospital Cardiac Arrest Registry. Prehosp Emerg Care. 2014 Oct 2;18(4):511–9.

27. Luc G, Baert V, Escutnaire J, Genin M, Vilhelm C, Di Pompéo C, et al. Epidemiology of out-of-hospital cardiac arrest: A French national incidence and mid-term survival rate study. Anaesth Crit Care Pain Med. 2019 Apr;38(2):131–5.

28. Dyson K, Brown SP, May S, Smith K, Koster RW, Beesems SG, et al. International variation in survival after out-of-hospital cardiac arrest: A validation study of the Utstein template. Resuscitation. 2019 May;138:168–81.

29. Schütte S, Acevedo PNM, Flahault A. Health systems around the world – a comparison of existing health system rankings. J Glob Health. 2018 Jun;8(1):010407.

Legends to figures

Figure 1. Sites participating in ReAC (France, A) and CanROC (Canada, B) registries

Table 1. Recommended Utstein core variables and time events recorded in RéAC and CanROC registries: matching definitions

Table 2. Characteristics of EMS systems, OHCA patients and outcomes between France and Canada (preliminary data)

Figure 1. Sites participating in ReAC (France, A) and CanROC (Canada, B) registries

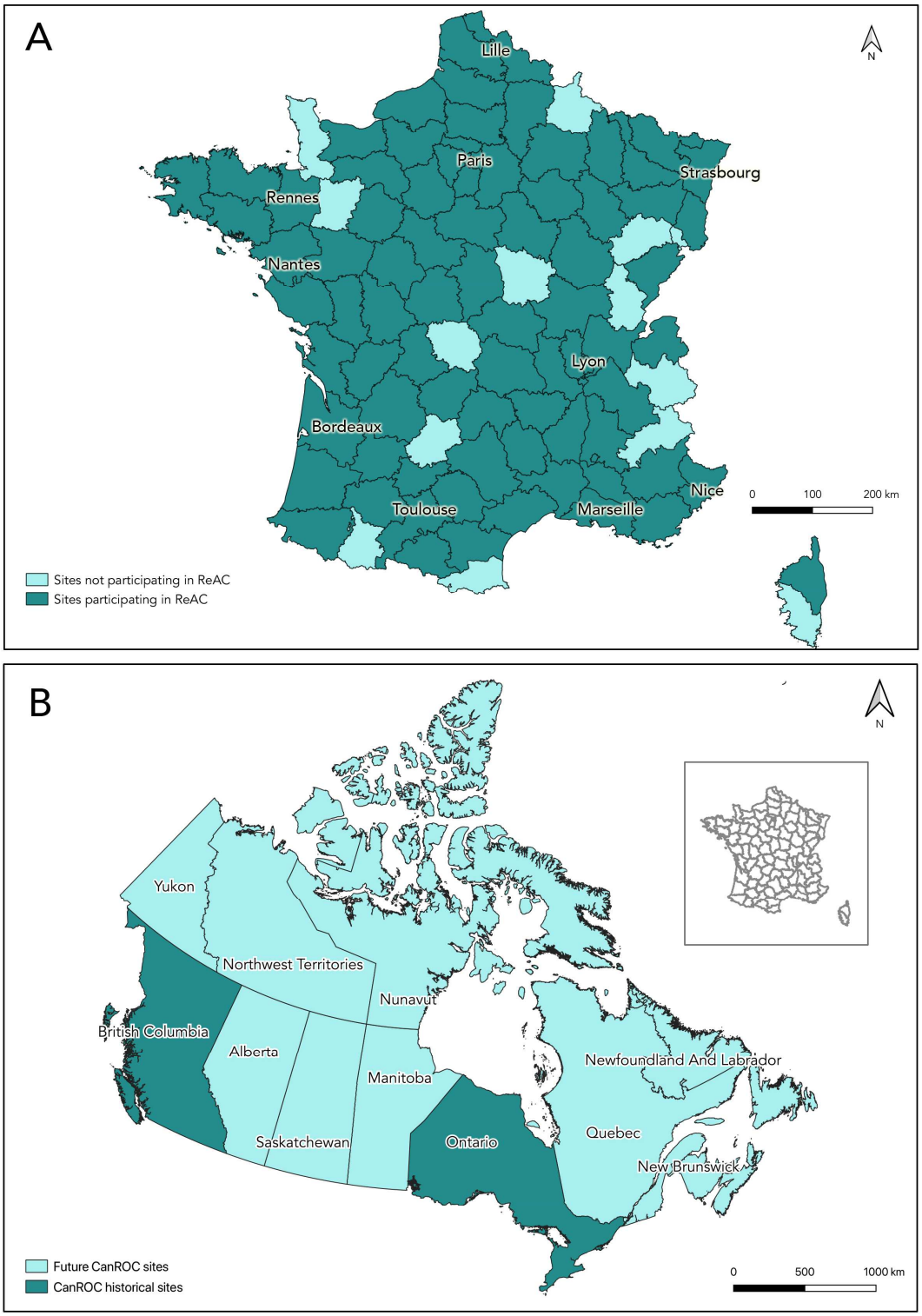

Table 1. Recommended Utstein core variables and time events recorded in RéAC and CanROC registries: matching definitions

	RéAC	CanROC	Matching definitions
CORE UTSTEIN VARIABLES			
Resuscitation not attempted			
All cases	Yes	Yes	No
DNAR	Yes	Yes	Yes
Considered futile	No	Yes	No
Resuscitation attempted			
All cases	Yes	Yes	Yes
Any defibrillation attempted	Yes	Yes	Yes
Chest compressions	Yes	Yes	Yes
Assisted ventilation	Yes	Yes	Yes
Location of arrest			
Out-of-hospital			
Home	Yes	Yes	Yes
Public place	Yes	Yes	Yes
Other	Yes	Yes	Yes
In-hospital			
Ward	Yes	Yes	Yes
Emergency department	Yes	No	No
Operating room	No	No	No
CCU/ICU	No	No	No
Other	Yes	Yes	Yes
First monitored rhythm			
Shockable			
VF	Yes	Yes	Yes
VT	Yes	Yes	Yes
Non-shockable			
Asystole	Yes	Yes	Yes
PEA	Yes	Yes	Yes
Unknown	Yes	Yes	Yes
Arrest witnessed/monitored			
By layperson/bystander	Yes	Yes	Yes
By healthcare personnel	Yes	Yes	Yes
Arrest not witnessed	Yes	Yes	Yes
CPR before EMS arrival	Yes	Yes	Yes
Aetiology			

Presumed cardiac	Yes	Yes	No
Trauma	Yes	Yes	Yes
Submersion	Yes	Yes	Yes
Respiratory	Yes	Yes	Yes
Other noncardiac	Yes	Yes	No
Unknown	Yes	Yes	Yes
Outcome			
Any ROSC	Yes	Yes	Yes
Yes	Yes	Yes	Yes
No	Yes	Yes	Yes
Unknown	Yes	Yes	Yes
Survived event	Yes	Yes	Yes
Discharged alive	Yes	Yes	Yes
Neurologic outcome at discharge	Yes	Yes	Yes
CPC 1 or 2	Yes	Yes	Yes
CPC 3 or 4	Yes	Yes	Yes
CPC 5	Yes	Yes	Yes
CORE UTSTEIN TIME EVENTS			
Date of death	Yes	Yes	Yes
Time of witnessed/monitored arrest	Yes	Yes	Yes
Time when call received	Yes	Yes	Yes
Time of first rhythm analysis	Yes	Yes	Yes
Time of first CPR attempts	Yes	Yes	Yes
Time of first defibrillation attempted	Yes	Yes	Yes

CCU: Critical care unit; CPC: Cerebral performance category; CPR: Cardiopulmonary resuscitation; DNAR: Do not attempt resuscitation; EMS: Emergency medicals services; ICU: Intensive care unit; PEA: Pulseless electric activity; ROSC: Return of spontaneous circulation; VF: Ventricular fibrillation; VT: Ventricular tachycardia.

Table 2. Characteristics of EMS systems, OHCA patients and outcomes between France and Canada (preliminary data)

	France	Canada
Country		
Size (km^2)	551,695	9,984,670
Density (inh./km^2, mean[min-max])	122 [0-42,253]	4 [0-5,492]
Population (n)	66,992,699	37,589,262
Urban population (%)	80	80
Registry		
Name	RéAC	CanROC
Year of creation	2011	2005
Patients included since creation (n)	103,722	99,317
Study population (2011-2016) †	55,358	33,688
Estimated incidence rate (adults)	75,3/100,000	83/100,000
EMS systems		
Type	Stay-and-stabilize	Stay-and-stabilize or scoop-and-run
Guidelines	National	National
Emergency call centre	One per district*	Depending on region
EMS agencies (n)	96	40
Units, n (density/100.000 inh. [min-max])	BLS: 6,301 (10 [8-20]) ALS: 466 (0.7 [0.2-2.4])	BLS or ALS: 791 (8.42 [2.5-11.5])
Triage and dispatch	Clinically-driven (physicians)	Primarily non-physician, dispatch trained
Response mode (no. of rescuers)		
BLS	Firefighters (4-6)	Firefighters or primary care paramedics (2-4)
ALS	Physician-led MMT (3)	Advanced paramedics (2)
Critical care	Physician-led MMT (3)	Rarely for OHCA (air ambulance, ON)
Response time objectives	Firefighters < 10 min Physician-led MMT < 30 min (national)	First responders < 6-8 min (urban) Advanced paramedics: no goal metrics
Choice of destination	Upon agreement between the triaging physician at the emergency call center and the in-hospital physician	British Columbia: choice made by paramedics on scene (sometimes upon approval of specialist paramedics at the emergency call centre); information given directly to the in-hospital physician Ontario: dictated by dispatch unless special circumstances with bypass agreements
ER bypass	Always	Inconstant, depending on region
Population (overall)†		
Age, years (median [IQR])	68 [53-82]	67 [54-80]
Sex (%)	Male (63)	Male (60)
Aetiology (%)	Presumed cardiac (64)	Presumed cardiac (90)
Location (%)	Home (75)	Home (83)
Bystanders (%)		
Non-EMS witnessed OHCA	49	40
CPR	42	46
Defibrillation before EMS arrival	2	4
Initial rhythm (%)		
*Shockable*ˣ *(VF/VT)*	16	22
Not shockable (Asystole, PEA, other)	84	78
EMS procedures		
EMS-RT, minutes (median, IQR)		
Call-arrival at scene		
BLS/first responders	10 [7-15]	6.5 [5-8.5]

ALS/MMT	20 [14-28]	7 [5-10]
Call-1st rhythm analysis	13 [9-18]	9 [7-12]
Call-1st injection of adrenaline	25 [18-34]	20 [16-25]
Attempted resuscitation by EMS (%)	82	60
Discontinued prior to transport	79	45
Defibrillation by EMS (%)	14	11
Infusion access	IV > IO	IV > IO
Airway management	Intubation	Intubation/SGA
Chest compression	Manual > mechanical	Manual > mechanical
ECMO	In-hospital > prehospital	Rarely in-hospital
Outcomes† (%)		
ROSC	24	48
Transportation to hospital	21	50
Survival at hospital discharge (overall)	5	11
Good neurological status° (survivors)	84	92

†: Population-based data are drawn from the British Columbia and Ontario CanROC sites (Canada) and from the overall ReAC population (France), in adult, non-traumatic, EMS-treated OHCA cases

x: patients shocked either prior to EMS arrival or by EMS teams

°: Cerebral performance category (CPC) ≤ 2; status assessed at hospital discharge.

ALS: advanced life support; BLS: basic life support; CPR: cardiopulmonary resuscitation; ECMO: extra-corporeal membrane oxygenation; EMD: electro-mechanical dissociation; EMS: emergency medical services; EMS-RT: EMS response time intervals (from call to arrival at scene); ER: emergency room; IO: intra-osseous; IQR: interquartile range; IV: intra-venous; MMT: mobile medical team; OHCA: out-of-hospital cardiac arrest; ON: Ontario; PEA: Pulseless electric activity; ROSC: return of spontaneous circulation; SGA: supraglottic airway device; VF: ventricular fibrillation; VT: ventricular tachycardia;

** 'Département'; highest French administrative level of intraregional subdivision*