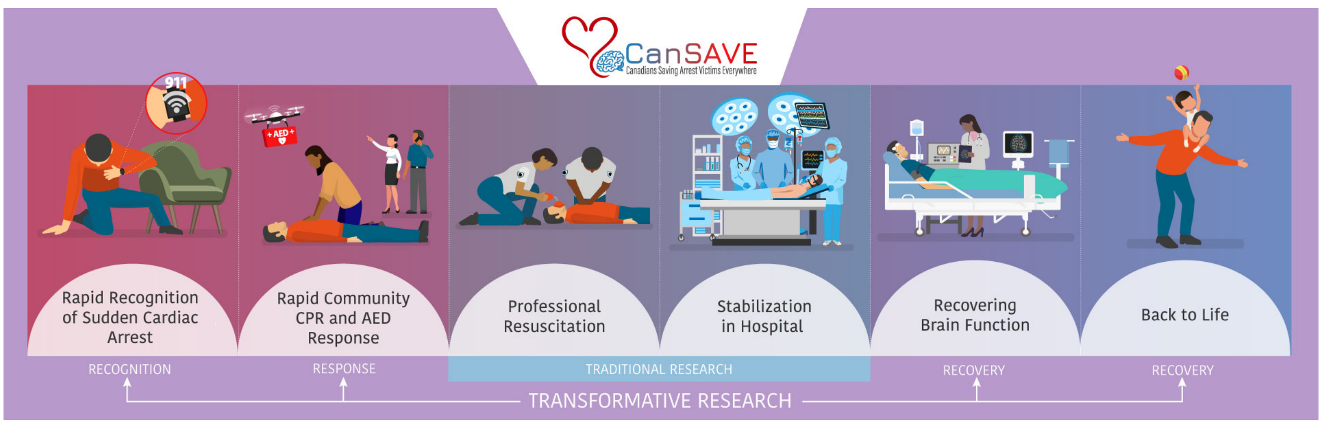
CANSAVE
SCIENTIFIC SYMPOSIUM
2023



APRIL 5 & 6
UBC ROBSON SQUARE
VANCOUVER, BC

INTRODUCTION

We are pleased to report on the successful first face-to-face meeting of the CanSAVE investigators and international scientific collaborators. The meeting took place in Vancouver at UBC Robson Square on April 5 and 6, 2023.

The purpose of the symposium was to review the progress and status of our research programs and, with the help of international and national topic experts, to identify ongoing priorities and plan future steps. Invited participants included all CanSAVE members, representatives from BC Emergency Health Services, the Heart and Stroke resuscitation team, persons with lived experience (survivors), and international experts with experience in each of the CanSAVE research programs.

The symposium included initial summaries of work-to-date and then two sessions for each program stream to engage the audience in the discussion of future short- and longer-term priorities. Where possible, each program leader also suggested a vision and strategies to advance the research and requested comments and reflections from the audience.

Report Format

This report details the meeting content, across our 3 transformative out-of-hospital cardiac arrest (OHCA) research themes: ***Rapid Recognition**, **Rapid Response**, **and Recovery**.*

The '*Current State of the Research*' sections of the report are extracted from the opening presentations given by CanSAVE research leads and our international guest experts. Subsequent report sections are amalgamated summaries of whole group feedback, strategic discussions and planning next steps for each specific research area.

RAPID RECOGNITION

The Rapid Recognition research stream includes two research teams, one investigating the benefit and design of biosensors to detect OHCA, and another team seeking to identify the best methods for emergency communication centers to quickly identify cardiac arrest and achieve early cardiopulmonary resuscitation (CPR).

RAPID RECOGNITION: BIOSENSORS

CURRENT STATE OF THE RESEARCH

What we know

Jacob Hutton, University of British Columbia, Canada

In an analysis of all cardiac arrest cases over a two-year period, including treated and untreated cases, over 50% are not treated. The primary driver of that treatment discrepancy is the presence of a bystander witness. In unwitnessed cases (accounting for 75% of cases overall), 57% do not receive treatment from paramedics, in comparison to witnessed cases (accounting for 25% of cases overall), only 1.5% have treatment withheld. In bystander-witnessed cases, 17% will survive to hospital discharge, whereas only 1.5% to survive to hospital discharge in un-witnessed cases.

Our research questions:

- How can we use technology to bridge this gap in recognition and treatment?
- If we did, what would the expected incremental increase in the number of survivors to hospital discharge be?
- For unwitnessed cases, if they were wearing some sort of theoretical biosensor, are there certain types of cases that may experience a larger benefit?

We took a two-year sample that included almost 12,000 cases from the BC Cardiac Arrest Registry, to model the potential gains from widespread personal sensor use that could detect a cardiac arrest and call 9-1-1. Our results indicate that a bystander witness increases the odds of survival by about 8.7 times. This is broken down into two independent pathways: the interventional pathway of providing CPR and applying an AED; secondly, the independent recognition that a bystander can provide. We suggest that a biosensor could function as that independent recognition.

Based on our research framework, we find that the recognition component of a bystander witness is about 84% of the total effect. The odds ratio attributable to recognition alone is about 6.7.

Using this as a foundation we built simulations to look at previously unwitnessed cases in our cohort, to determine what outcomes would be if a range of these were instead witnessed. The results demonstrate that, conservatively, we can more than double survival to hospital discharge if 100% of previously unwitnessed cases used a sensor. And even with a sensor that only alerts 50% of the time, the gains are still large: 74% increase in survival. This gives us the foundation to say there are unrealized gains in survival that we can focus on by just increasing recognition.

The next question was: for a perfect biosensor, what kind of case may benefit most? Looking at subgroups based on cardiac arrest characteristics and location, that biggest gains are focusing on arrests that happen in private locations, where we may expect almost 19% more survivors per 10% incremented recognition.

Takeaways from our modeling work

There are significant gains to be had by just focusing on increasing recognition, even if no additional cases receive CPR or AED, and that the estimates we have in this project may be higher in the real world.

From an implementation perspective we can say that there is evidence that different types of patients may benefit from recognition. And so, when we look further down the line to implementing biosensors, this can help choose who we want to target.

Development of the sensor- what we are looking to understand?

Calvin Kuo, University of British Columbia, Canada

There are a lot of biosensor technologies out there that already monitor cardiac health- watches athletic chest straps and other- but very few are meant to monitor cardiac arrest specifically.

We need a cardiac arrest monitoring system that monitors continuously to identify all cardiac arrests and activate a response accordingly. Postdoc Mahsa Kahlili led a study into testing sensors on different locations on the body, to determine the level of accuracy we could expect from a cardiac monitoring device. While potential users would prefer a device on the wrist, it is not the greatest place for measuring cardiac signal. To get a more accurate measurements of these things, the fingertip is the best option.

We need to understand external parameters and the sources of error affecting the sensors in real world use. If we have a measured understanding of this, we can start to make estimates on prediction accuracy for things like cardiac arrest. It may be beneficial to build a sensing methodology that looks at all the physiological changes that happen during the cardiac course and not just the fact that the heart stops: falling, agonal breathing, etc.

To improve survival, we need both an instant depiction of the cardiac event and a prediction of one.
Babak Shadgan, University of British Columbia, Canada

We are exploring the development of multi-modal biosensing techniques. The core of this type of biosensor is based on the optical sensors near infrared spectroscopy and PPG pulse oximeter. With these sensors we can measure a wide range of vital signs: cardiac pulsation, respiratory patterns, and oxygen saturation; and we are also looking at measuring the motion and positioning of the user as well at geolocation.

MEDIUM-TERM AND ULTIMATE GOALS

1. *Cardiac Arrest Sensor development*

a) Hardware: pursue partnership with industry partners and create new hardware that includes electrophysiology, photoplethysmography, acoustic, near infrared spectroscopy (NIRS), temperature, and accelerometry/movement-based

b) Software: Develop (or modify previously created application) to receive data from sensors to detect a cessation of circulation and activate 9-1-1 services

2. Collect data from healthy and cardiac arrest states.

a) Collect data from healthy individuals to define normal parameters.
b) In collaboration with other members from the research team, the centre prototype will be tested in animal models. We will collaborate with existing swine laboratory models used within the UBC and will apply our prototype during other planned experiments. As swine models are typically

euthanized at the end of experiments, our prototype will have the opportunity to measure data during cardiac arrest.

3. Develop machine learning algorithms to detect cardiac arrest.

a) Using data collected, machine learning algorithms will be developed to distinguish between normal and cardiac arrest states.
b) Data from multiple sensors, alone and in combination, will be evaluated for sensory performance.

4. Final Testing

a) Clinical tests: research team members will facilitate approvals and research setting. This will allow for clinical testing to define parameters of cardiac arrest:

i. Detection of false positives: we will apply the device on healthy individuals to determine the rate of false positive activations.
ii. Detection of true positives: in settings with expected deaths (medically assisted dying clinical settings) we will test the device's ability to detect clinical death.
iii. Further refinement of diagnostic algorithms

SIGNIFICANT CHALLENGES AND BARRIERS

Consumer comfort and user compliance

We would like cardiac arrest surveillance to take place across the board with people wearing cardiac arrest sensors for the rest of their lives. But since SCA is not that frequent, how can we make an accurate sensor people will find useful and wear?

We know that households who receive new information about health risks from an event or new diagnosis increase their overall levels of spending by 10%, including investments in both preventative and low value services. So, people are shopping for devices. Through our modeling project we see that the biggest gains in survival would be in the private location arrest detection where 87% of SCA occur.

There is a market for a home-based sensor but there is a disconnect between the engineering perspective and the user perspective.

Engineers would ideally want people to wear a headband every day, but users prefer a watch, bracelet, or a ring- the types of sensors that are the worst for us from an engineering perspective due to issues with skin contact. Further, there is a lack of continuous monitoring since people take them on and off and charging the device is needed. People who are at higher risk may be more willing to wear a sensor, and more willing to wear more obtrusive sensor designs. One option is implantable sensors which can increase the accuracy substantially.

Sensitivity, specificity, and false positives.

There is little data in the literature examining the utility, effectiveness, or accuracy of biosensors for cardiac arrest. When accuracy is addressed, it is typically focused on sensitivity. One of our key recommendations is that a cardiac arrest sensor should really optimize specificity, even potentially at the cost of sensitivity to ensure that false positives don't burden an already overwhelmed EMS response system.

Industry and personal health company partnerships and buy In

If we fully develop a sensor on our own, we are looking at 10+ years before it gets onto users; if we partner with industry, we could potentially have something ready to be tested on real people in a year or two. We have been looking to partner with existing companies that have already built sensors, but we have not had much luck. It must be partnership that can facilitate access to raw code from the device since we think this is probably the fastest way to bring a personalized sensor to the cardiac arrest realm. But companies we have approached are not interested in sharing their raw data.

Organizational socialization and buy-in

We need to bring more people to the table to make the case to industry and health care systems by showing feasibility; the potential impact that cardiac arrest sensors can have in the personal wellness space; and that sensors can be integrated into the public response system.

Strategies:

- Developing a white paper or position statement by CanSAVE on why this this crucial.
- Find an industry partner: a medical device manufacturer that is already in this space.
- Outreach to companies looking to reorientate their activity towards health and prevention; they may help find us find partner willing to engage money, people, and other resources to the project.
- UBC commercialization support, department incubators and connections with innovative commercial entities for other ideas.
- Connect with impact investment committees that look at new technologies and their impact on their mission who then send the plan to investment experts to help determine whether they should invest in or not.

Licensing and privacy

We need to determine if we need to think about whether a cardiac arrest detection device needs to be licensed as a personal health device or a medical device. This will also determine our pathways through testing and development and use.

Lack of human testing opportunities.

Getting data from cardiac arrest events is challenging since cardiac arrest incidence is so low. For example, if we design a trial where we put sensor on people and we assume that our sensor could deliver a 20% survival versus a 10% survival without the sensor, you need 200 cardiac arrest cases per group. So, we would need 200,000 people wearing sensors to get that many people who had a cardiac arrest so that we could see a difference.

Measuring real life use?

One option is to start with a larger survey around predictive use and the theory of planned behavior to measure intention and then pilot the sensor inside the best parameters outlined by the responses to this type of survey

MAID study

Our study has been approved by ethics and we are finalizing our sensor design so that we can implement it. One question is whether MAID (Medical assistance in dying) participants who are undergoing like lethal doses of sedatives is an appropriate model for your average cardiac arrest victim.

POTENTIAL IMPACT

Every year EMS respond to an estimated 38,000 Canadians experiencing SCA. However, even in the best systems, only 5%–7% of SCA cases with an EMS response survive to return home. A large contributor to this poor overall survival rate is that no one witnesses the cardiac arrest in the majority of cases. Cardiac Arrest outcomes are highly dependent on the time from the arrest to medical treatment, with each passing minute decreasing the likelihood of survival by approximately 13%. Sensors to detect cardiac arrest and request assistance have the potential to increase the number of survivors from cardiac arrest in Canada by several thousand per year.

RAPID RECOGNITION: OPTIMIZING COMMUNICATION CENTER RESPONSE

CURRENT STATE OF THE RESEARCH

The 9-1-1 Communications Processes in Canada

Christian Vaillancourt, Ottawa Hospital Research Institute

When a 9-1-1 call is received for a possible cardiac arrest, we need to achieve the correct response as soon as possible. We are counting seconds not minutes. The 9-1-1 communication and dispatch system in Canada is insufficient for getting to our goal of accurate and fast response to sudden cardiac arrests necessary for optimal survival.

Processing the 9-1-1 Call

The first person you get on the phone is not medical responder but a primary answering service switch board operator, with unnecessary inherent delays. If we know it is a medical emergency, we should have a 9-1-1-2 code to directly connect to ambulance specific dispatch but we don't.

There is an EMS communication center caller identification script. This is important, but it is time consuming and cumbersome. What can we do to streamline or automate this? There is also a hold lag between dispatching the ambulance and starting CPR instructions. Can we automate the dispatch of resources and focus on the caller?

Identification of sudden cardiac arrest

To initiate CPR instructions, a 9-1-1 call taker needs to be able to recognize a cardiac arrest. Agonal breathing is a key indicator, but 9-1-1 call takers miss this 25% of the time. A 30-minute educational video intervention was implemented to train 9-1-1 call takers to recognize agonal breathing, the outcomes of this pilot was a decrease in missed sudden cardiac arrests. This program is now in four provinces and can be expanded.

Administering CPR Instructions

The stress on scene can overwhelm the bystander and frustrate 9-1-1 call taker efforts to implement CPR instructions. Time is lost in balancing the activation of the paramedic response to the scene and the need to be fast and direct with

CPR instructions. Quickly and economically communicating the CPR instructions is key but we need more, well-rounded 9-1-1 call taker education to be able to cut the noise and focus on the caller. Do we officially change the CPR script? Or allow for flexibility in it?

The GoodSAM App and the Potential for Improving OCHA Recognition

Mark Wilson OBE, Co-founder & Director GoodSAM, United Kingdom

GoodSam is powerful technological solution used by emergency and community responders across the globe. If you dial 9-1-1, and say certain words like ‘not conscious’ ‘not breathing’ or any defined terms that mean it is or possible will be a cardiac arrest. The App does three main things after this:

1. an algorithm automatically alerts the emergency services and command the series of events needed.
2. it uses geolocation to automatically situate the caller and
3. it has a highly advanced 9-1-1 video system that can open the mobile camera of any 9-1-1 caller to allow dispatch personnel to view the scene in real time.

It also has an advanced crowd-sourced AED mapping function where anyone can log and geotag an AED and not only get information on the condition of the AED– battery function – but also passcodes for access if it is locked.

GoodSAM has been shown to triple survival rates is some areas of the UK and is showing similar results in other countries.

The ability of the app to geolocate those in need and connect those with people who can help has led to several other applications that may make it more financially attractive as system to protentional funders, industry partners and government agencies: recruit and manage volunteer responders for natural disasters and mutual aid response in the community.

MEDIUM-TERM AND ULTIMATE GOALS

Continuing to Investigate AI and App Based Emergency Response Systems

The technology we are discussing is here already and we need to accelerate its use where it would be beneficial.

IMB Watson and AI integration and GoodSAM App based systems could help us meet our time to CPR goals by:

- Applying natural language processing algorithms to gather information during the hold period blind spots.
- Triaging incoming 9-1-1 calls more effectively
- Helping 9-1-1 call takers assess cardiac arrest/ agonal breathing more accurately and quickly.
- Automatically dispatching the right resources to the scene
- Automating determination of the location, so that 9-1-1 call taker can focus on the person on the phone.
- Offer real time CPR support through Video.

Getting ahead of Next Gen 9-1-1 Rollout

By 2025 the Next Gen 9-1-1 digital system will be in place in Canada. There is a huge and urgent opportunity for us to think about how we can integrate our research to influence the roll out and use of the system.

Developing a culture of research and education within 9-1-1 dispatch

The dispatchers and the communication centers are the critical intersection of many of these programs. Their value cannot be overstated. Leverage the CanROC network to bring together dispatch centers and agencies across Canada to build a dispatch research network.

Creating a dispatch communication field of study

Expanding the training offered to 9-1-1 call takers to meet our goals of time to excellent CPR and adding ambulance field work hours to the communication officer training criteria.

Better understanding of the time to response

The CanROC national cardiac arrest database includes CPR process data, which is difficult to collect, but the time from primary call to the answer service to dispatch center to intervention should be better measured.

Opportunities for further study:

- **Bystander action time:** Research shows that it takes approximately a minute and 20 seconds for someone to make the actual 9-1-1 call. Can we get bystanders to act faster?
- **9-1-1 hold time "blind spot":** over the past three years in the survival rate British Columbia has been dropping significantly. We have always assumed that the wait time to a 9-1-1 call taker 30 seconds but with news reports of people waiting a lot longer and often not getting through at all.

SIGNIFICANT CHALLENGES AND BARRIERS

- Who is missing from the table for dispatch research, socialization and roll out?
- How would we integrate this in to the new "Next Gen 9-1-1" in Canada?
- Surveillance and privacy regulations in Canada may limit our application.
- Who would oversee its use?
- Where could it fail?
- What are the best funding options?

POTENTIAL IMPACT

The above strategies will have significant impact on survival by shortening time to bystander CPR and use of AEDs. Quality of bystander CPR could be evaluated by video analysis through Good Sam and corrected in real time. Time to get professionals to the scene could be shortened by a more efficient dispatch process.

RAPID RESPONSE

The rapid response research stream includes two foci, one team investigating the feasibility and benefits of drone delivery of AEDs, and another team testing the feasibility and benefits of community responder programs.

RAPID RESPONSE: DRONES FOR AED DELIVERY

CURRENT STATE OF THE RESEARCH

Drone Delivery Feasibility
Ian Drennan, University of Toronto

The AED Drone project in Ontario has been ongoing since 2019. The project's primary objective is to integrate a drone-delivered AED into the 911 response for cardiac arrest and other life-threatening medical emergencies.

To date, the project has hit several milestones towards implementing drone-AEDs. We have worked with an Engineering group from the University of Toronto to develop mathematical models for drone placement, improvements in EMS response times with the strategic placement of drones, and to use machine learning to develop adaptive dispatching algorithms to help with drone dispatching. We have done several test flights to determine the feasibility of drone-AEDs using both urban and rural geographical areas, different weather, and times of day. We have tested multiple methods for delivering the AED to the bystander and worked with the public and lay responders to understand the perceptions of drones and improve understanding of AEDs. Part of our feasibility work was to compare response times between AED drone delivery and ambulance to mock sudden cardiac arrest resuscitations.

Conclusions from the project thus far demonstrate that AED drone delivery is feasible, with the potential for improvements in response time during simulated sudden cardiac arrest scenarios. Further research is required to determine the appropriate system configuration for AED drone delivery in an integrated emergency medical service system as well as optimal strategies to simplify bystander application of a drone- delivered AED.

The Sweden Experience with Drone Delivery of AEDs

Andreas Claesson, Karolinska Institute Sweden

Researchers in Sweden started looking at Drones in 2014 because sudden cardiac arrest survival rates had not risen in 10 years, and it was clear they needed a rapid intervention that reached people in their homes and in the community quickly. In 2020, after years of theoretical modeling, planning and drone testing, the team submitted a very thorough safety analysis to Transportation Sweden and a permit was granted to launch a feasibility study in June 2022. The study was conducted between 1 June and 30 September 2020 in three areas within the controlled airspace of Säve Airport, Gothenburg, Sweden, covering 125 km^2, with about 80 000 inhabitants. The primary outcome measure was the proportion of successful accurate AED deliveries when drones were dispatched and in cases of suspected cardiac arrest. Secondary outcomes were the response time as compared to ground EMS; specifically, to understand if the bystander has enough time to use the AED before EMS arrived.

The study was published in the European Heart Journal last year. Out of 53 cardiac arrest alerts, the team was able to deliver an AED in 11 cases, seven before EMS, with a time benefit of 2 minutes. The study showed that AEDs can be carried by drones to real-life cases of OHCA with a successful AED delivery rate of 92%, demonstrating feasibility.

The research team also is considering alternative uses for drones since they sit idle *8-10% of the time*. In December 2022 the program performed 20 LiveView flights to provide real time video feeds from traffic accidents, train accidents, drowning etc.

MEDIUM-TERM AND ULTIMATE GOALS

Transportation Agency Buy-in and Approvals: Our primary goal is to implement a drone-AED into clinical practice and 911 response. This is critical for us to continue to move this area of research forward. Implementation will provide opportunity to further evaluate and refine the program. It will also help with funding and regulatory barriers, by showing proof of concept and the potential impact of this program.

Our immediate goal is to work with regulators to get the approvals to conduct this research using Beyond Visual Line of Sight technology as part of the 911 system.

Additional goals include establishing funding streams to ensuring a sustainable program, and to identify opportunities to collaborate with others in this space to develop a network of researchers of drone-AEDs.

SIGNIFICANT CHALLENGES AND BARRIERS

Transportation agencies buy-in and approvals

Complying with regulations and ultimately approval from air traffic regulators is a large barrier. This is a novel use of beyond visual line of sight (BVLOS) technology requiring immediate launch and flight plans that are not pre-approved to get to the scene as quick as possible. Transport Canada and NAV Canada are risk adverse, and the drone system is not yet seen as a priority for them. Sweden originally faced a similar problem, and it was overcome by providing data on feasibility and safety of test flights.

The key is to include all relevant stakeholders-- industry, Medical professional, community groups, EMS, air transportation regulators-- at the conversation table.

Social acceptability of drones

The second barrier is potentially the community /social acceptability of flying drones in the community. Based on work that Katie Dainty published, we do think that people are okay with flying drones for medical reasons, in fact, more acceptable than for commercial enterprises like amazon and uber eats. More work needs to be done to justify the relative cost effectiveness over other health care costs. The strongest argument likely rests around increasing accessibility and reducing the inherent inequity of heath care in smaller communities.

Bystander application of the AEDs

A major challenge is to ensure that the bystander at the scene will use the AED once delivered. Katie's work showed that lay-persons were not always comfortable using AEDs. Bystanders are generally unfamiliar with AED use. In addition, if there was only bystander or primary rescuer available, they had to leave the patient (and stop CPR) to retrieve the AED (and thus there is a tradeoff of risk-benefit). Alternatively, there may be too many bystanders and no-one taking the responsibility. We have overcome barriers to AED use by incorporating a cell phone with facetime application to allow bystanders at the scene to speak with someone on the phone (e.g., paramedic monitoring the drone program) to walk them through using the equipment. Major public education on the use of AEDs continues be a critical component of the success of all AED programs and will be critical to a successful drone program as well.

Research directions

It will be important to decide what the next style of research should be. Could be a clinical trial but more likely using an implementation science framework or step wedge design. It is probably more powerful to run a multicenter trial, hopefully partnering with other places like Sweden to increase our number of drone deliveries and increase the sample size for future research. We believe at this point in our research we have done considerable background testing and our next step is to study the integration of the drone AED into the 911 response.

More information is needed to determine the impact of drone programs including significant changes in survival and neuro-outcome, but also process measures such as proportion of times an AED delivered is applied, the time differential to application of shock, and adverse effects such as a potential decrease in CPR quality. The CanROC registry will be able to provide ongoing information and comparison of jurisdictions as drone programs role out. Determine the important metrics to study for a drone program is essential. There are most likely more important metrics than just patient survival and neurologic outcome that would indicate a successful program.

Implementation and sustainability funding

Drones are expensive. Preliminary work has been funded through grants and industry sponsorships and in-kind funding. We need alternative sources of funding to make a drone-AED program sustainable long-term. Other sources of funding such as Philanthropy, Industry, Government, and Healthcare organizations will likely provide the ultimate sustainable resources and need to be explored further. Marketing the drone program is key to garnering financial support.

Sustainability also has to do with drone usage. In areas that are likely to benefit the most from drone programs (rural and remote regions) utilization hours for drone-AEDs would be low due to the low number of cardiac arrests. To help increase the acceptability of drone-AED programs it is important to examine other uses for drones when not responding to cardiac arrests. We have developed a medical kit which includes an AED plus naloxone, epinephrine autoinjectors, tourniquets and other equipment that we feel could be used by bystanders and has the potential to save lives. There are other potential viable options for increasing drone utilization rates, and these should be explored as well within the local context of the drone program. Sharing drone resources could also help share financial costs associated with a drone program. Drones could potentially a larger portfolio of use (e.g., package delivery, delivery of other medical equipment, etc.). This might make it easier to sustain an integrated AED delivery program if a wider use case for Drones. How can the drones serve needs for other emergency partners such as fire, police and other agencies or commercial agencies.

Implications of the new 911 system in Canada

The Next Gen 9-1-1 system in Canada will make it possible to provide additional details about emergency situations. For example, in the future, Canadians could send a video of an accident, as well as provide medical information to first responders. This could lead to safer, faster, and more informed emergency responses. How this will be integrated into the Drone studies and eventual program implementations is unknown.

Competitive technologies

Low cost, miniaturized AEDs are currently being developed, with the goal of having AED's as ubiquitous as fire extinguishers. People at the scene might carrying these mini personal defibrillators but, it's unlikely that uptake will be substantial within the next 10 years. Cheaper or smaller doesn't mean that lay persons at the scene will use them or buy them. Personal AEDs are much more complex than just putting them on the market. Working prototypes of Flying Ambulances are being investigated in France. It will be at least 10 years before such vehicles are commercially available.

Changing environment of community response

Many communities have slow response times and would benefit today from drone delivery of AEDs. These communities may also fit the profile for community engagement with dedicated community responders integrated into the 9-1-1 system. If so, an appropriately trained volunteer potentially would get to the scene with an AED faster than an unmanned drone. There is also the possibility that again these two programs run synergistically to improve AED response times. It is unlikely that in large community responder programs that every community responder can carry an AED (financially this would be difficult) however community responders that get an AED delivered by a drone could significantly improve response times. This is another example of how there are multiple ways that potentially must work together to make a real impact in our AED utilization and response.

Who will run these programs?

Scalability requires buy in across the stakeholders. Would they be managed by paramedic services? Unions will have to be supportive. Perhaps other administrative models will be required in various, specific circumstances.

KEY STRATEGIES

Our path in Ontario/Canada is amazingly similar to the path taken by the Swedish group, however they started 5 years prior. They had many of the same challenges, and continue to face some of the same challenges, but have continued to work to overcome the barriers and have successfully implemented a drone-AED into the 911 response.

Our next step is to implement into 911 system, to study in real 911 response, and to continue to modify our program as necessary as we learn through actual 911 emergencies.

A successful drone-AED program does not need to show improvements in survival. Other markers of success such as earlier AED application, arrival at the scene, increased shockable rhythms/shocks provided etc. are early wins for a program that would show success.

It was suggested to partner with other organizations to share usage and costs associated with drone programs. Similarly, looking for ways to ensure drones do not sit idle for long periods seemed to be key to the group to ensure acceptability of these programs.

Interestingly, there were concerns from the group that the potential landscape and use cases for drones is changing (personalized AEDs, community responders etc.). It seems overall that the niche for drone technology is somewhat unclear. As drones become more commonplace this will most likely change.

FOCUS OVER THE NEXT YEAR

The Canadian drones AED delivery project has come a long way. Considering the challenges, we are facing, and the questions discussed over the last two days, our focus is to advance further research required to determine how to overcome regulatory hurdles and integrate drone AED delivery into the emergency medical service system.

POTENTIAL IMPACT

The potential impact for suburban and more rural communities is high if AED drone delivery can be effectively integrated into the 9-1-1 response. Analyses are needed to define and identify geographic areas that have a minimum number of OHCAs with longer EMS response times to justify an AED program. Supporting those at the scene to apply the AED will be a necessary adjunct to the mechanical delivery of the AED.

RAPID RESPONSE: COMMUNITY VOLUNTEER RESPONSE

CURRENT STATE OF THE RESEARCH

Volunteer Community Response

Steve Brooks, Queen's University

We know that a lot of people are not getting early CPR and AED response. We are missing so many opportunities to get survivors in the field to hospital so that we can provide them with optimal care once they're there.

Community responder programs are not homogenous. Some programs notify nearby community members who are not screened and independently take CPR training. Other programs include only members who are registered, vetted, and trained and equipped and often are off-duty professional health emergency or police responders.

Most are activated through an app-based system. There has been an explosion of different mobile device apps over the last 10 years that engage community members, notify them of the location of an incident, the location of a public AED, and direct them to the scene. These apps are used by the anonymous and independent lay-responses and by the vetted and trained lay-responders. These apps and community volunteer programs have been successfully implemented in different parts of the world and are active today in the US, Canada, the UK, Singapore, France, Australia, and Scandinavia.

Clinical trials and explorations are up and running.

The Pulse Point app RCT has been implemented in British Columbia, Winnipeg, and Columbus, Ohio. It is a randomized control trial, with randomization automatically within the emergency dispatch 9-1-1 communication system. It is randomized to notify nearby volunteers with the app or stay silent. The primary outcome is the proportion of bystander CPR and AED use. The study is not powered to detect differences in survival. It has been a very difficult trial to implement and maintain with incredible challenges keeping the recruitment at a much lower rate than we anticipated. The main reason is the need for automation to only apply it to arrests in public places and avoid home arrests due to privacy and liability concerns. Hence, algorithms are conservative and exclude too many arrests in public places.

The Neighbors Saving Neighbors pilot study is being implemented outside of Kingston, Ontario where paramedic response times can be upward of 20-30 minutes. The pilot is a program like the European model of vetted, registered, insured, equipped, and trained users responding in parallel to the professional response. The study outcomes are safety, feasibility, and effectiveness with training of simple, hands-only CPR and AED use, in addition to training on how to hand over to paramedic and fire when they arrive. The study uses the GoodSam app as the dispatch mechanism. The long-term goals are to optimize this program in Kingston, and then work with the Heart and Stroke Foundation of Canada to potentially scale up to other communities.

The US Experience with Commmunity Responder Programs

Tom Rea, University of Washington, USA

The challenge of cardiac arrest resuscitation: Seconds matter.
Early CPR and defibrillation are the most powerful predictors of survival. This requires optimizing community response.

To date, most geospatial smart strategies limit response to public locations. Yet most cardiac arrests occur in residential settings. Optimizing this so it can crowdsource community response to the home has the potential to markedly improve outcome. AHA and International guidelines already support this: "*Use of mobile phone technology by emergency dispatch systems to alert willing bystanders to nearby events that may require CPR or AED use is reasonable*."

Looking to the Netherlands for highly successful model as an ideal example: (i) the most successful communities ultimately enlist 5-10% of the population; (ii) the responder program is activated in upwards of half of all resuscitations; and (iii) volunteer responders decrease time to CPR and defibrillation.

The US is a much more heterogeneous culture with a wide spectrum of values and behaviors. It has a larger set of challenges for implementing this type of system especially in the private residential setting:

- Residential Response Concerns
- Safety of volunteers
- Liability of volunteers
- Qualifications of volunteers
- Safety of callers and patients

None of these worries seem to be significant barriers in the Netherlands or rural Scotland.

The Verified Responder Project (VRP) was launched in 2018 in 4 US Cities over 1 year. The first step was to survey potential community volunteer groups—law enforcement, Fire, and EMS providers—about being activated (when off-duty) for a residential response. When 80% responded very favorably, Interested stakeholders were recruited. The requirements for participation were that they were committed to the one-year project, and they agreed to use the Pulse Point app.

The VRP program was implemented with trained volunteer responders for suspected cardiac arrests to public *and* private locations using Pulse Point app. The study looked at: if the intervention was safe for all involved; the Impressions of responders and 9-1-1 callers; and whether the logistics and operations systems were feasible.

Verified responders comprised about 0.05% of the population. Outcomes of the study demonstrated that off-duty verified responders were alerted in 8% of cardiac arrests and provided initial care in 2%. This model was well-received, safe, & operationally feasible and there was interest in continuing with this type of program.

One observation of note: There were twice as many activations for other conditions compared to cardiac arrest. The top 5 (masqueraders) were seizure, choking, overdose, syncope, and hypoglycemia. This asks us: should "verified responders" be equipped with other lifesaving equipment or skills?

Next Steps are to get smarter with implementation & operation (PAD & AED), evaluate different strategies to increase participation (measure to improve), and consider potential treatment for other conditions.

The Dutch Experience with Community Responder Programs

Rudy Koster, Former Director of Amsterdam Resuscitation studies, the Netherlands

Over the last 50 years several million lay-people in the Netherlands have been trained at least once in CPR and AED use. Today we have about 240,000 people who get training every year.

Our advantage: we do not compromise on the quality of the training. Training includes replication of cardiac arrest, compressions, and ventilations, and since 2002, it includes use of AED. All this training is for lay-people only, and everyone receives the standardized, high-level training.

The second key element is we are very aggressive in measuring the exact time intervals for all the steps in response. For example, measuring the exact time of connection to defibrillator. Systems are notorious for time drift and if don't correct for that, your measurements are rubbish.

The third key element was a community response and a community activation system. The Netherlands started with a text message-based system and now we have moved on to an App based system.

The impact of our work is that we have been able to increase survival from 9% to 23% especially in patients with shockable rhythm. What we achieved is something that took at least 25 years, so don't expect that things will change so quickly.

MEDIUM-TERM AND ULTIMATE GOALS

The Neighbors Saving Neighbors pilot:
Sorting out implementation barriers and challenges to get it up and running and measure for outcomes, and then decide with our partners which pieces of the model work and what our strategy is for building this program in other communities. The failure of the Kingston project will be if it goes nowhere due to lack of uptake, funding, or organizations willing to support roll out.

Scaling up Neighbors Saving Neighbors program
Ultimate goal: implementing organized programs nationally that involve the engagement of community members, whether they be anonymous, or whether they are registered, vetted, and trained and equipped, but nonetheless, an effort distinct from the professional response.

Aspirational goals:

- Ubiquitous use of Pulse Point or GoodSam style app-based activation systems.
- Everyone has the opportunity across all communities to join one of these programs and use the skills that they are equipped with in an organized fashion with support.
- Changing public's expectation around the standard emergency response to sudden cardiac arrest by elevating community response as safe, fast, and ultimately live saving.
- Becoming integrated into to the emergency health systems and dispatch centers and paramedic services.

SIGNIFICANT CHALLENGES AND BARRIERS

Recruitment and retention of people for Pulse Point Trial

PulsePoint has a goal recruitment of 552 but it is on pause in BC where we only have 70 patients recruited. It has been a very real struggle. I (S.B.) won't get into details of that, but we're probably going to have to end that study without our full recruitment.

Dispatch Center and EMS service buy-in for both projects

The engagement with dispatch centers is critical for community responder programs but it has been one the most challenging operational aspects of implementing both the PulsePoint trial and implementing the Neighbors Saving Neighbors. We need to extend outreach efforts and find champions of our work to join our conversation within dispatch centers.

Scalability

The goal is to implement volunteer community response programs that have achievable, high quality, standardized response protocols, that is easy to adopt and that works in lots of different places. Our heterogenous social-cultural landscapes can make scale up difficult, but we can't make bespoke customized solutions for everyone.

Approach scalability differently: A quality Improvement approach:

We can't wait for 10 years of an RCT to tell us where to go with this, so another option is to partner with other communities that are very interested (eg. White lake, Napanee, Crossville, and BC) to follow your steps to date and build as the NSN program is built (just a bit behind) incorporating what they learn in near-real-time. Define the common denominators for any successful community response program then create a Living Tool Kit to share with other communities or provinces so they can start piloting now.

Funding for pilots and beyond

But from a funding and operational point of view for our pilots, do we give everyone an AED? The Scottish model we used for our pilot was one AED for 10 volunteers. We are working with partners right now to look at refurbished defibrillators but maybe in the future, the personal AEDs will solve that issue for us?

But as these projects scale up any model, we share will need to be able to help the communities plan and finance the project. Understanding critical operational requirements, e.g., volunteers per sq mile, AEDs required per # of volunteers will be important so interested communities can plan financially.

Building A Culture – Socialization of Volunteer Community Response

We have the opportunity to start a broader cultural shift to change societal expectations of emergency response**.** This would include the dispatch of community volunteer or PulsePoint or GoodSAM user to your location or your home. Kaity Dainty's research has shown that that upwards of 80% or more people survey said they'd be very comfortable with this system.

Addressing the generational gap in people who sign up for these programs by effectively campaigning to and engaging with people across generations with messaging around: community, family, public safety, mutual aid, and survival.

Working with national partner to develop this. Heart and Stroke is committed as a partner. The organization is national with a strong brand with trust across the country, both in the general population but also with EMS and industry partners.

Legislative authority and oversight

There are gray areas in legal and regulatory issues around volunteer community responders. There are Good Samaritan laws that are currently in place that protect organic bystanders' response, but it is unclear what the laws are around organized community response, and it is unclear how the law impacts dispatch center participation.

Who leads, coordinates, and pays for these programs?

If these programs become national or provincial, where should they sit organizationally and legally? Should this be a third party like the Heart Stroke Foundation or other similar organizations that could make this sustainable and scalable on national level, or should these types of programs be adopted by a particular level of government or government agency (e.g. paramedic program)? Perhaps there is a National Board of Volunteer Response with Emergency Health Services, Dispatch centers, government and Indigenous members and Heart and Stroke for consistency, measurement, and evaluation?

Who will pay for these types of programs? How much will this cost in terms of training, equipment (AED) and management and measurement and evaluation? Do EMS systems need to fund this? What would take to convince the government to say that this program should be funded within the envelope of funding?

KEY STRATEGIES

- Raising awareness of this model for communities
- Engage with decision-makers about the shortfall in emergency response for many areas of Canada outside of dense urban settings.
- Develop partnership with Heart and Stroke Canada, national EMS organizations, and dispatch organizations to educate about the problem and potential solutions.
- Seek funding to develop a multi-site, multi-provincial quality improvement initiative with data collection.

FOCI OVER THE NEXT YEAR:

- Complete the Frontenac Pilot study.
- Seek funding for multi-centre QI study/implementation science grant.
- Develop costing for the program.
- Develop toolkit for implementation in partnership with Heart and Stroke

POTENTIAL IMPACT

The potential impact is enormous if results like those in the Netherlands can be replicated. Integrated community responder programs could guarantee the rapid application of CPR and AED providing most cases with the response profile that has the best outcomes.

EFFECTIVE BRAIN RECOVERY

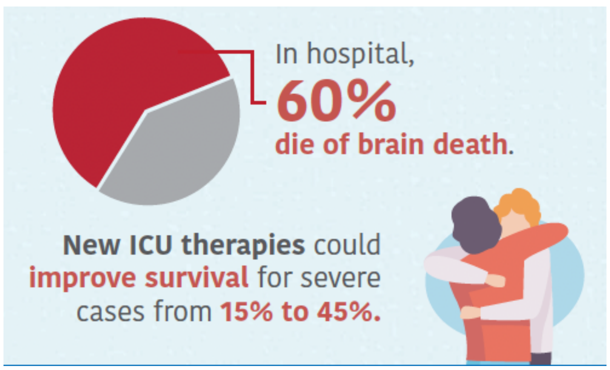
The Brain Recovery research stream includes two project teams, one examining invasive methods of goal-directed cerebral monitoring, and another team investigating the science of surorship to for better post-discharge survivorship.

BRAIN RECOVERY: POST-CARDIAC ARREST MANAGEMENT

CURRENT STATE OF THE RESEARCH

Invasive Post-OHCA Monitoring

Myp Sekhon, University of British Columbia, Vancouver General Hospital



The big question for post sudden cardiac arrest ICU care is: are we giving the incorrect intervention or is our understanding of the disease not what we think it is?

There is a teeter totter in critical care that we try to optimize: balancing oxygen delivery and utilization. We have had several clinical trial and studies over the years that focused on the oxygen delivery, but the results were neutral. Neutral results are very informative: they don't change our practice or give us an intervention to implement but they inform our understanding of the disease.

In 2017, we started undertaking a very provocative way of studying this disease using parenchymal array monitoring with an electrode that reads the dissolved tension of oxygen in the brain tissue, a retrograde single lumen catheter in the sigmoid sinus, and an intercranial pressure catheter. For the non-invasive comparator we used a cerebral oximetry or NIRS. The research was a fishing expedition. We didn't know what we were going to find out and we threw all the 25 million data points that we gathered against the wall and look for relationships. Results were disappointing and raised more questions.

The current research at VGH

We are now able to comprehensively monitor and understand this disease on a level that has not been done before. However, for the record, invasive brain monitoring does not have any role in the future of altering disease, but it serves a direct model of study in intensive care setting to help us link noninvasive corollaries.

VGH study outcomes to date

The assumption was that if we deliver oxygen to a target bed, it will get across and into the cell, but that isn't the case. Patients in the study continued to demonstrate low brain oxygen levels 40% of the time. This raises the question: is diffusion normal? Is oxygen offloading off the hemoglobin in this ischemia reperfusion disease and getting into the brain and being utilized?

Patient Phenotypes

In a separate study, patients were divided into those who had normal brain oxygen levels versus low levels. Patients with low brain oxygenation levels have a diffusion problem, meaning that no matter what we do in the cohort, they will not exhibit normal transport of oxygen from the micro vasculature into the brain. There are different patients' phenotypes. These findings could potentially allow us to individualize the care in intensive care. For example, of two cardiac arrest patients received the same prehospital recognition and interventions, one patient might wake up as soon as they get to the hospital and the other one may never wake up. Could this be related to something simple in the prehospital setting?

Should we be focusing to measure blood flow during the CPR phase and resuscitation like measuring total end tidal CO2 right from the start so we can inform better triage decisions on scene: this person has a better chance at return of spontaneous circulation if I do 20 more minutes of CPR in the street;, another patient, no matter what I do, they need to get to ECPR as soon as possible.

Biomarkers findings

One of the things that we've shown is when the brain is lacking oxygen, there is almost an instantaneous release of proteins and bring specific proteins from the brain that are then into the systemic circulation. That understanding brings up the concept of point of care devices available for biomarkers that you can take plasma, put it on a cartridge and get your level in 15 minutes. This opens the realm of using blood-based biomarkers for the purpose of diagnosis of in vivo severity or in vivo pathophysiology to inform prognosis.

Five to ten years into the future, we might be able get a blood biopsy from a patient to measure these brain specific proteins from which you can start to stratify people quickly, within minutes of arrest, within admission to hospital admission and then start to see how they can differ. Right now, the data on biomarkers for this type of future opportunity is being collected through the current neuroinvasive monitoring research.

STEPCARE Trial

Markus Skrifvars, University of Helsinki, Finland

The optimal mean arterial pressure (MAP) after a sudden cardiac arrest is currently unknown. A systematic review has been completed and will soon be published looking at all the randomized trials with standard and a higher blood pressure target groups to determine if a higher MAP after cardiac arrest improves patient outcome. The results suggest that 180-day mortality favors standard MAP targets but no difference for neurological functional outcome. No clear signs of any major side effects related to cardiac function related to the use of noradrenaline to maintain higher pressure.

The recently funded STEPCARE (Sedation, Temperature and Pressure After Cardiac Arrest and Resuscitation) randomized trial will study 3500 comatose patients who have been resuscitated from cardiac arrest. All patients will be randomized to a control or an intervention arm for sedation, temperature, and blood pressure targets. These are.

1. Continuous deep sedation for 36 hours or minimal sedation (SEDCARE)
2. Fever management with or without a feedback-controlled device (TEMPCARE)
3. A mean arterial pressure target of >85mmHg or >65mmHg (MAPCARE)

Participants will be followed up at 30 days and 6 months. The primary outcome will be survival at 6-months. The study is powered for a 5.5% difference in mortality. This one size fits all approach is a serious limitation, but no better design is feasible. This large trial will examine specific subgroups to try and isolate a more targeted approach for these three foundational therapies.

MEDIUM-TERM AND ULTIMATE GOALS

What is the right patient, the right treatment and what is the right monitor for ICU care of post cardiac arrest patients?

The right patient

In the ICU we tend to approach this disease as a homogenous group, but we know there is tremendous heterogeneity with respect to the patient's underlying physiology and the outcomes.

One issue with the research is that we need enormous sample sizes for the sort of questions we are asking about heterogeneity and how we should incorporate subgroups into study designs, for example: in-hospital SCA, out-of-hospital SCA, witness and unwitnessed, male (most SCA) and females (worse outcomes after age 51).

The right treatment means more research investigating ways to stratify people to find the right treatment. Some major questions:

- Neuroimaging as a diagnostic tool to show how these patients differ?
- Neuromonitoring as a non-invasive approach to stratify people?

Differentiating in vivo patient specific pathophysiology, and phenotypes.
Biomarkers for testing for diagnosis in vivo estimation of the severity of injury
We always want to be a least invasive as possible and ultimately how to non-invasively identify specific subgroups requiring a particular treatment approach.

The right monitor
Instead of 'what tool do we want', first, we should ask 'what actual physiologic parameters do we want to measure' and then 'how would that impact the type of monitoring tool that we need or can use clinically?'

SIGNIFICANT CHALLENGES AND BARRIERS

We are at the infancy stage as to understanding the disease.
Before picking the right treatment, we need a better understanding of the pathophysiology of the disease. Current thought on auto regulation monitoring is predicated on outdated and incorrect physiologic dogma regarding neurovascular autoregulation that is still cited and taught. In the 1890s we understand that blood flow changes concurrently with changes in blood pressure. But then in 1959, we thought that this autoregulation controlling flow over a wide range of pressures was perfect. We know now that this is not true.

KEY STRATEGIES

Complete the current funded projects and start to grow cross-site collaborative opportunities.

FOCUS OVER THE NEXT YEAR

Studying the immune system's response to global ischemia – reperfusion of the brain following resuscitation from cardiac arrest. Phenotyping patients based upon pathophysiology.

POTENTIAL IMPACT

Ultimately understanding better treatments in an individualized way could dramatically improve brain recovery and decrease the number of people who die a neurologic death in hospital after the ischemic insult of cardiac arrest.

CURRENT STATE OF THE RESEARCH

The Science of Survivorship

Katie Dainty, North York General Hospital, Toronto
Kirstie Haywood, University of Warwick, UK

"Survivorship is not just a hug at discharge"

Survivorship is the great challenge as a result of our increasing success with survival. Traditional approaches to survival have been focused on clinical survival-to- discharge from hospital and fail to take into consideration the long-term physical and psychosocial needs of survivors, understanding what co-survivorship means for loved one, and how other family members and witnesses might be impacted.

There is a growing science to survivorship

There is a science behind survivorship with a growing body of evidence that necessitates an evolution in how we think about survival from cardiac arrest. The challenge for the critical care and resuscitation communities is understanding what the spectrum of 'good' survivorship looks like and to develop better post-acute systems of care as a result.

Measuring what matters

Community engagement with survivors and co-survivors drives our work to build better measurements of quality of life after cardiac arrest. Capturing the spectrum of needs that will evolve, resolve or emerge over time for survivors, co-survivors and family are key to understanding.

Existing Measurements

The COSCA initiative (Core Outcome Set for Cardiac Arrest) for example was a great partnership between patients, their partners, clinicians, research scientists, and the International Liaison Committee on Resuscitation that developed a consensus of core outcome measures for cardiac arrest. However, according to survivor-partners, none of the tools (Euro-QoL,HUI, the SF 36, etc) comprehensively capture the experiences of the aftermath of a cardiac arrest and lived experiences.

Evolving the measurements

Moving from generic or more generalized health related quality of life measures towards more disease specific measures in order to capture nuanced changes over time.

Moving toward well-developed survivor and family member-initiated measurements that are responsive to their needs at particular points in time and not set for clinician-driven ideas of key follow-up points.

More specificity around patient reported perspective or their quality of life story and patient experience measures including how they navigate the healthcare system and resources outside the healthcare system.

What the literature is telling us

Our systematic and transparent review of all the available qualitative literature that sought to better understand the experiences of both survivors, supporters and family members illustrated to us that survivorship is enduring and evolving over months and years, and many felt they were not getting the help they needed.

Three themes stood out from a survivor perspective:

- Making sense of one’s cardiac arrest- why me, what now, how do get help and when?
- Learning to trust one’s body and mind again- working with a changed body and mind.
- Evaluating life and goals- relationships direction and what matters

Three themes for co-survivors also struggled with personal challenges:

- Emotional response to witnessing the event,
- Becoming a caregiver- without any resources, new and serious responsibility on top of other responsibilities.
- Engaging with a new complicated world- navigating healthcare system, life with an ICD, concern for my survivor

MEDIUM-TERM AND ULTIMATE GOALS

The development of patient related outcome measures (PROMS) for recovery and survivorship after cardiac arrest with an international team of researchers, survivors and co-survivors (Katie & Kirstie currently leading this).

Move beyond measurement just for research and into routinely collected data in the clinical setting ; this should also include advocating for routine referral to survivorship resources.

Harness technology- such as an app or website- for easily accessible information and avenues of care when survivors and co-survivors need it:

- Provide 'what to expect after your sudden cardiac arrest' resources.
- Include a self-assessment measurement function for survivors to track their own experience in a way that makes it easier for the care team to respond to survivor needs.
- Connect survivors to others with similar culture and experience

Define and develop a culturally competent, minimum standard of care – a continuum of care across Canada with survivors and co-survivors in the center (the UK is leading work on this now)

SIGNIFICANT CHALLENGES AND BARRIERS

Current approach

Survival still very clinical and does not routinely recognize cognitive, emotional, and social concerns. Current cardiac rehab is often not available as a continuum of care, certainly not an expectation, especially away from urban centers.

Implementation of a basic standard of care

We need to understand what the best, minimum level of care is that's equitable and scalable to all communities and implement that with an eye to improvement as we work with partners to establish this system of care across Canada.

Socialization of SCA and its survival impact

Resuscitation and sudden cardiac arrest has a public identity crisis; we need to sell the importance and scope of cardiac arrest and survivorship and the critical need for bystander intervention. Stroke awareness has the FAST campaign, what is ours?

Key strategy: elevate the conversation through social media campaigns.

Authority (e.g., Researchers, Medical Professionals, Heart and Stroke) and Social Proof (survivors' stories, bystander stories, family stories on IG, TikTok, You Tube) to help move things forward.

Having a "house" for this Canadian effort

Canada has the equivalent of a Resuscitation Council through Heart & Stroke with training programs, a national database (CanROC), research support and this now we have CanSAVE, an affiliated research group interested in transformation. We need a national, systematic, organizational drive to communicate what the expectation is for survivorship, and then building programs around it to deliver on that expectation across Canada.

Who's missing

Policy makers, health care managers, and cultural shift experts need to be partners at the socialization, development, and implementation tables?

The BIG ask: Funding for Survivorship Science AND Canadian Systems of Care: research, implementation and sustainability funding are required.

KEY STRATEGIES

- Evolution, not revolution. EVOLVE the people, the measurments, and systems currently in place.
- Developing an international PROM for cardiac arrest survival.
- Collect relevant data routinely that will support development of clinical systems.
- Build the vision of what this could look like in Canada.

FOCUS OVER THE NEXT YEAR

- Continue international work on the PROM for cardiac arrest (Kirstie & Katie with international team)
- Continue co-design research to develop a cardiac arrest survivorship mobile app to provide information and outcome measurement options for survivors and co-survivors (Katie's lab)
- Continue to partner with the Heart & Stroke Foundation to include cardiac arrest survivorship as a key pillar in their People with Lived Experience strategy and emerging web resources.

POTENTIAL IMPACT

We will be able to define the extent and unique kinds of challenges that survivors and co-survivors experience across the survivorship journey. We expect new interventions to be part of routine care and to include every survivor and/or family member in Canada.

We hope to catalyze better care systems and better integration into life for all those with previously unrecognized challenges.

CONSENSUS OF SYMPOSIUM SUCCESS

The CanSAVE Symposium was a unique and valuable event.

CanSAVE has advanced from an ad-hoc UBC facilitated national resuscitation research group focused on the transformation of the response and care for patients with sudden unexpected death to a consolidated research group with international resuscitation collaborators.

Attendees commented multiple times on the value of this kind of event that allows free exchange of ideas across specific programs and the need for a structured knowledge exchange and brainstorm space with high value feedback and perspective from local, national, and international experts.

The Symposium made possible:

- confirmation that this type of symposium has value.
- opportunity for strategic discussion of next steps toward success
- international connections and perspectives across 6 key research areas
- Clarity around linkages between the research areas and possible collaborations.
- practical questions and potential solutions for each program
- further refinement of CanSAVE purpose and potential impact
- building awareness of our research programs across programs, nationally with Heart & Stroker partners and Emergency Services
- connections with international experts who provided added value to our discussions and who seem willing to continue the collaboration.

PLANS FOR THE CONTINUATION OF CANSAVE

Continue to transform the response to out of hospital cardiac arrest through discovery and implementation science facilitated by Canadian and international collaboration.

CanSAVE As a Unique Collaboration

CanSAVE started as a group of researchers in different resuscitation spaces in Canada who collaborated to write a National Center of Excellence Grant. Although the grant was unsuccessful, the work into visioning and planning was recognized to have value and the members committed to maintaining the connections.

Through a UBC catalyst grant the UBC resuscitation researchers were able to build a modest infrastructure to strengthen the UBC team, formuate an identify to CanSAVE and continue regular meetings.

This current meeting added the wisdom of international researchers in the identified 6 programs. Participants in this current meeting voiced strong approval to continue CanSAVE and maintain the International partnerships.

CanSAVE as Part of the Canadian Resuscitation Landscape

CanSAVE does not purport to include all resuscitation researchers in Canada. It defines itself as an organic collaboration of transformative researchers on the edge of resuscitation science each with a specific transformational goal and an existing focused research program. CanSAVE includes the research programs with the greatest potential to substantially save more lives from cardiac arrest.

Heart and Stroke Canada is the identified leader in resuscitation training and government advocacy, and has a very productive research program in cardiovascular science. It has recently committed to Resuscitation as a key strategic priority and has partnered with CanROC to build a national registry of out-of-hospital cardiac arrest. The H&S Resuscitation Advisory Committee (RAC) helps to guide the advancement of resuscitation strategies in Canada. The RAC membership includes significant overlap with CanSAVE and CanROC, ensuring alignment and coherence of goals across these organizations.

CanSAVE Brings Implementers to the Table

The meeting included EMS leaders and H&S leadership and demonstrated the value in these collaborations to strengthen the partnerships necessary for implementation of potentially effective new ideas.

It will be necessary in the future to maintain close working relationships with H&S and the CanROC network including EMS systems, to successfully implement the key ideas ready for local testing and then for scaling up to the national level. It is vital to keep these communications strong from the inception and early research phases to build the excitement and commitment to change during the implementation phase. It also can alert CanSAVE researchers to upcoming changes in EMS or recent trends in data that can inform our programs (e.g., Next Gen 911, falling survival)

CanSAVE Grant Development is a Key Goal

Each program has individual grants in play to support the research. CanSAVE provides the existing collaborations in a defined and more formal way to support a larger infrastructure grant when opportunities present. The collaboration with the CanROC national registry and H&S community initiatives are also key strengths for future large grant success.

CanSAVE Funding for Sustainability

Currently CanSAVE is in the middle of the second 2-year UBC Catalyst grant of $200,000. We are eligible for a third 2-year grant. By the end of that term (2026) we must have other infrastructure grants in place in addition to individual program grants if we wish to maintain active collaborations and strengthen our CanSAVE identity. A key strategy going forward is to continue to search for opportunities and develop competitive infrastructure grant applications.

SUMMARY

The 2023 CanSAVE inaugural international symposium was a clear success. It met its objectives and provided a unique opportunity for further planning with broad input for all 6 programs.

It is our intention and the hopes of the participants that yearly meetings of this type will facilitate progression of discovery to translation and implementation.

APPENDIX

Symposium Agenda

Wednesday, April 5

8:00-8:30 **Registration, Coffee, and Light Breakfast** **HSBC Foyer**

8:30-9:00 **Opening Welcome and Symposium Overview** **HSBC Hall**
BC RESURECT Hosts Jim Christenson and Brian Grunau
Acknowledgement of Indigenous Canadian Ancestral Lands

9:00-11:30 **CanSAVE Research Area Leads and International Guest Presentations HSBC**

9:00-9:30 Optimizing Post Discharge Rehabilitation
Katie Dainty and Kirstie Haywood

9:30-10:00 Optimizing ICU care
Myp Sekhon and Markus Skrifvars

10:00-10:30 Drone AED Delivery
Ian Drennan and Andreas Claessen

10:30-11:00 Community Responders
Steve Brooks, Rudy Koster and Tom Rea

11:00-11:30 Sensors
Calvin Kuo, Babak Shadgan, Jake Hutton, Nicola Gaibazzi

11:30-12:00 Optimizing Emergency Communication
Christian Vaillancourt and Mark Wilson

12:00-1:00 **Lunch Break**

1:00-2:00	**Concurrent Working Group Sessions** Deciding key strategies, priorities, and challenges to present to whole group. Optimizing Post Discharge Rehabilitation **C675** Optimizing ICU Care **C671** Drone AED Delivery C**010** Community Responders **C245** Sensors **HSBC Hall** Optimizing Emergency Communication **C673**	
2:00-6:30	**Working Groups Present: Draft Strategies, Priorities and Challenges** 2:00 Optimizing Post Discharge Rehabilitation 2:45 Optimizing ICU care 3:30 Drone AED Deliver **4:15-4:30 Break** 4:30 Community Responders 5:15 Sensors 6:00 Optimizing Dispatch	**HSBC Hall**
6:30-8:30	**Reception and Networking**	**HSBC Foyer**
9:00-11:00	**Optional Dinner and Drinks at JOEY's Burrard**	

Thursday, April 6

8:00-8:30	**Coffee and light Breakfast**	
8:30-12:00	**Research Program Draft Outcomes and Strategic Priorities** 8:30-9:00 Sensors Brian Grunau 9:00-9:30 Emergency Communication Christian Vaillancourt 9:30-10:00 Community Responders Steve Brooks **10:00-10:30 Break** 10:30-11:00 Drone AED Delivery Ian Drennan 11:00-11:30 Optimizing ICU care Myp Sekhon 11:30-12:00 Optimizing Post Discharge Rehabilitation Katie Dainty **Box Lunch**	**HSBC Hall**
12:00-1:00	**CanSAVE Sustainability Planning Discussion**	**HSBC Hall**
1:00-1:30	**Symposium Close: Concluding Remarks** BC RESURECT Hosts Brian Grunau and Jim Christenson	**HSBC Hall**

Symposium Participants

Symposium Hosts

Jim Christenson
Co-Director, BC Resuscitation Research Collaborative (BC RESURECT)
Professor and Past Head, Department of Emergency Medicine, University of British Columbia
Senior Medical Advisor fo Emergency Care BC
Research focus: cardiovascular emergencies, especially resuscitation science

Brian Grunau
Co-Director, BC Resuscitation Research Collaborative (BC RESURECT)
Assistant Professor, Department of Emergency Medicine, University of British Columbia
Emergency Physician, St. Paul's Hospital
Research Focus: Management of out-of-hospital cardiac arrest

Symposium Presenters

Katie Dainty CanSAVE Lead
Research Chair in Patient-Centered Outcomes North York General Hospital, Toronto
Research Focus: patient and family experience, patient-centered outcome measures, and quality improvement in community health care environments; bystander experience and survivorship following sudden cardiac arrest.

Kirstie Haywood
Professor, Warwick Medical School University of Warwick, UK
Warwick Research in Nursing and Emergency, Prehospital, Perioperative and Critical Care (EPPiC) research groups
Research Focus: applied health outcomes research; active engagement of patients and public to enhance the relevance, acceptability, and quality of research.
Optimizing 9-1-1 and Emergency Communication

Christian Vaillancourt CanSAVE Lead
Senior Scientist at the Ottawa Hospital Research Institute and was awarded a uOttawa Research Chair in Emergency Cardiac Resuscitation.
Research Focus: improving 9-1-1 cardiac arrest recognition and CPR instructions

Mark Wilson OBE
Neurosurgeon, Pre-Hospital Care UK Co-founder & Director GoodSAM
Research focus: Enabling better lay-response, triage, and treatment of SCA; strong interest in hypoxic and traumatic brain injury.

Steve Brooks CanSAVE Lead
Clinician-Scientist in emergency medicine and resuscitation science at Queen's University Kingston Ontario; Chief Medical Officer at Rapid Response Revival, an Australian start-up CellAED.
Research focus: community response to cardiac arrest; increasing access to early CPR and defibrillation.

Rudy Koster
Initiator and Former Director of the Amsterdam Resuscitation Studies (ARREST) study group, Amsterdam University Medical Center
Research Focus: participation of lay responders with AEDs for residential cardiac arrest.

Ian Drennan CanSAVE Lead
Assistant Professor in the Division of Emergency Medicine and School of Graduate Studies at the University of Toronto and Paramedic Scientist; Affiliate Scientist in the Department of Emergency Services at Sunnybrook Health Science Centre.
Research focus: resuscitation science and prehospital clinical medicine.

Andreas Claesson
Researcher at Karolinska Institutet Stockholm, Sweden.
Research Focus: Drone delivery of AEDs to shortening time to defibrillation and increase survival from out-of-hospital cardiac arrest.

Mypinder Sekhon CanSAVE Lead
Clinical associate professor in the Division of Critical Care Medicine
University of British Columbia
Intensivist and clinician scientist at Vancouver General Hospital
Research Focus: Critical care management of severe traumatic brain injury patients.

Markus Skrifvars
Professor, Pre-hospital Emergency Medicine University of Helsinki, Finland
Lead Investigator of the trial Sedation, TEmperature and Pressure after Cardiac Arrest and Resuscitation. Research Focus: Intensive care after sudden cardiac arrest

Calvin Kuo CanSAVE Lead
Associate Professor, School of Biomedical Engineering University of British Columbia
Research Focus: Human motion and wearable technologies

Babak Shadgan CanSAVE Lead
Assistant Professor, Department of Orthopedics, University of British Columbia Associate Faculty member at the UBC School of Biomedical Engineering (UBC)Principal Investigator at the International Collaboration on Repair Discoveries (ICORD)-Implantable Biosensing Laboratory.
Research Focus: wearable and implantable biosensors

Jacob Hutton
PhD Candidate in the Experimental Medicine Program at UBC Faculty of Medicine Paramedic with BC Emergency Health Services.
Research Focus: leveraging cardiac arrest data to conduct epidemiological modeling for projects related to early detection and intervention for cardiac arrest using wearable and non-wearable sensors

CanSAVE Member Participants

Uda Walker
Research and Symposium Coordinator
BC RESURECT /CanSAVE

Saud Lingawi
PhD Candidate
UBC School of Biomedical Engineering Research Focus: wearable sensor technologies

Scott Klein
Associate Professor
St. Jerome's University in the University of Waterloo
SCA Survivor
Research Focus: role of faith-based organizations in community responses to sudden cardiac arrest

Mahsa Khalili
Postdoctoral Fellow
UBC Department of Emergency Medicine Research Focus: wearable sensor technologies

Ryan Hoiland
Postdoctoral Researcher (PhD in cerebrovascular physiology), Vancouver General Hospital University of British Columbia
Research Focus: the pathophysiology of hypoxic-ischemic brain injury in patients following cardiac arrest.

Allan de Caen
Pediatric Intensivist/ Clinical Professor PedsCCM
Stollery Children's Hospital, University of Alberta
Chair of Canadian Resuscitation Outcomes Consortium (CanROC) pediatric subcommittee.

Jon Deakin
Paramedic Practice Leader, Victoria BC British Columbia Emergency Health Services; Lead educator at the School of Health Sciences, Justice Institute of BC
Research Focus: clinical practice portfolios in cardiac arrest management, STEMI / ACS'S care, and advanced airway management

CanSAVE Special Guests

Dakota Gustafson
Ph.D in Laboratory Medicine & Pathobiology from University of Toronto Currently Combined M.D.-M.Sc. Queen's University
Research Focus: resuscitation outcomes

Matthieu Heidet
Emergency Medicine Physician
Henri Mondor University Hospital, Créteil, France RéAC (Registre électronique des Arrêts Cardiaques)
Research Focus: optimization of access to prehospital care; AI and technology

Paul Snobelen
Community Safety & Resuscitation Program Specialist Peel Regional Paramedic Services, Ontario
Research Focus: development and implementation of pre-hospital programs supporting the chain of survival; Volunteer Community Responder Program in the Region of Peel.

Ken Carrusca
Cardiac Arrest Survivor Vancouver, BC

Heart & Stroke Partner Participants

Sandra Zambon
Manager, Stakeholder Engagement
Heart and Stroke Canada
Research Focus: community development and engagement, advocating and building programs to increase awareness and action around CPR and AED use.

Diana Bayles
Senior Manager, Resuscitation Product Development and Delivery Heart and Stroke Canada
Research Focus: resuscitation product delivery

Shelly Parker
Director, Resuscitation Heart and Stroke Canada
Focus: blended learning and the training, use and, availability of AEDs.

Diego Marchese
EVP, Mission, Research, Social Enterprise Heart and Stroke, Canada
Focus: research, health promotion, patient education, and advocacy areas

British Columbia Emeregency Health Services Partner Participants

Mike Christian
Chief Medical Officer
British Columbia Emergency Health Services BC RESURECT Executive Committee
Research focus: diverse background beginning as a paramedic prior to entering medicine in which he specialized in Intensive Care as well as Prehospital and Transport Medicine.

Anders Ganstal
Medical Director, Cardiac Arrest
British Columbia Emergency Health Services
Research focus: emergency physician, EPOS physician, Interior Health High Acuity Transport Physician. Research Focus: with interest in improving prehospital cardiac care.

Nico Preston
Director of Research and Innovation (Interim) British Columbia Emergency Health Services Research focus: Data science, out-of-hospital research, technology, and innovation.

Symposium Sponsors

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ZOLL Medical Participants

Pamela Thornton
Director of Sales
Canada Paramedics and Fire

Annemarie Silver
Vice President
Clinical & Scientific Affairs ZOLL Medical, US
Annemarie serves as Executive Sponsor of ZOLL's newly created Women LEAD Employee Resource Group.

Kimberly Small
National Sales Manager
Canadian Hospital ZOLL Medical Canada

Stryker Canada Participants

Jay Mitchosky
Senior Marketing Manager Emergency Care
Stryker Canada