Ambulance Victoria

Cardiac Arrest Improvement Strategy 2023-2028

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A publication produced by the Centre for Research and Evaluation, Ambulance Victoria.

If you would like to receive this publication in an accessible format please contact the VACAR team at: VACAR2@ambulance.vic.gov.au.

Acknowledgement of Country

Ambulance Victoria acknowledges the Traditional Owners of the lands in Victoria. We pay our respects to Aboriginal and Torres Strait Islander cultures and to Elders past and present and recognise Aboriginal self-determination is a human right.

At Ambulance Victoria we recognise the diverse and unique cultures and histories of Aboriginal and Torres Strait Islander peoples and value the knowledge of countless generations of Custodians. We commit to working together to build a fair and just future. We will come together with Aboriginal and Torres Strait Islander communities to identify, understand, and develop opportunities to create and sustain a culturally aware organisation.

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Contents

Definitions

Adults	Patients aged greater than 15 years of age, or where the age is missing/unknown.
Emergency Medical Services (EMS)	Denotes Ambulance Victoria paramedics or first responders, including fire services, or community emergency response teams.
EMS-attempted resuscitation	Cases where either paramedics or first responders attempted to resuscitate a patient in cardiac arrest using CPR and/or defibrillation, irrespective of duration.
EMS response time	The time from the emergency call being answered by the call-taker to arrival of the first EMS crew on scene.
Event survival	A patient with a palpable pulse on arrival at hospital as documented on the paramedic's patient care record.
Presumed cardiac aetiology	Cases where the cause of arrest is not due to a known precipitator (e.g. trauma, overdose/poisoning etc), as acquired from the paramedic's patient care record.
Return of Spontaneous Circulation (ROSC)	A detectable pulse at any time during the case.
Survival to hospital discharge (or discharged alive)	Patients who are discharged from hospital alive.
Shockable rhythm	Cardiac rhythms which are appropriate to receive defibrillation, including ventricular fibrillation and pulseless ventricular tachycardia, by EMS or a bystander with a public AED
Utstein patient group	Patients who are witnessed to arrest by a bystander, present in a shockable rhythm and receive an attempt at resuscitation by EMS.

Abbreviations

AED	Automated External Defibrillator
AIDE	Artificial Intelligence in carDiac arrEst
ALS	Advanced Life Support
AV	Ambulance Victoria
CI	Confidence Internal
CPR	Cardiopulmonary Resuscitation
EMS	Emergency Medical Services
EMR	Emergency Medical Response
ESTA	Emergency Services Telecommunications Authority

MICA	Mobile Intensive Care Ambulance
OHCA	Out-of-Hospital Cardiac Arrest
PAD	Public Access Defibrillation
QOL	Quality of Life
ROSC	Return of Spontaneous Circulation
SD	Standard Deviation
VACAR	Victorian Ambulance Cardiac Arrest Registry
VF	Ventricular Fibrillation
VT	Ventricular Tachycardia

List of tables

List of figures

Strategic **Priority 1**

Community CPR and public access defibrillation

Enhance community-based participation in cardiopulmonary resuscitation and public access defibrillation.

Invest in community education programs and Heart Safe Communities

Targeted delivery of CPR awareness education in schools (our Call, Push, Shock program)

Identify inequities and barriers to the use of public access defibrillation

Use digital media applications to enhance the community response
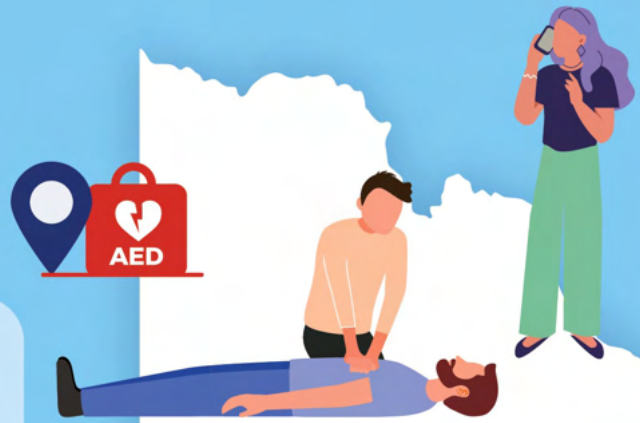
OUR V

To improve card
rates in Vic

Strategic **Priority 3**

Enhance paramedic access to high-fidelity, team-based, training with feedback

Establish a system-wide model for post-cardiac arrest debriefing

Facilitate education with a focus on resuscitation training and end-of-life decision making

Establish the evidence-base for existing resuscitation targets

High-performance CPR

Establish world-leading performance in resuscitation and ensure all patients receive high-quality CPR.

Strategic **Priority 2**

Comprehensive system response

Optimise cardiac arrest recognition, call-handling and dispatch and provide a comprehensive system response.

Increase our first responder capacity in regional areas

Provide focused reporting and monitoring of call handling performance

Examine the potential for audio-visual connection for emergency calls

Expert panel review and feedback of cardiac arrest recognition in the emergency call

VISION

diac arrest survival toria by **30%**

Strategic **Priority 4**

Culture of excellence

Create an organisational-wide culture of excellence in resuscitation that embraces quality and performance.

Develop enhanced analytics of resuscitation care and outcomes across Ambulance Victoria

Embed local champions in regions to promote high-performance CPR training

Establish accountability for the monitoring and review of cardiac arrest

Conduct world-leading clinical trials to advance the evidence-base

About the strategy

Out-of-hospital cardiac arrest (OHCA) is a global health problem, with a significant burden of morbidity and mortality in Australia and developed countries. In 2018/19, Ambulance Victoria reported its highest ever survival rate from OHCA for patients who were bystander witnessed and presented with an initial shockable rhythm (known as the Utstein comparator group), with 41% of patients surviving to hospital discharge across the state, and 56% in inner Melbourne (Figure 1). The number of survivors per million population also increased to its highest ever result of 65 people per million person-years. These improvements in survival were not due to luck, but rather, the implementation of a targeted and comprehensive resuscitation quality improvement bundle that sought to train more than 5,000 paramedics across the state in high-performance cardiopulmonary resuscitation (CPR), provide real-time feedback on CPR performance, and provide post-event debriefing on resuscitation performance.

However, the COVID-19 pandemic had a devastating impact on the OHCA system-of-care across Australia and internationally. Published reports from Ambulance Victoria indicate that survival outcomes fell by more than 50% during the first COVID-19 wave in 2020 (Ball, 2020, p157-163), and survival rates have since not returned to pre-COVID levels. Ongoing monitoring by Ambulance Victoria's Centre for Research and Evaluation indicates that year-on-year survival remains significantly lower during the post-pandemic years compared to 2018/19. The factors driving this reduction are complex and multi-factorial. A series of evaluations conducted by the Centre for Research and Evaluation have determined changes in arrest locations, low use of public access defibrillation, and poorer resuscitation performance (e.g. hands off chest time), were significant contributors to poorer patient outcomes. Other factors, such as community viral transmission (COVID-19 and influenza) also play a key role in determining seasonal outcomes.

Despite these observations, most of the reduction in survival from OHCA experienced in Victoria remains unexplained. To improve survival from OHCA and determine priority areas and initiatives to drive improvements in patient care over the next 5 years, Ambulance Victoria have committed to developing a Cardiac Arrest Improvement Strategy.
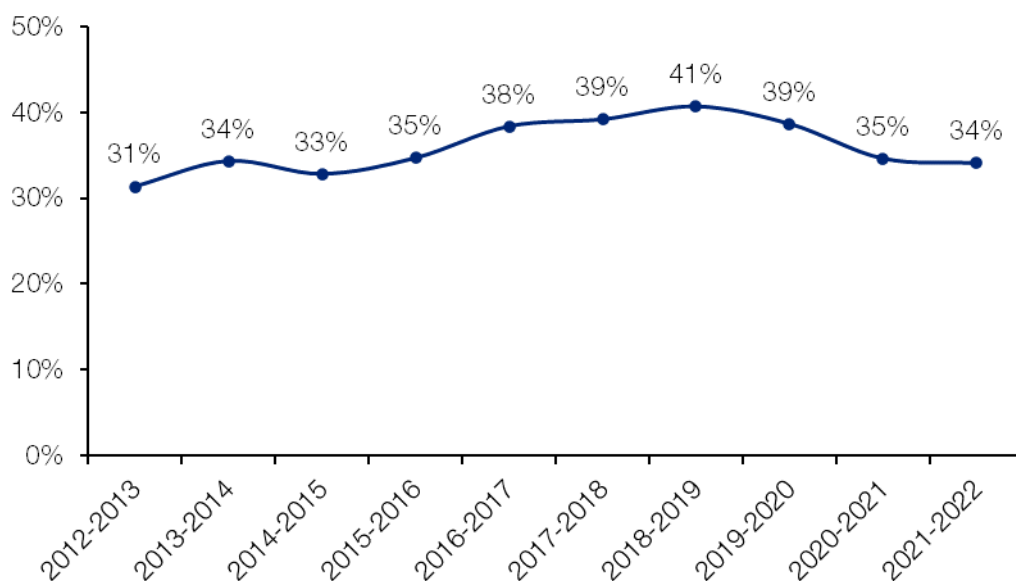
Figure 1: Survival to hospital discharge for bystander witnessed initially shockable OHCA (Utstein subgroup) over time.

The strategy is being delivered as a planned initiative to Ambulance Victoria's Board and Quality & Safety Committee. It has been devised through cross collaboration with key divisions involving subject matter experts, and informed by registry data and modelling provided by the Victorian Ambulance Cardiac Arrest Registry (VACAR). Importantly, the strategy aligns with Ambulance Victoria's Strategic Direction for 2023-2028, ensuring that all patients receive best care, improved health outcomes and experience. The strategy was informed by a number of key initiatives, including:

▶ The establishment of subject matter expert groups, including a Stakeholder Group and an International Expert and Peer Review Group

▶ Statistical modelling to determine areas where the highest survival gains are likely to be realised

▶ An examination of variation in care and outcomes with a focus on regional and temporal variation

▶ Identification of current and planned clinical trials

▶ A review of local initiatives and how they align with organisational best practices

▶ An external environmental scan of key policy and strategy documents for improving cardiac arrest outcomes

▶ A gap analysis to determine differences between Ambulance Victoria's current response to cardiac arrest and international best practice.

The strategy will provide a strategic focus for improving OHCA outcomes between 2023 and 2028, and has been peer reviewed by leading international experts to determine alignment with the evidence-base and international best practices. **The strategy has been developed with an ambitious goal to improve survival to hospital discharge outcomes by 30% in bystander witnessed, initial shockable OHCA (the Utstein comparator group), or from 34% in 2021-2022 to 44% in 2027-2028.**
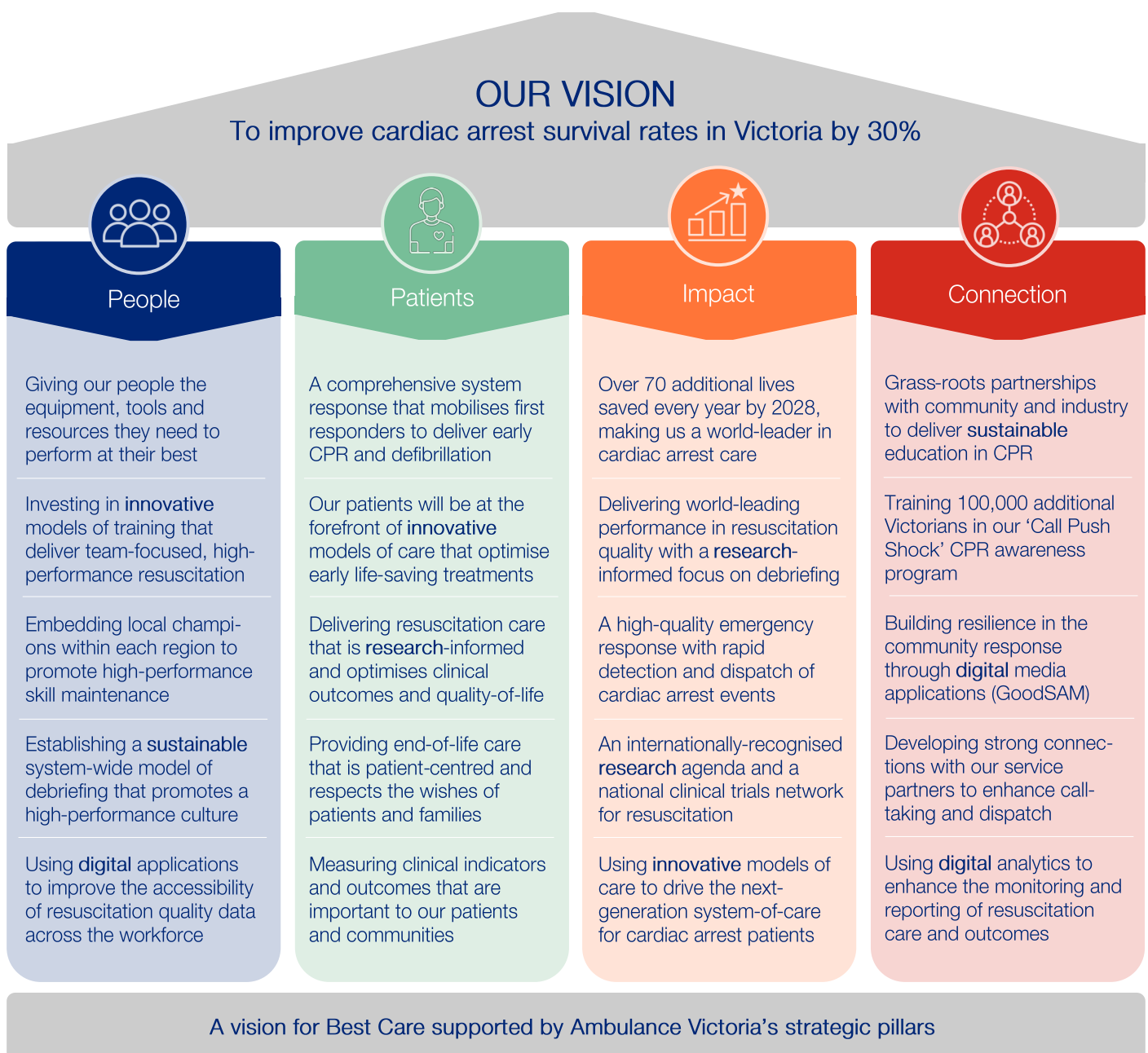
Our patients, our responsibility

OUR VISION
To improve cardiac arrest survival rates in Victoria by 30%

People	Patients	Impact	Connection
Giving our people the equipment, tools and resources they need to perform at their best	A comprehensive system response that mobilises first responders to deliver early CPR and defibrillation	Over 70 additional lives saved every year by 2028, making us a world-leader in cardiac arrest care	Grass-roots partnerships with community and industry to deliver **sustainable** education in CPR
Investing in **innovative** models of training that deliver team-focused, high-performance resuscitation	Our patients will be at the forefront of **innovative** models of care that optimise early life-saving treatments	Delivering world-leading performance in resuscitation quality with a **research**-informed focus on debriefing	Training 100,000 additional Victorians in our 'Call Push Shock' CPR awareness program
Embedding local champions within each region to promote high-performance skill maintenance	Delivering resuscitation care that is **research**-informed and optimises clinical outcomes and quality-of-life	A high-quality emergency response with rapid detection and dispatch of cardiac arrest events	Building resilience in the community response through **digital** media applications (GoodSAM)
Establishing a **sustainable** system-wide model of debriefing that promotes a high-performance culture	Providing end-of-life care that is patient-centred and respects the wishes of patients and families	An internationally-recognised **research** agenda and a national clinical trials network for resuscitation	Developing strong connections with our service partners to enhance call-taking and dispatch
Using **digital** applications to improve the accessibility of resuscitation quality data across the workforce	Measuring clinical indicators and outcomes that are important to our patients and communities	Using **innovative** models of care to drive the next-generation system-of-care for cardiac arrest patients	Using **digital** analytics to enhance the monitoring and reporting of resuscitation care and outcomes

A vision for Best Care supported by Ambulance Victoria's strategic pillars

Figure 2: Alignment between the Cardiac Arrest Improvement Strategy's initiatives and Ambulance Victoria's Strategic pillars.

Out-of-hospital cardiac arrest is one of the leading causes of death worldwide and a significant public health problem in Australia. Every year, more than 25,000 OHCA occur in Australia, 7,000 alone in Victoria. Although survival rates from OHCA are reported to be low across developed countries, Ambulance Victoria has consistently been among the world-leaders in cardiac arrest outcomes, with survival rates that exceed international norms.

Over the last two decades, Ambulance Victoria have delivered significant innovations in OHCA care, through developments in clinical practice, better call-handling and dispatch, telecommunicator CPR, community engagement in CPR programs, the launch of a smartphone CPR crowdsourcing app (GoodSAM) and an internationally recognised research program. In 2019, we also delivered one of largest investments in OHCA care, with the state-wide roll-out of a resuscitation quality improvement bundle that trained over 5,000 paramedics in high-performance CPR. The quality improvement initiative was supported by team-based resuscitation training, real-time feedback on CPR performance, structured resuscitation choreography and scene leadership, and post-event debriefing. Collectively, these initiatives have resulted in hundreds of additional survivors from OHCA every year, giving many patients a second chance at life.

Despite our best efforts, the impact of the COVID-19 pandemic continues to be felt across the health system. In particular, there have been a number of significant impacts to care that have resulted in fewer patients surviving an OHCA. Paramedic and first-responder donning of personal protective equipment led to delays in the commencement of resuscitation interventions, such as CPR and defibrillation. Critical changes to clinical practice guidelines aiming to minimise the aerosol risk associated with OHCA interventions also impacted the quality of resuscitation. In addition, social restrictions led to fewer people experiencing an OHCA in public, reducing the likelihood of bystander treatment before the arrival of paramedics. Unfortunately, the easing of COVID-19 restrictions in Victoria has not resulted in the expected improvements in survival and patient outcomes remain lower today than in the pre-COVID era.

Ambulance Victoria's Cardiac Arrest Improvement Strategy 2023-2028 represents our ongoing commitment to find new ways to strengthen the 'Chain of Survival' for OHCA. The strategy is a culmination of international best practice, local input from subject matter experts, and over two-decades of evidence-based insights and learnings informed by the Centre for Research and Evaluation and the VACAR. The strategy underpins an organisation-wide culture of excellence in OHCA care and delivers innovations in systems-of-care for cardiac arrest patients.

Importantly, the strategy aligns with Ambulance Victoria's Strategic Plan for 2023-2028 and our vision to be 'a world leading ambulance service in terms of our people's

experience, patient health outcomes, the impact we make and our connection to each other, our partners, and the broader healthcare system'. The Cardiac Arrest Improvement Strategy's program of initiatives are closely aligned to Ambulance Victoria's four focus pillars that will help transform our services and health outcomes over the next five years, including: People, Patients, Impact and Connection. The Cardiac Arrest Improvement Strategy will also be supported by Ambulance Victoria's key enablers (innovation, digital, research, and sustainability) and explain how we have prioritised these initiatives and how we will work to deliver them (Figure 2).

The strategy sets an ambitious goal to achieve a 30% improvement in survival to hospital discharge for OHCA patients by 2028 (the Utstein comparator group). We know from international experience that these survival rates are possible with a targeted and comprehensive strategy to enhance the system response that targets the links in the Chain of Survival. In doing so, we set a standard that recognises our commitment to deliver the very best care for our patients.

Nicola Reinders
Executive Director, Quality and Patient Experience

Impact of the COVID-19 pandemic

The COVID-19 pandemic has introduced unprecedented challenges for healthcare services worldwide. The impacts have been felt across all of Ambulance Victoria's services, and in particular, key patient cohorts. In June 2020, following the first wave of the COVID-19 pandemic in Australia, the Centre for Research and Evaluation identified a significant reduction in survival to hospital and hospital discharge outcomes for OHCA patients. Since that time, Ambulance Victoria has undertaken numerous monitoring and reporting activities to understand temporal changes in patient outcomes and patient- and system-level factors contributing to lower survival during the COVID-19 pandemic.

Ambulance Victoria were among the first health services in world to report the devastating collateral impacts from COVID-19. Led by the for Centre for Research and Evaluation, a peer-reviewed manuscript was published in an international journal exploring the effect of the COVID-19 'first wave' (March to May 2020) on OHCA outcomes (Ball, 2020, p157-163). The report showed a significant reduction in the initiation of resuscitation by paramedics during the pandemic. Additionally, arrests occurring in public locations reduced, as did the proportion of patients receiving defibrillation from a public automated external defibrillator (AED). Significant delays were also observed in the commencement of key clinical interventions (e.g. defibrillation and adrenaline administration). Crude survival rates declined by almost 50% during the first wave, equating to 35 excess deaths per million person-years. Importantly, the modelling indicated that, despite controlling for variation in patient and system-level factors (e.g. delays in reaching the patient), the likelihood of survival had fallen by approximately 50%. The report indicated that if the situation was left unmanaged, collateral damage from the COVID-19 pandemic could lead to more than 200 excess deaths from OHCA in Victoria in 2020.

A subsequent analysis was also conducted by the Centre for Research and Evaluation and presented to the Quality and Safety Committee in November 2020. In that analysis, the effect of the pandemic on OHCA outcomes was explored over the first two COVID-19 waves (March to September 2020). The findings reinforced the observations in the first wave, including: 1) reduced rates of attempted resuscitation by paramedics; 2) fewer public location cases;

3) fewer shocks performed by bystanders, and 4) longer delays to paramedic clinical interventions. However, reductions in survival to hospital discharge had attenuated somewhat, with a 35% relative reduction in survival during the first two COVID-19 waves compared to historical years. Similarly, after adjusting for patient- and system- level factors, there was a 30% reduced likelihood of survival compared to previous years.

As part of this analysis, a comprehensive evaluation of changes in resuscitation quality was also undertaken. During the first two waves of the pandemic, chest compression fraction declined, pre-shock and post-shock pauses were longer, mechanical CPR was applied earlier and resuscitation duration was longer for OHCA patients presenting in an initial shockable rhythm. All of these factors may have contributed to reduced survival.

The 2020/21 VACAR annual report also provided a focused analysis on the impact of the ongoing pandemic on OHCA outcomes. The analysis outlined similar observations to earlier reports, and in particular, noted reductions in defibrillation by bystanders. Survival to hospital for OHCA events occurring during periods of lockdown was significantly poorer at 44.4% compared with 56.3% for cases occurring during non-lockdown periods. In addition, the percentage of cases surviving to hospital discharge was lower during lockdown periods compared to non-lockdown periods (22.8% vs. 34.2%). After adjustment for patient- and system-level factors, the likelihood of survival to hospital discharge for patients presenting in a shockable rhythm reduced by 40% during lockdown periods compared to non-lockdown periods. The report found that, although a patient was still 1.5 times more likely to survive an OHCA in 2020/21 compared to 2005/06, the chances of survival were lower than pre-pandemic years.

The Centre for Research and Evaluation have continued to monitor the impact of the COVID-19 pandemic on the OHCA system of care. Table 1 illustrates the demographic differences for OHCA patients (excluding Emergency Medical Service [EMS]-witnessed events) between periods of lockdown and non-lockdown in Victoria between July 2020 and June 2022.

During periods of lockdown, there were 2,774 cardiac

arrests compared with 9,994 in non-lockdown periods. Statistically significant differences were found between the proportion of arrests occurring in public locations (5.4% in lockdown vs. 8.9% in non-lockdown), the proportion of bystander-witnessed arrests (26.4% in lockdown vs. 29.3% in non-lockdown), the proportion of arrests where initial defibrillation was performed by a public AED (7.0% in lockdown vs. 15.7% in non-lockdown), the proportion of patients who survived to hospital (47.5% in lockdown vs. 55.2% in non-lockdown) and survived to hospital discharge (23.1% in lockdown vs. 31.3% in non-lockdown).

The data highlight the ongoing challenges faced by Ambulance Victoria in its response to OHCA during the COVID-19 pandemic, and underscore the need for a strategised and comprehensive Cardiac Arrest Improvement Strategy.

"Left unmanaged, collateral damage from the COVID-19 pandemic could lead to more than 200 excess deaths from OHCA in Victoria in 2020"

Table 1: Characteristics and survival outcomes of OHCA patients during lockdown and non-lockdown periods in 2020-2022.

	Lockdown period	Non-lockdown period
Total events^	2,774	9,994
Age (years), mean (SD)	66.7 (19.2)	66.2 (18.9)
Male gender, n (%)	1,841 (66.5)	6,621 (66.4)
EMS response time (minutes), median (90th percentile)	8.5 (20.0)	9.0 (26.0)
Public location, n (%)	150 (5.4)	892 (8.9) †
Presumed cardiac aetiology, n (%)	1,957 (70.6)	7,090 (70.9)
Bystander-witnessed, n (%)	731 (26.4)	2,923 (29.3) †
EMS attempted resuscitation, n (%)	1,017 (36.7)	3,851 (38.5)
Initial shockable rhythm, n (%)	266 (9.6)	1,034 (10.4)
Initial defibrillation by public AED*, n (%)	18 (7.0)	160 (15.7) †
Event survival, n (%)*	116 (47.5)	544 (55.2) †
Discharged alive, n (%)*	56 (23.1)	303 (31.3) †

^Includes adult patients, excluding EMS-witnessed events. *For patients presenting in a shockable rhythm. †$p<0.05$ for comparison between lockdown and non-lockdown period.

How we respond to OHCA in Victoria

The state of Victoria, Australia has an estimated population of 6.6 million spread over almost 227,000km², with over 5.0 million people living in the state's capital city of Melbourne. Ambulance Victoria is the state-wide EMS provider and comprises ambulance paramedics who have advanced life support skills (e.g. laryngeal mask airway, intravenous epinephrine) and Mobile Intensive Care Ambulance (MICA) paramedics who are authorised to perform endotracheal intubation, rapid sequence induction, needle thoracostomy and administer a wider range of medications.

Paramedics in Victoria have the base qualification of a three-year bachelor degree in Paramedicine. MICA paramedics are experienced paramedics who undergo a university-level post-graduate diploma in Intensive Care Paramedic Practice. Since December 2018, all paramedics are required to be registered with the Paramedicine Board of Australia via the Australian Health Practitioner Regulation Agency in order to practice.

Australia operates a single national telephone number for community access to emergency services (i.e. Triple Zero '000'). Telephone triage of emergency calls in Victoria is performed using the Medical Priority Dispatch System. Unless circumstances suggest ventilations (as is the case for patients under the age of 18 years old), suspected cardiac arrest events identified in-call receive further call-taker instruction (telephone CPR) recommending chest compressions until professional help can take over.

Advanced Life Support and MICA paramedics are dispatched concurrently to suspected cardiac arrest events in the community. A first responder program for early defibrillation by firefighters operates for cardiac arrest patients in greater Melbourne and a number of large regional towns. In addition, Ambulance Victoria co-responds with 101 volunteer community teams in smaller, predominately rural communities across the state.

Approved community volunteer responders, called GoodSAM responders, are also dispatched to suspected cardiac arrest events. GoodSAM (Smartphone Activated Medic) is a free global smartphone application that is used to facilitate a rapid response to cardiac arrests across the globe by connecting nearby persons to patients experiencing a cardiac arrest in those critical minutes before emergency services arrive. GoodSAM is activated at the same time as ambulance dispatch by Triple Zero (000) and alerts nearby registered users of the app of an event, as well as the location of the nearest AED. Since the launch of the GoodSAM app in Victoria on January 28th 2018, more than 10,000 individuals and businesses have registered their AEDs through the app. As of 30 September 2023, there were almost 13,000 volunteers registered in the GoodSAM app.

Ambulance Victoria cardiac arrest protocols follow the recommendations of the Australian Resuscitation Council. Ambulance Victoria paramedics are not obliged to commence resuscitation when the clinical presentation is inconsistent with life. Paramedics may discontinue resuscitation if advanced life support has been performed for 45 minutes without sustained return of spontaneous circulation (ROSC) unless there are exceptional circumstances as described in clinical practice guidelines.

In 2019, a resuscitation quality improvement initiative was rolled out across the state, training all paramedics and first responders in high-performance CPR. The initiative was supported by team-based resuscitation training, real-time feedback on CPR performance, structured resuscitation choreography and scene leadership, and post-event debriefing. Paramedics in Victoria are also required to complete an annual high-performance CPR skills competency test. Ongoing monitoring of resuscitation quality occurs after every resuscitation attempt and paramedics attending a resuscitation are provided with a data-driven post-resuscitation debriefing report. These debriefing reports, called Team Performance Reports, consist of 19 metrics which align with international treatment recommendations and key actions within the Chain of Survival.

Improving survival from OHCA

Ambulance Victoria has a great legacy in driving continuous quality improvement in OHCA care. Pages 20 and 21 show the key initiatives used by Ambulance Victoria over the past two decades to improve OHCA outcomes across Ambulance Victoria and regional Victoria.

Ambulance Victoria is also part of the Global Resuscitation Alliance, an international collaboration with a mission to increase OHCA survival rates by 50%. The Global Resuscitation Alliance promotes ten programs to improve OHCA survival, which are grounded in evidence and best practice and are designed to provide a framework for EMS systems (Figure 3). In recent years, Ambulance Victoria has also been working to implement the 10 programs. Some of the progress achieved to date includes:

▶ **Telephone CPR and rapid dispatch:** Ambulance Victoria and the Emergency Services Telecommunications Authority (ESTA) have been working closely throughout the COVID-19 pandemic to decrease call-handling time and the time to cardiac arrest recognition. In particular, Ambulance Victoria and ESTA collaborated to deliver and validate the Artificial Intelligence in carDiac arrEst (AIDE) study, a machine learning framework to enhance the detection of cardiac arrest in the call. The results of the AIDE study are under review, and may help to drive innovations in the detection of OHCA during the emergency call and reduce time to key interventions, such as telephone CPR.

▶ **High-Performance CPR with ongoing training and quality improvement:** In February 2019, Ambulance Victoria delivered one of largest investments in OHCA care, with the state-wide roll-out of high-performance CPR. This consisted of team-based resuscitation training, real-time feedback on CPR performance, structured resuscitation choreography and scene leadership, and post-event debriefing. The preliminary findings of this initiative have been published in an international journal (Nehme, 2021, p236-44) and demonstrate a significant improvement in CPR quality, as well as the risk-adjusted odds of survival to hospital discharge, particularly among initial shockable arrests. Annual reaccreditation and training of high-performance CPR is mandated through the Mandated Practice Skill Set initiative.

▶ **Measuring resuscitation efforts:** A key element of the implementation of high-performance CPR was the routine monitoring of resuscitation performance and the introduction of data-driven post-resuscitation debriefing reports. The reports, known as Team Performance Reports, provide paramedics with objective feedback on their resuscitation performance using 19 metrics which align with international treatment recommendations. Every month, over 700 paramedics and their respective team managers receive these Team Performance Reports, creating a powerful high-performance culture at Ambulance Victoria.

▶ **First responder program:** Ambulance Victoria has a well-established first responder program with Fire Rescue Victoria and the Country Fire Authority through the Emergency Medical Response (EMR) program. These crews are co-responded to suspected cardiac arrests and commence life-saving CPR and rapid defibrillation prior to Ambulance Victoria arrival. EMR crews then assist with continuing efforts at the resuscitation where required. A significant expansion of the first responder program is expected in 2023, which will see Ambulance Victoria co-respond with the Country Fire Authority to suspected OHCA events across an additional 50 regional areas in Victoria.

▶ **Smart technology to improve the community response:** Ambulance Victoria introduced the GoodSAM community responder smartphone application in 2018. The GoodSAM app connects people in cardiac arrest with nearby trained and trusted responders in the critical minutes between a Triple Zero (000) call and emergency services arriving. An AED registry was also established alongside the launch of the app, which registers and integrates the locations of almost 10,000 AEDs in Victoria, allowing community responders to retrieve their closest AED during a GoodSAM alert.

	01	**Establish a cardiac arrest registry**
	02	**Begin telephone CPR with ongoing training and Quality Improvement**
	03	**Begin high performing EMS CPR with ongoing training and quality improvement**
	04	**Begin rapid dispatch**
	05	**Measure professional resuscitation using the defibrillator recording (and voice if possible)**
	06	**Begin an AED program for first responders, including police officers, guards, and other security personnel**
	07	**Use smart technologies to extend CPR and public access defibrillation programs to notify volunteer bystanders who can respond to nearby arrest to provide early CPR and defibrillation**
	08	**Make CPR and AED training mandatory in schools and in the community**
	09	**Work towards accountability — submit annual reports to the community**
	10	**Work towards a culture of excellence**

Figure 3: The Global Resuscitation Alliance's 10 Programs to Improve Cardiac Arrest Survival

1999

VACAR

Victorian Ambulance Cardiac Arrest Registry (VACAR) established

2000

Metropolitan Ambulance Service and Rural Ambulance Victoria start training paramedics in Advanced Life Support (ALS)

Firefighters in metropolitan Melbourne are trained as emergency medical responders (EMRs), being dispatched at the s... time as Ambulance Victoria param... to life-threatening emergencies

2012

Expansion of MICA single responder units in metropolitan Melbourne and rural Victoria

MICA PARAMEDIC

2010

VACAR starts collecting patient-reported quality of life (QOL) and functional recovery data

AV commences an AED Registry wh... records the locations of AEDs across Victoria

2016

AV clinical practice guidelines for resuscitation updated

2017

240+ career firefighters across Victoria are trained through the EMR program

Commencement of the EXACT clinical trial (titration of oxygen after cardiac arrest)

2018

AV CPR awa...

Heart Safe Communit... train more... 1 mill... people sin...

2022

Commencement of FIRST and AUGMENT-VA clinical trials

Artificial Intelligence developed to improve the detection of cardiac arrest in Triple Zero (000) calls (the AIDE study)

2020

Introduction of Team Performance Report for cardiac arrest debriefing for AV paramedics

Roll out of Performan... for paramed...

Improve Cardiac Arrest Outcomes

2003

CPR awareness program launched in Victoria by Metropolitan and Rural Ambulance Services

2007

Simplification of telephone-assisted CPR instructions to 400 compressions before mouth-to-mouth

x400 compressions

2009

Expansion of the firefighter EMR program to outer metropolitan and regional areas of Victoria

2008

Metropolitan Ambulance Service

Rural Ambulance Victoria

Alexandra District Ambulance Service

merge to form

Ambulance Victoria (AV)

AED

...ich of

...areness programs, including

...ties, ...e than

...ion
...ce 2004

Pilot of real-time and post event feedback on CPR quality for paramedics

Launch of the GoodSAM first responder app to paramedics and members of partner organisations

2019

VACAR 20-year anniversary and milestone 100,000th OHCA case recorded

...f High ...ce CPR ...dics

Establishment of Sudden Cardiac Arrest Australia (SCAA) support group for cardiac arrest survivors

Expansion of the GoodSAM first responder app to appropriately trained first aid members of the public

20 YEARS ANNIVERSARY

Our philosophy: measure & improve

From roadside to recovery, the VACAR has been monitoring, measuring and improving the journey of OHCA patients for over two decades. The VACAR was established in 1999 and represents an internationally recognised standard of OHCA monitoring and reporting. The registry is managed by Ambulance Victoria and is overseen by a multidisciplinary Steering Committee. The VACAR incorporates prehospital clinical and operational data as well as hospital follow-up data for all OHCA events in Victoria where Ambulance Victoria are in attendance.

Data for more than 130,000 OHCA patients attended by Ambulance Victoria have been captured in the VACAR. The data is collated in the registry based on the internationally recognised Utstein template and definitions (Perkins, 2015, p1286-1300). The data that informs VACAR are sourced from Communication Centre dispatch records, EMS and first responder patient care records, hospital medical records, and telephone interviews conducted with adult survivors (or their proxies) 12 months post-arrest. Hospital outcome data is supplemented by death records from the Victorian Registry of Births, Deaths and Marriages. In total, VACAR collects over 150 operational and clinical data variables, including the Utstein style descriptors.

The VACAR provides essential information for the assessment of EMS performance in relation to the treatment and outcomes of OHCA patients. In particular, a number of key clinical indicators have been implemented, which are designed to measure the quality-of-care and allow for the benchmarking of EMS performance. These clinical indicators include ambulance response times, CPR quality, scene outcomes, event survival and survival to hospital discharge. The VACAR has also been used to inform the impact of Ambulance Victoria programs such as the EMR Program, the 'Call, Push, Shock' community CPR education program, the Heart Safe Community initiative, and temporal evaluation of public access defibrillation (PAD).

The VACAR is also a powerful mechanism for supporting clinical trials, including the First Responder Shock Trial (FIRST) and the Manual Pressure Augmentation in Ventricular Arrhythmias (AUGMENT-VA) trial, which are nested within the registry for the purposes of data collection and monitoring. In addition, the VACAR has successfully established an internationally recognised research program, and has contributed over 200 peer-reviewed publications in the field of resuscitation and OHCA across major international journals. The results of the research program are used to provide an evidence-base for Ambulance Victoria clinical practice guidelines and systems-of-care.

In 2010, the VACAR expanded its methodology to become one of few registries globally to routinely capture the quality-of-life and functional recovery of adult survivors of OHCA. A structured telephone interview with survivors 12 months following the event is conducted using previously validated quality-of-life assessment tools. This initiative ensures that VACAR provides a robust framework for the measurement of immediate, early and long-term outcomes following OHCA.

Finally, data from the VACAR is used to inform other national registries, including the Australian Resuscitation Outcomes Consortium (Aus-ROC) Epistry and the End Unexplained Cardiac Death (EndUCD) Registry. The Aus-ROC Epistry was established with the aim of understanding regional, ambulance service, and treatment factors associated with improved OHCA survival and outcomes in Australia and New Zealand. The Epistry enables benchmarking across providers and identification of system-wide strategies associated with survival. In comparison, the EndUCD registry aims to collect data on all OHCA patients aged 1-50 years, and combines VACAR data with coronial data to provide novels insights into the causes of OHCA in younger individuals.

What our people told us

Environmental scan

In March 2023, Ambulance Victoria's Centre for Research and Evaluation undertook an environmental scan of international policy documents informing best practice in OHCA care. The documents included scientific evidence and international consensus statements, including key policy positions from the Global Resuscitation Alliance, International Liaison Committee on Resuscitation, American Heart Association, Institute of Medicine (USA) and the National Health Service (Scotland). In total, 16 subject domains were identified that informed best practices in OHCA care and indicated a high level of consensus among international experts. The domains included:

1. Establishment of a cardiac arrest registry
2. Telephone CPR
3. High-performance CPR
4. Rapid dispatch
5. Community recognition
6. Community CPR and response programs
7. CPR skills in school aged children
8. Public access defibrillation
9. Measuring resuscitation quality
10. End of life decision making
11. Support for bystander and responders following OHCA
12. Accountability through open reporting
13. A culture of excellence
14. Inequalities and access to care
15. Research and implementation science
16. Systems of care

Among these 16 domains, a total of 57 programs, initiatives and/or strategies that targeted improvements in OHCA care were identified (e.g. CPR awareness campaigns, high-fidelity training, community responders).

Surveying our people

A cross-sectional survey was developed for our organisational leaders which incorporated the findings of the environmental scan. The survey was performed to identify which domains and initiatives should be prioritised in Ambulance Victoria's Cardiac Arrest Improvement Strategy, taking into account existing strengths in Ambulance Victoria's response to OHCA.
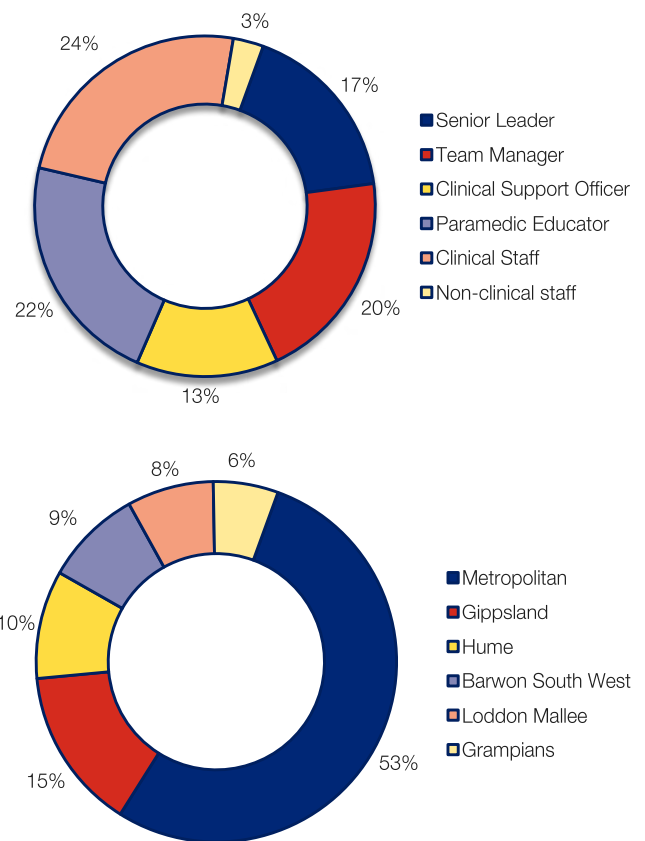

Figure 4: Characteristics of senior leader responders, including position description (top) and primary work location (bottom)

For the purposes of the survey the 57 strategies were collapsed across 10 overarching domains, including: Community CPR, high-performance CPR, culture of excellence, end-of-life care, cardiac arrest recognition, rapid dispatch, resuscitation quality, accountability, registry development and innovation and research. Respondents were asked to: 1) Rate on a scale from 0 to 100 which of the domains were a priority for Ambulance Victoria; 2) Which strategies within each domain were feasible to implement over 3 to 5 years and likely to drive improvements in patient outcomes; 3) Provide open-ended responses to any barriers or strategies that may exist outside those identified in the international literature.

The survey received 104 responses from leaders across Ambulance Victoria including senior management, team managers and clinical support officers (Figure 4). Of the respondents, 47% were from regional areas. Figure 5 shows the priority rankings attributed to each of the 10 domains. The 5 top-ranked priority domains included community CPR, high-performance CPR, culture of excellence, end-of-life care, and cardiac arrest recognition, each of which attracted an overall rating ≥90%.

The 57 strategies identified in the external environmental scan were also prioritised by Ambulance Victoria's leaders. Among the most highly ranked of the 57 strategies were staff training to facilitate end-of-life discussions, increasing AED application rates, community education campaigns, enhanced monitoring of call handling delays, and local champions to promote CPR skill maintenance.

The community CPR strategies were of consistently high priority, with over 70% of respondents supporting an increase in community AED application rates, an expansion of the firefighter co-responder program in regional Victoria, research to determine the most geographically appropriate placement of AEDs, novel dispatch strategies to facilitate efficient guidance of bystanders to the nearest available AED, lobbying for CPR training of all school-aged children, and an increase in bystander CPR rates to above 85%.

The high-performance CPR strategies also observed high rates of support from respondents, including regular high-fidelity simulation training with monitoring and feedback of CPR performance and further developing resuscitation choreography to emphasise the importance of scene leadership roles. The culture of excellence domain observed moderate to high support for initiatives directed at local champions to promote CPR skill maintenance and the establishment of Regional Cardiac Arrest Improvement Working Groups.

Finally, there was very high agreement for initiatives in the end-of-life domain, including staff training to facilitate end-of-life discussions and increased clinical guidance for managing patients with end-stage disease. Conversely, there was only moderate support for proposed initiatives directed toward rapid dispatch and measuring resuscitation quality.

In addition to the 57 strategies that were rated by Ambulance Victoria's leaders, a thematic analysis of open-ended questions was also undertaken to identify any barriers or strategies not identified from the environmental scan. Examples of the open-ended responses provided are shown in Table 2 (organisational jargon has been reworded for the audience). The top 10 themes identified in the open-ended responses included:

▶ A lack of appropriate accreditation of high-performance CPR (the leading issue identified)

▶ The need for greater investment in community CPR programs

▶ The need for enhanced and more accessible reporting of CPR performance and patient outcomes

▶ The need for more frequent exposure to resuscitation training for paramedics

▶ Inadequate resourcing of ambulances and alternative resource models

▶ A lack of education and training on end-of-life care

▶ The need for supportive performance monitoring and debriefing

▶ The need for improved staff morale and workplace culture

▶ A broader program of research in resuscitation science

▶ Suggested changes to resuscitation practice

The findings and insights generated through the survey have directly informed the shape and direction of the Cardiac Arrest Improvement Strategy.
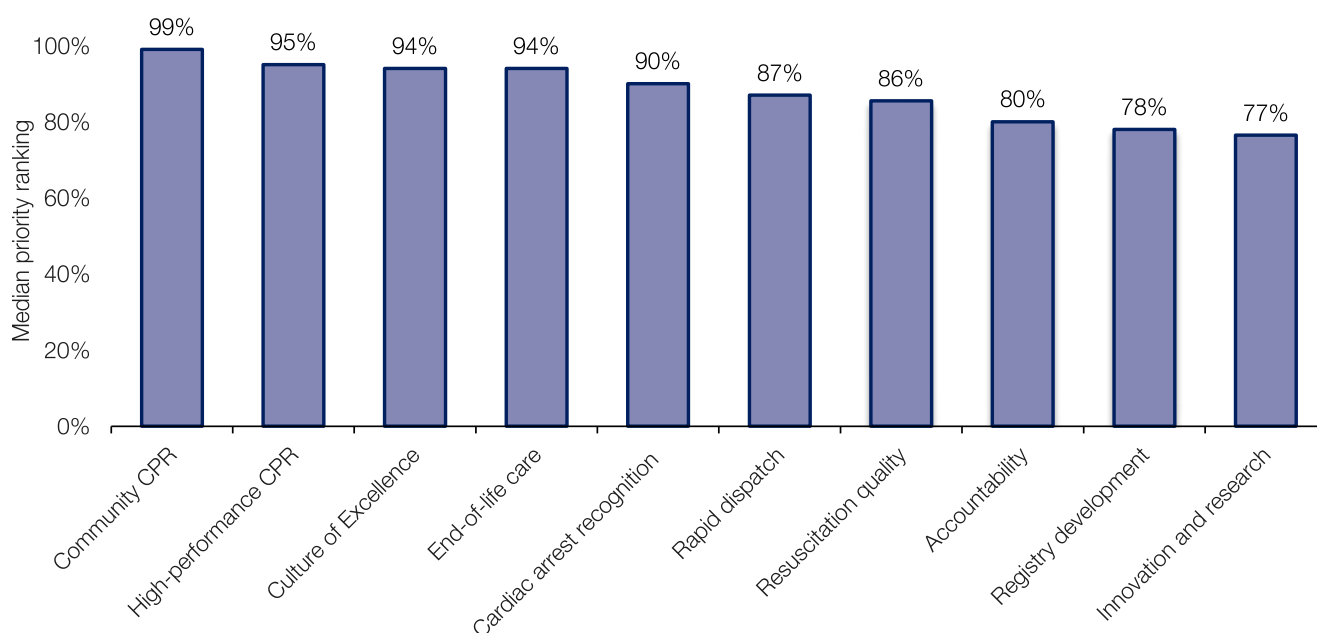

Figure 5: Domain rankings according to 104 responses from Ambulance Victoria's leaders

Table 2: Quotes attributed to Ambulance Victoria's senior staff identified through open-ended responses

- In my 30+ years at Ambulance Victoria with exposure to over 400 OHCA, early defibrillation and CPR are the only definitive actions that improve survival.

- A more governed system for refreshing high-performance CPR competency rather than "peer to peer" sign off. For example, an annual competency assessment built in to a face-to-face education day.

- State-wide high-performance CPR parameters have stalled with good chest compression fraction and CPR quality, but pre-shock pause is consistently outside target and is likely the single biggest gain to be made.

- Public education to improve recognition of OHCA, training in CPR and access to defibrillators are the keys to improving OHCA survival.

- Improve branch training environments and equipment to provide readily accessible training locations where skills stations can be left set up, and provide some decent training mannequins. Many rural branches have inadequate or no training space which is a significant barrier to regular training.

- Integrate high-performance CPR training into EVERY education day.

- Compulsory CPR training in schools should be a priority.

- One barrier to the 'culture of excellence' is the decreased standard present in the high-performance CPR credentialing assessment. Non shockable rhythms (PEA/asystole) are not included in the practical assessment. This erodes the standard that exists, as assessment drives learning - a cohort of paramedics are not learning that portion of the response.

- Embed provision of AED instructions as part of Triple Zero pre-arrival instructions, including the location of the closest AED.

- Embed dedicated cardiac arrest clinicians at a central communications point to provide remote direction to bystanders in real time (e.g. via video).

- Practice makes perfect, particularly in areas where there is low exposure. It is interesting that our current CPR credentialing are peer reviewed and hence there is a lack of quality control around CPR performance.

- High-fidelity training is of the key things we are missing. We have a junior workforce, with limited exposure to real cardiac arrest. We need training in cardiac arrest and ROSC management.

- I can't stress enough how important regular face-to-face education and then competency assessments are for all operational staff. I believe the current CPR credentialing inadequately measures this.

- The current feedback provided to staff on their performance in OHCA is often dismissed by staff as it is received too long post event and is perceived as not accounting for case by case variables.

- The current high-performance CPR credentialling assessment is a flawed process. The use of educators/assessors would increase cost, however, could be a worthy investment.

- There is variability in the capability of educators across the state in providing high-performance CPR training. The approach to resuscitation and training varies sigfnicantly and undermines the important work of the organisation to align all practitioners to the same model of care.

- Most patients with OHCA benefit purely on interventions before our arrival. Education, awareness and access to earlier interventions before our arrival will make the biggest difference to these patient outcomes. Access to defibs and CPR training (should be compulsory in all schools and workplaces) will do the most towards improving these outcomes.

- Cardiac arrest care has clearly stalled in last few years, driven by lack of focus (COVID) and uncertainty about changing Clinical Practice Guidelines and PPE requirements during COVID. Education of the research underpinning interventions will improve compliance (eg mechanical CPR).

- Improving the number of PADs that are available 24/7 in rural areas and ensuring that they are visible on GoodSAM is fundamentally important.

- We need better support for community groups to maintain AEDs. Currently, there is one major brand of pads out of stock (going on six months now), and small clubs and organisations cannot afford to replace entire machines, so they are being taken out of service instead.

- We need a technological focus - ultraportable AEDs is the first step, but getting a defib into every car, house, post box in Victoria would be a nice Utopian goal.

- Embed CPR training into school curriculum. Increasing interest from schools would be great to see. We attended multiple schools during the Shocktober campaign but it was us approaching them. Would be better if it was the other way around.

- Expand GoodSAM with more sign ups and expand the program by providing the community with incentives to be involved.

- We need dedicated cardiac arrest clinicians at a central communications point to provide remote direction to bystanders in real time, using audio-visual connection or other modality.

- Provide mobile teams to assess CPR performance and provide practice opportunities.

Our strategic priorities

Strategic Priority 1:
Enhance community-based participation in cardiopulmonary resuscitation and public access defibrillation

Priority lead: Executive Director Communication and Engagement

Why we chose this priority

The most important opportunity for improving OHCA outcomes is within the first few minutes of collapse. Timely response by bystanders remains a key factor driving favourable outcomes for patients with an initial shockable rhythm. Defibrillation by bystanders using an AED can halve the time to first defibrillation, and has been associated with survival rates over 50%. Importantly, early defibrillation by bystanders is also associated with better long-term functional recovery outcomes. Unfortunately, only one in ten OHCAs with an initial shockable rhythm currently receive defibrillation by bystanders, and the development of strategies to increase this approach has been identified as a leading research priority by the International Liaison Committee On Resuscitation (Kleinman, 2018, p802-819). As such, improving first responder access to AEDs is a strategic priority for Ambulance Victoria and will drive significant improvements in OHCA outcomes.

Although existing evidence supports the clinical effectiveness of public access defibrillation (PAD) programs, there is relatively little evidence informing their optimal placement and cost-effectiveness. A key international knowledge gap is the use of digital media applications to enhance first responders' ability to deliver timely defibrillation, particularly in the home (Kleinman, 2018, p802-819). The single biggest barrier to increasing the use of AEDs by bystanders is their location; although 75% of

OHCA currently occur in the home, the vast majority of public AEDs are situated in high-density public locations.

In 2018, Ambulance Victoria rolled out the GoodSAM smartphone application. GoodSAM alerts off-duty health professionals, emergency services workers and members of the public with CPR training to potential OHCA events in their vicinity, allowing them to respond and deliver life-saving CPR and defibrillation. Importantly, the app also alerts first responders to the location of a nearby AED if one exists.
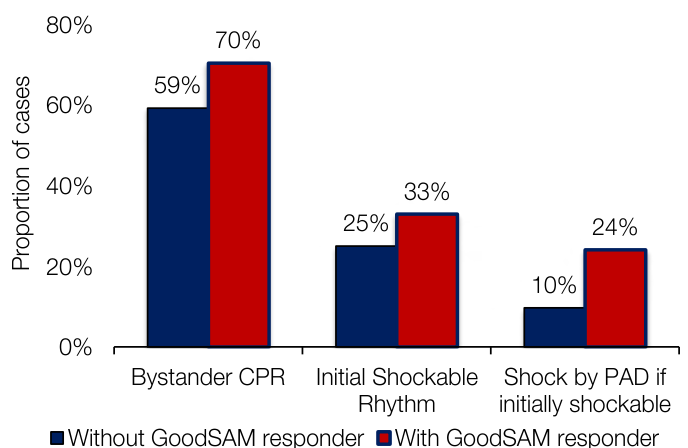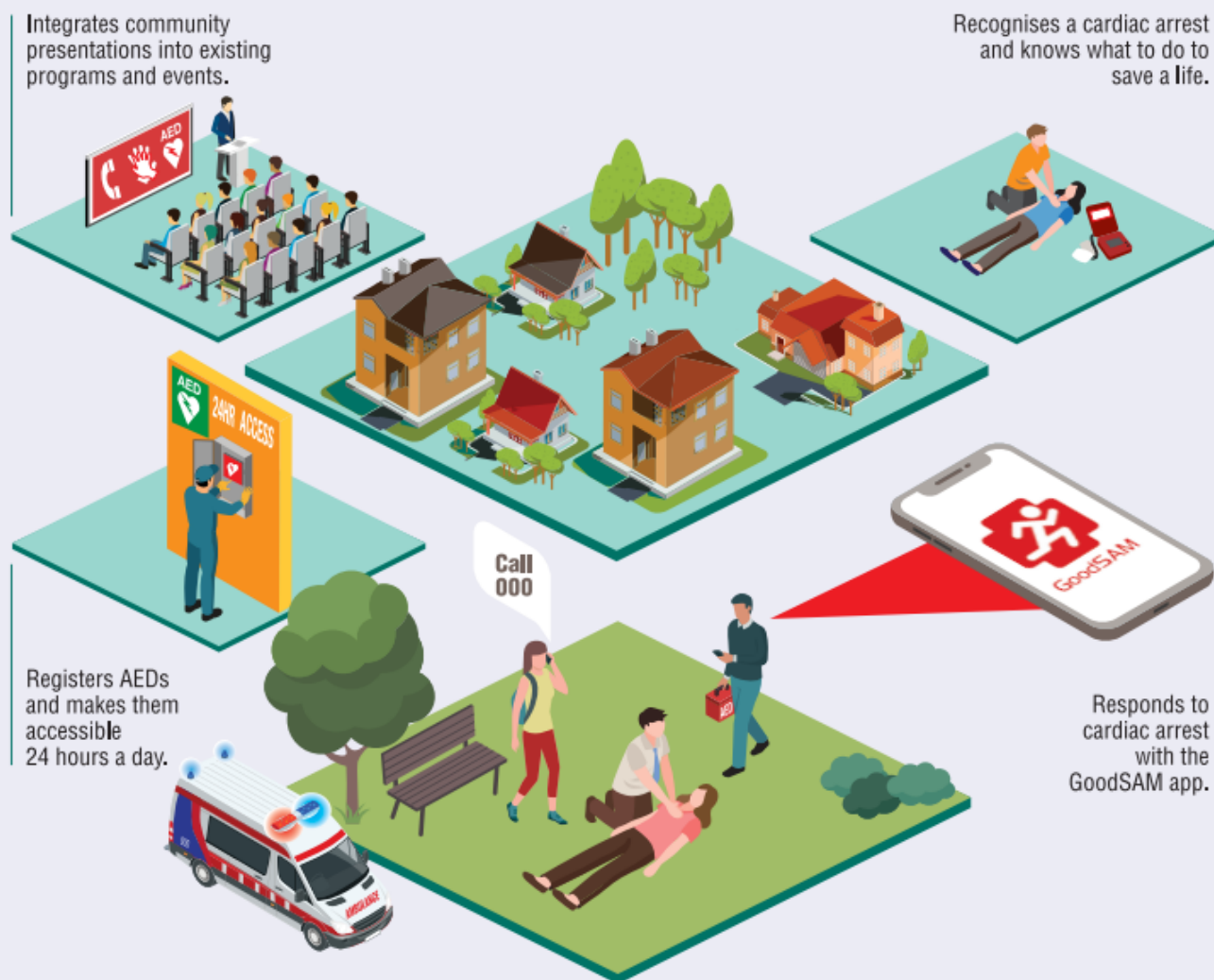

Figure 6: Impact of GoodSAM responder on bystander CPR and public AED use.
Source: VACAR 2020-21 data

A Heart Safe Community...

Integrates community presentations into existing programs and events.

Recognises a cardiac arrest and knows what to do to save a life.

Registers AEDs and makes them accessible 24 hours a day.

Call 000

Responds to cardiac arrest with the GoodSAM app.

...empowers communities to take life-saving action while the ambulance is on its way.

Figure 7: The Heart Safe Community Model

The GoodSAM app is integrated into the emergency call system and responders are activated simultaneously with emergency ambulances, ensuring no additional delays to care.

The GoodSAM app has also significantly influenced the system-of-care for OHCA patients in Victoria. Patients who receive a GoodSAM attendance are significantly more likely to receive bystander CPR, present in a shockable rhythm, and receive a shock from a bystander using an AED (Figure 6). Despite this, rates of public AED use remain low, even among GoodSAM responders (16%), and this likely reflects the socioeconomic, geographical, and practical inequities in the current placement of AEDs across our communities.

The type of bystander present at an OHCA is also a significant barrier to the success of PAD programs. Even when trained, lay bystanders often lack the knowledge, awareness, and willingness to acquire and use an AED. Similarly, the provision of prior training in CPR does not always translate into higher rates of bystander CPR in OHCA. Growing evidence now shows that bystanders with prior medical training or health professionals are significantly more likely to provide bystander CPR and AED use, and this has been associated with improved survival outcomes (Haskins, 2020, p72-79). These studies have led to increased calls for more off-duty medical professionals to respond to OHCA events as part of a coordinated system response.

Ambulance Victoria has been working with the Heart Foundation to establish 'Heart Safe Communities', a public education initiative which aims to improve survival from OHCA by empowering bystanders to step in and have a go at CPR and using an AED (Figure 7). The initiative has resulted in thousands of community members being trained in CPR and AED use. In addition, Ambulance Victoria has trained thousands of people in CPR and AED use through participation in, and championing of, world Restart a Heart Day. Despite these initiatives, exposure to CPR and AED education remains limited in many high-risk communities and community groups (including schools), and programs such as Heart Safe Communities are yet to be rolled out across all Victorian communities.

What we heard

The survey of our organisational leaders identified community CPR and AED use as the **leading priority** to improve OHCA outcomes. The top 5 priority areas, as identified by our people, included: 1) Increasing AED application rates; 2) Expanding the firefighter co-responder program in Victoria; 3) Optimising the placement of community AEDs; 4) Exploring innovative digital strategies to facilitate increased AED retrieval and use, and; 5) increasing CPR training for school-aged children.

Outcome	Indicators	Initiatives
▶ Maximise community participation in CPR and PAD	▶ 40 new Heart Safe Communities ▶ More than 100,000 Victorians trained in Ambulance Victoria's CPR awareness program (Call, push, shock) ▶ In bystander witnessed OHCA, increase the rate of bystander CPR to ≥85% ▶ In initially shockable OHCA, increase the rate of first shocks by bystanders to ≥35% ▶ Increase the GoodSAM membership base ▶ Increase the number of registered AEDs ▶ Increase the proportion of medically-trained GoodSAM responders arriving on scene	▶ Expand Heart Safe Communities to an additional 40 high-risk locations across Victoria ▶ Strengthen the 'Call Push Shock' community awareness program across high-risk regions in Victoria, particularly those with a high incidence of OHCA or low rates of bystander CPR ▶ Deliver a targeted 'Call Push Shock' community awareness program in school-aged children in collaboration with our partner organisations ▶ Develop a community communications plan to enhance the uptake of the GoodSAM app, particularly in low-uptake and hard-to-reach communities ▶ Conduct a state-wide community 'scavenger hunt' during Restart a Heart day to identify unregistered AEDs within the community ▶ Enhance the analytical potential of Ambulance Victoria's AED registry to identify high-risk communities in Victoria with the lowest density of public AEDs ▶ Partner with community and partner organisations to deliver grass-roots initiatives that improve the uptake of CPR training and access to public AEDs ▶ Translate the findings of the FIRST trial and identify ongoing opportunities to enhance the use of AEDs by GoodSAM responders. ▶ Establish a proof-of-concept study of AED-delivery using drone technology ▶ Develop a behavioural change framework to inform further engagement and responsiveness in the use of the GoodSAM app ▶ Investigate potential incentives to increase health professional engagement and responsiveness in the GoodSAM app

Table 3: Proposed indicators and initiatives to enhance Strategic Priority 1

What we'll do to improve

In line with international best practice and existing service delivery gaps, we'll spend the next 5 years strengthening and optimising the community response to OHCA. Our program of initiatives, as outlined in Table 3, details a comprehensive plan targeting community education initiatives through investments in the Heart Safe Communities and 'Call Push Shock' programs. The program will also see a strong investment in CPR education to local community groups, including a strong push for CPR education in school-aged children and school groups in collaboration with our partner organisations.

In addition to community education, we'll undertake research to test novel strategies to improve community first responder access to public AEDs, and establish an Australian-first proof-of-concept study to deliver an AED using drone technology. We will develop a behavioural change framework to inform further engagement and responsiveness in the use of the GoodSAM app and investigate potential incentives to increase health professional involvement. These collective initiatives will help inform the next generation community response to OHCA in Victoria.

Strategic Priority 2:
Optimise cardiac arrest recognition, call-handling and dispatch and provide a comprehensive system response

Priority lead: Executive Director Operational Communications

Why we choose this priority

After OHCA occurs, every minute counts. Recognising that a person is in cardiac arrest and providing early CPR and defibrillation has the greatest impact on survival. The rate of survival more than doubles with the provision of bystander CPR and more than triples with bystander use of a defibrillator (Nehme, 2019, p85-91). In Victoria, some of the most significant increases in survival from OHCA have been achieved by optimising these early actions. For example, research from the VACAR showed that simplifying call-taker CPR instructions in the emergency call was associated with an increase in bystander CPR and survival to hospital discharge (Bray, 2011, p1393-1398).

When a patient has a cardiac arrest, they immediately become unconscious, and either stop breathing or have abnormal breaths. Calling an ambulance is the typical way OHCA patients enter the health care system. All ambulance services in Australia (except the Australian Capital Territory) use a commercial call-taking system to categorise calls to ambulance - called the Medical Priority Dispatch System. These protocols initially ask the caller questions to determine if a person is in cardiac arrest (e.g. Is he/she awake? Is he/she breathing?). If answers to these questions are both 'no' (including equivocal descriptions of breathing), the call-taker will activate a whole of system response that consists of:

▶ Telephone CPR instructions

▶ Advice to locate the nearest AED

▶ Activation of a GoodSAM community responder

▶ Dispatch of firefighter or community emergency response teams with basic life support training

▶ A two-tiered EMS response, including Advanced Life Support and MICA Paramedics

These interventions are critical to the activation of the Chain of Survival and are why call-takers are often referred to as the gate keepers of the emergency response. Despite strong historical performance in recognising OHCA at the point of call, approximately 15% to 20% of cases are not currently recognised in the call and these patients do not receive the whole of system response. The main barrier to recognition is the myriad of descriptions used by callers to describe the cardiac arrest patient's consciousness and breathing. The International Liaison Committee on Resuscitation believe that enhancing call-taker recognition of cardiac arrest is likely to be one of the most cost-effective solutions to improving survival (Kleinman, 2018, p802–819).

Call-takers can significantly enhance the first link in the chain of survival by identifying the cardiac arrest early and providing bystanders with telephone CPR guidance and the location of a nearby AED. Ambulance Victoria already has a telephone CPR program, however, there is potential for it to be enhanced with ongoing training, feedback and quality improvement. Unfortunately, the COVID-19 pandemic had a disastrous impact on our emergency call centres, leading to unacceptable delays in call-handling and dispatch, particularly for OHCA patients. Although many of these challenges have been addressed through investments in additional communications personnel, there remains a lack of ongoing monitoring and targeted quality improvement in the call-taking and dispatch of OHCA cases. In particular, Ambulance Victoria currently do not monitor any measures of call-taking performance for OHCA patients and this undermines the timeliness of the whole of system response.

To further optimise cardiac arrest recognition, call-handling, and dispatch, it is essential to take a quality improvement approach. Specialised training for emergency call-takers could enhance their ability to recognise the symptoms of cardiac arrest, while regular feedback and coaching could improve call-taker skills and ensure adherence to established protocols. In particular, the Global Resuscitation Alliance recommends that call-takers receive education regarding the significance of agonal respirations and how to recognise them. Telephone CPR instructions are important in patients with agonal respirations, since they are the patients who are most likely to survive. Agonal breathing is present in approximately 60% of patients with bystander-witnessed OHCA (Fukushima, 2015, p314-317), and often confuses the caller and/or dispatcher into thinking the patient is not in cardiac arrest.

The Global Resuscitation Alliance also recommends a strong data-driven quality improvement approach to call-handling performance. They recommend indicators of performance including a 1 minute call-to-recognition time,

recognition of agonal respirations in 90% of cases, the provision of telephone CPR instructions in 75% of EMS treated OHCA, and the first compression started within a median of two minutes from call start.

Ambulance Victoria and ESTA have been working closely to improve call-taker time to recognition of OHCA and increase the incidence of bystander CPR and AED use at the scene. In particular, Ambulance Victoria and ESTA recently collaborated to deliver and validate the AIDE study, a machine learning framework to enhance the detection of cardiac arrest in the call. The results of the AIDE study are under review, and may help to drive innovations in the detection of OHCA in call and reduce time to key interventions, such as call-taker CPR.

What we heard

A cross-sectional survey of Ambulance Victoria's leaders identified strong support for cardiac arrest recognition and rapid dispatch to be prioritised in the Cardiac Arrest Improvement Strategy. Both domains received an overall priority level of 90/100 and 87/100, respectively. There was strong agreement that public awareness campaigns should focus more on the signs and symptoms of a cardiac arrest and the importance of early bystander action.

In comparison, there was only moderate consensus on which initiatives would yield improvements in call-handling and dispatch. Among these initiatives were the use of real-time audio-visual technology to enhance bystander instructions, telephone CPR training modules for call-takers that include listening to calls during simulation conditions, expert review of call recordings of confirmed OHCA calls to provide feedback to call-takers and embedding decision-support tools and/or artificial intelligence into the call-taking process. There was also moderate agreement for the need to examine whether call-taker characteristics (e.g. experience and exposure) are associated with cardiac arrest recognition in the emergency call.

Other survey domains also provided strong support for initiatives in call-handling and dispatch. For instance, the registry domain identified strong support for the recording and reporting of the time from Public Service Answering Point 1 (Telstra connection) to ambulance dispatch while the community CPR domain identified strong support for the expansion of a firefighter co-responder program in Victoria. Open-ended survey responses also identified a consistent theme around delays in call handling and dispatch and the need to build response capacity for suspected cardiac arrest events by responding managers, non-emergency ambulances or police resources.

What we'll do to improve

In partnership with ESTA, we will use the next 5 years to strengthen the quality and performance of our call-handling and dispatch and continue to build capacity in our response to cardiac arrest. Our program of initiatives, as outlined in Table 4, details a plan of initiatives targeting improvements in the system response to cardiac arrest, from enhancing call-taker recognition of cardiac arrest to developing additional live-saving capacity to respond to events in the community.

As part of these initiatives we will increase Victoria's first responder capacity by expanding the firefighter co-responder program into more regional areas of Victoria and investigate the feasibility of expanding the response capacity to suspected cardiac arrest calls to include other frontline resources. We will also enhance the quality feedback loop with call-takers by implementing telephone CPR training modules for call-takers that include listening to calls during simulation conditions and undertaking reviews of call recordings to provide feedback to call-takers.

We will strengthen our data sharing arrangements with ESTA and begin collecting and reporting on data relating to call-handling delays and delays to commencement of bystander CPR. We will examine the potential value of audio-visual connection for OHCA to provide more enhanced over-the-telephone clinical assessment and treatment instruction for OHCA patients and examine the value of decision-support tools in the call-taking process.

Finally, we will conduct targeted research exploring the barriers to cardiac arrest recognition in the emergency call and determine whether call-taker characteristics, such as their experience and exposure to OHCA calls, are associated with cardiac arrest recognition. The findings of this work will help inform education strategies to optimise the performance of call-takers in OHCA calls.

Outcome	Indicators	Initiatives
▶ A multifaceted system response that minimises delays to cardiac arrest recognition and dispatch and provides life-saving telephone instruction before the arrival of EMS	▶ Increase cardiac arrest recognition in the emergency call to >90% ▶ Reduce the median time to cardiac arrest recognition to <60 seconds from call start ▶ Reduce the median time to dispatch of the first EMS resource to <90 seconds ▶ Reduce the time to first compression started to <120 seconds ▶ Increase the proportion of cases where a first responder arrives before EMS to >50%	▶ Increase Victoria's first responder capacity by expanding the firefighter co-responder program into regional areas (the Fire Medical Response program) ▶ Examine the potential value of audio-visual connection for OHCA to provide more enhanced over-the-telephone clinical assessment and treatment instruction ▶ Implement telephone CPR training modules for call-takers that include listening to calls during simulation conditions ▶ Increase data sharing opportunities with ESTA to enhance the reporting of call-handing performance ▶ Conduct research to examine whether call-taker experience and exposure are associated with cardiac arrest recognition ▶ Examine the impact of decision-support tools and/or artificial intelligence in the call-taking process to improve the detection of cardiac arrest (the AIDE trial) ▶ Provide focused reporting on call-taking performance in OHCA calls across internal and public reports ▶ Introduce expert panel review of call recordings of confirmed OHCA calls to provide feedback to call-takers ▶ Investigate the feasibility of expanding the response capacity to suspected cardiac arrest calls to include other clinical and non-clinical staff as first responders

Table 4: Proposed indicators and initiatives to enhance Strategic Priority 2

Strategic Priority 3:
Establish world-leading performance in resuscitation and ensure all patients receive high-quality CPR

Priority lead: Medical Director

Why we chose this priority

Survival from OHCA is determined by the timeliness of pre-hospital interventions, known as the 'Chain of Survival'. Globally, EMS systems are actively monitoring key components of the chain, including early recognition, early CPR, early defibrillation and post-resuscitation care. However, achieving optimal outcomes for OHCA patients is also dependent on the quality of implementation of evidence-based interventions, and not just their timeliness. This is particularly true for resuscitation quality, where variation in EMS provider clinical performance may help to explain disparities in OHCA outcomes across regions. Internationally, the best patient outcomes from OHCA occur in systems that robustly implement scientific evidence, and conduct quality improvement initiatives to measure the quality and safety of clinical interventions.

In February 2019, Ambulance Victoria implemented a system-wide resuscitation quality improvement program training over 5,000 paramedics in high-performance CPR. The program consisted of minimally interrupted CPR, team-focused choreography, real-time audio-visual feedback, and data-driven post-event debriefing. Prior to the COVID-19 pandemic, a study examining the preliminary findings of the program showed that the risk-adjusted odds of survival to hospital discharge improved by 33%, representing 8.7 (95% CI: 3.2, 14.1) additional survivors per million population (or 46 additional survivors over the intervention period).

Unfortunately, improvements in survival and resuscitation quality were short-lived due to the COVID-19 pandemic (see Impact of the COVID-19 pandemic; page 14). Monitoring of resuscitation quality indicated that a number of clinical practice changes implemented during the pandemic may have influenced overall care and performance. First, there were significant increases in the use of mechanical CPR which resulted in increased hands-off chest time and lower chest compression fractions (see Figure 8). Delays to key interventions, such as defibrillation and adrenaline administration, increased significantly. Figure 8 shows that call-to-shock delays >10 mins were significantly higher in the COVID-19 period compared to the pre-pandemic comparator period.

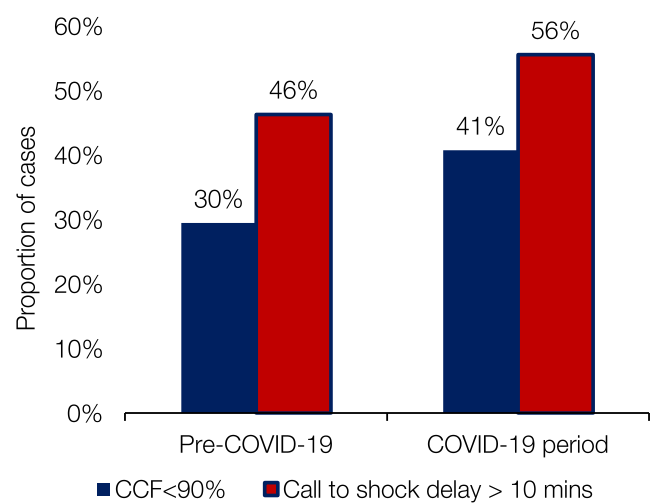Although these delays are predominantly associated with

Figure 8: Impact of the COVID-19 pandemic on chest compression fraction and call to shock delays.
Source: VACAR 2019-22 data.

donning personnel protective equipment, other factors may also explain a deterioration in performance over time. A lack of face-to-face training, changes in resuscitation choreography to accommodate COVID-19 modifications to practice, and limited opportunities for paramedics to undertake ongoing skill maintenance, are also likely to have contributed to the deterioration in resuscitation quality during the pandemic.

What we heard

The survey of our organisational leaders identified high-performance CPR as the **second leading priority** for Ambulance Victoria. The top 4 strategies, as identified by our people, included: 1) Regular high-fidelity simulation training with monitoring and feedback of CPR performance; 2) Development of resuscitation choreography to emphasise the importance of leadership roles (team leader); 3) Providing and tracking skill-reporting manikins for simulation, assessment and accreditation, and; 4) Increased frequency of mandated high-performance CPR training with defined re-training periods (e.g. quarterly).

Outcome	Indicators	Initiatives
▶ All patients receive clinically appropriate, high-quality and minimally interrupted resuscitation	▶ Increase the median chest compression fraction to 93% ▶ Increase the median proportion of compressions at the target depth and rate to over 75% ▶ In initially shockable OHCA, increase the proportion of patients receiving their first Ambulance Victoria defibrillation within 2 minutes of arrival to over 85% ▶ In initially shockable OHCA, increase the proportion of patients with an adequate duration of resuscitation (≥45 minutes) to over 85% ▶ Improve first-pass intubation success to over 85% ▶ Enhance end-of-life decisions by reducing the rate of futile resuscitation attempts in clinically appropriate groups (e.g., initial asystole, terminally ill, not for resuscitation)	▶ Improve paramedic access to skills stations and manikins for simulation training and accreditation ▶ Encourage regular high-fidelity simulation training with monitoring and feedback of CPR performance ▶ Mature resuscitation choreography by integrating scene leadership roles (team leader) ▶ Increase the frequency of mandated high-performance CPR training with exposure to team-based training and choreography ▶ Establish a branch level clinical debriefing model between paramedic and team managers that leverages data-driven measures of resuscitation quality ▶ Provide greater training, education and treatment guidance for paramedics to enhance end-of-life decision making ▶ Conduct research to establish the evidence-base for existing resuscitation targets ▶ Conduct research to examine the impact of the COVID-19 pandemic and personal protective equipment on resuscitation quality and performance ▶ Conduct research to determine the optimal physiological targets for prehospital post-arrest care

Table 5: Proposed indicators and initiatives to enhance Strategic Priority 3

In the thematic analysis of open-ended response, concerns relating to the training and accreditation of resuscitation at Ambulance Victoria were among the most common barriers identified by senior leaders. Senior leaders indicated a lack of re-training/practice, a lack of equipment for training, and inadequacies in the current annual accreditation program (i.e. the Mandated Practice Skill Set) were key barriers to advancing the quality of resuscitation. In addition, a lack of adequate education in end-of-life care and decision making was the second most common theme identified.

What we'll do to improve

A number of EMS systems have championed the local implementation of quality resuscitation practices through team-based training, real-time feedback on CPR performance, structured resuscitation choreography and scene leadership, and post-event debriefing. Underpinning these initiatives is a culture of excellence driving deliberate and frequent training and education in resuscitation practice, and a strong commitment to the development of evidence-based strategies and implementation science.

To achieve this, Ambulance Victoria's Cardiac Arrest Improvement Strategy will prioritise paramedic education and training in resuscitation, with improved access to skills stations and manikins for simulation training, and increased frequency of high-performance CPR training with exposure to team-based training and choreography. In addition, the strategy will continue to develop resuscitation choreography by better integrating scene leadership roles into resuscitation and providing a structured framework for resuscitation debriefing that leverages data-driven measures of resuscitation quality. Resuscitation training will have a renewed focus on end-of-life care decision making for clinically appropriate groups (e.g., initial asystole, terminally ill, not for resuscitation) and will focus on providing guidance to less experienced staff on withholding and ceasing resuscitation.

Finally, the strategy will invest in targeted research to advance the evidence-base in resuscitation quality metrics, better understand the impact of the COVID-19 pandemic and personal protective equipment on resuscitation quality and performance, and determine the optimal physiological targets for prehospital post-arrest care.

Strategic Priority 4:
Create an organisation-wide culture of excellence in resuscitation that embraces quality and performance

Priority lead: Executive Director
Quality and Patient Experience

Why did we choose this priority?

Organisational culture is difficult to measure systematically, but is believed to be an important factor that influences quality-of-care and health outcomes. A cross-sectional survey of 537 hospitals in the United States identified lower mortality in patients with Acute Myocardial Infarction in hospitals that fostered a culture of excellence and a commitment to quality-of-care initiatives (Bradley, 2012, p618-626). Hospitals with lower risk-adjusted mortality often encouraged physicians to solve problems creatively, used physicians and nurses as champions to improve the quality of care, and supported hospital clinicians to meet monthly to review care with staff.

A culture of excellence in resuscitation underpins all high-performing EMS systems. A recent retrospective study led by Monash University interviewed 46 international EMS medical directors and cross-examined responses related to organisational values and goals with outcome data from OHCA. The study found that organisational goals directed at improving OHCA outcomes were independently associated with a 27% increase in the risk-adjusted odds of survival to hospital discharge (Dyson, 2020, p202-209). The study concluded that EMS systems should implement strategies to improve OHCA survival and empower staff to deliver those strategies.

A well established international mantra in resuscitation is that 'every VF patient survives' (attributed to the Resuscitation Academy). The mantra is intended to build the mindset so that behaviour (culture) will help drive continuous improvements in cardiac arrest care. The belief is that every death from VF is a preventable harm, which in practice is intended to drive a mindset of high-performance and reflective practice in the pursuit of excellence and continuous learning and improvement. For medical directors and senior clinical leaders, it is an opportunity to invest in targeted audits of resuscitations and ask one important question: why did this VF patient not survive? It is a question that is intended to drive the quality feedback loop for EMS systems and deliver opportunities to debrief, challenge and improve.

The Global Resuscitation Alliance recommends EMS agencies work toward a culture of excellence as one of the ten steps to improve OHCA survival. They recommend a series of actions to embed a culture of excellence in EMS systems, including: convening leadership meetings once a month, analysing data in partnership with operations and medical directors, and using data to inform training and clinical practice guidelines. Within the EMS organisational environment, this may include practices such as measuring and reviewing resuscitation quality and examining regional and temporal variation in outcomes and process-of-care measures. Developing a culture of excellence requires a strong emphasis on the implementation of evidence-based practices, ongoing training, teamwork and a commitment to continuous quality improvement.

A culture of excellence ensures that resuscitation teams consistently adhere to established best practices, including the latest guidelines for CPR and advanced life support. By following evidence-based protocols, healthcare providers can deliver high-quality care that has been proven to improve outcomes in OHCA. A culture of excellence fosters an environment where healthcare providers are trained and empowered to act quickly and confidently. A culture of excellence emphasises effective teamwork, clear communication, and role clarity among paramedics and first responders. When everyone understands their responsibilities and communicates effectively, the resuscitation process becomes more efficient and coordinated, minimising errors and maximizing the likelihood of survival. Key to this approach is the need for regular exposure to training, simulation, and resuscitation education.

Importantly, a commitment to continuous quality improvement underpins a culture of excellence. This involves tracking resuscitation outcomes, analysing data, and identifying areas for improvement. Through this process, Ambulance Victoria can identify opportunities to

refine clinical practice guidelines, address system-level issues, and implement changes that positively impact survival rates.

What we heard

The survey of our organisational leaders identified a culture of excellence as the **third leading priority** to improve OHCA outcomes. The top 4 strategies within this domain, as identified by our people, included: 1) local champions to promote CPR skill maintenance; 2) ensuring all regions have established Regional Cardiac Arrest Improvement Working Groups with clear governance structures; 3) providing feedback on OHCA outcomes to all individuals involved in the emergency response; and, 4) providing targeted education for staff regarding inequalities in resuscitation care for groups including women, people of colour and rural and regional Victorians. The survey also identified a number of key themes and barriers to improving OHCA outcomes, including a lack of timely and accessible reporting on OHCA outcomes and processes-of-care, a lack of formalised governance over the review of OHCA cases across regions, and the need for clinical trials and research to drive evidence and quality outcomes.

What we'll do to improve

We will take several actions to embed a culture of excellence in OHCA care at Ambulance Victoria. First, we will develop enhanced data analytics to provide staff and senior leaders with accessible and real-time data related to OHCA processes-of-care and outcomes. This will enable a better understanding of the current state of OHCA care and facilitate targeted improvements. Second, responsibility, authority, and accountability will be assigned to each Ambulance Victoria region to review and enhance resuscitation performance. In addition, we will embed local champions within each region to promote the maintenance of high-performance CPR skills and provide ongoing training. These champions will play a crucial role in ensuring that resuscitation skills are continually reinforced and updated to improve patient outcomes. Third, we will provide paramedics with notification and feedback every time an OHCA patient survives to hospital discharge. This feedback loop will help paramedics gauge the effectiveness of their interventions and recognise the value of their care.

Additionally, we will implement a number of initiatives to enhance the evidence-base in resuscitation science. To

prioritise investment in cardiac arrest research and address knowledge gaps, we will develop a publicly available research prospectus that will prioritise and support the development of resuscitation research. To support this work, we will undertake a large data linkage with the Victorian Emergency Minimum Dataset, Victorian Admitted Episodes Dataset, and the National Coronial Information System to gain comprehensive insights into patient care and outcomes after the prehospital journey. Furthermore, we will conduct innovative clinical trials to advance the evidence-base in cardiac arrest care. Trials such as FIRST, PANDA (PAramedic Randomized Trial of NoraDrenaline Versus Adrenaline in the Initial Management of Patients with Cardiogenic Shock), and CHEER-3 (Prehospital Extracorporeal CPR) will contribute to expanding knowledge and improving the quality-of-care provided to OHCA patients.

Lastly, we will advocate for the establishment of a national clinical trials network. In collaboration with the Aus-ROC and interstate ambulance services, this network will aim to promote collaboration and knowledge-sharing among resuscitation researchers and practitioners nationwide, ultimately leading to improved cardiac arrest care and outcomes.

Outcome	Indicators	Initiatives
▶ Establish a culture of excellence in cardiac arrest care by adopting the world's best practices and a motivation to measure and improve	▶ Development of clinical data analytics dashboards with a temporal and regional focus on resuscitation performance and outcomes ▶ Establishment of Cardiac Arrest Working Groups within each region with a clear governance and reporting structure ▶ State-wide notification of patient survival status to paramedics ▶ The development of a VACAR and hospital linked dataset with in-hospital outcomes ▶ The development of a VACAR and coronial linked dataset detailing causes of death ▶ Successful completion of clinical trials (FIRST, PANDA, CHEER-3) ▶ Development of a national clinical trial for OHCA	▶ Aspirational goal ('everyone in VF survives') embedded into all training and clinical communications ▶ Increase accessibility and/or communication around OHCA clinical performance to staff and senior leaders using enhanced data analytics ▶ Assign responsibility, authority, and accountability within each Ambulance Victoria region to monitor and improve resuscitation performance ▶ Embed local champions within each region to promote high-performance CPR skill maintenance and training ▶ Feedback OHCA survival to hospital discharge outcomes to paramedics involved in patient's care ▶ Undertake strategic data linkages to understand processes-of-care and outcomes beyond the prehospital environment (e.g. Victorian Emergency Minimum Datatset, Victorian Admitted Episodes Dataset, and the National Coronial Information System) ▶ Develop a publicly available research prospectus to prioritise investment in cardiac arrest research and address major knowledge gaps in epidemiology, resuscitation performance and patient outcomes ▶ Conduct innovative clinical trials that advance the evidence-base in cardiac arrest care (FIRST, PANDA, and CHEER-3) ▶ Establish a national clinical trials network with the Aus-ROC and interstate ambulance services

Table 6: Proposed indicators and initiatives to enhance Strategic Priority 4

Implementation

Implementing a comprehensive cardiac arrest strategy over a five-year period requires careful planning, cross-divisional collaboration and engagement from a number of national and international stakeholders. As part of the strategy, we will establish a working group comprising of strategic leads, organisational leaders, clinicians, and community representatives who will oversee the delivery of the strategy and ensure that initiatives are designed to deliver the expected outcomes and according to timeline. A high-level implementation timeline is described in Figure 9 and highlights the key initiatives that we will focus on to implement the Cardiac Arrest Improvement Strategy.

At the conclusion of every financial year, the VACAR will published an annual evaluation on the implementation progress of each initiative in its Annual Report which is publically accessible at www.ambulance.vic.gov.au/research.

In 2025, we'll focus on:
▶ Embedding local champions within each region to prom high-performance CPR training
▶ Establishing a national clinical trials network and comm planning for a national clinical trial
▶ Establishing Cardiac Arrest Working Groups within ead with a clear governance and reporting structure
▶ Providing focused reporting on call-taking performance OHCA calls across internal and public reports
▶ Expanding Heart Safe Communities to an additional 40 risk locations across Victoria
▶ Enhancing the analytical potential of Ambulance Victor registry to identify communities in Victoria with the low density of AEDs

2024

Figure 9: Implementation of key initiatives over the life of the Cardiac Arrest Improvement Strategy

2025

In 2024, we'll focus on:
▶ Providing feedback to paramedics on patient outcomes
▶ Developing a VACAR and hospital-linked dataset with in-hospital outcomes
▶ Developing a publicly available research prospectus to prioritise investment in cardiac arrest research
▶ Conducting clinical trials to advance the evidence-base in cardiac arrest care (FIRST, PANDA, and CHEER-3).
▶ Expanding the firefighter EMR program into regional areas (the Fire Medical Response program)
▶ Developing a clinical data analytics dashboard with enhanced monitoring of resuscitation performance and outcomes

In 2026, we'll f
▶ Examining th OHCA to pro
▶ Implementin listening to c
▶ Conducting OHCA calls
▶ Establishing drone techn
▶ Investigating ambulance r

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In 2027, we'll focus on:

▶ Enhancing resuscitation choreography by integrating scene leadership roles (team leader)

▶ Increasing the frequency of CPR training with exposure to team-based training and choreography

▶ Establishing a state-wide model for clinical debriefing between paramedics and team managers

▶ Providing greater training and education on end-of-life decision making

▶ Improving paramedic access to skills stations and manikins for simulation training and accreditation

▶ Developing a community communications plan to enhance uptake of the GoodSAM app

2026

2028

2027

focus on:

e potential value of audio-visual connection for ovide enhanced over-the-telephone assessment

g telephone CPR training modules that include alls during simulation conditions

expert panel review of call recordings for confirmed to provide feedback to call-takers

a proof-of-concept study of AED-delivery using ology

the feasibility of dispatching non-emergency resources to suspected OHCA

In 2028, we'll focus on:

▶ Strengthening the 'Call Push Shock' community awareness program across high-risk regions in Victoria

▶ Deliver a targeted 'Call Push Shock' community awareness program in school-aged children with our partner organisations

▶ Conducting a state-wide community 'scavenger hunt' during Restart a Heart day to identify unregistered AEDs

▶ Partnering with community organisations to deliver grass-roots initiatives that improve the uptake of CPR and PAD

▶ Developing a behavioural change framework to inform engagement in the use of the GoodSAM app

▶ Investigating potential incentives to increase health professional engagement and responsiveness in the GoodSAM app.

Our stakeholders

Strategy lead

▶ **Dr Ziad Nehme**
Director, Centre for Research & Evaluation
Chair, Victorian Ambulance Cardiac Arrest Registry
Ambulance Victoria

Stakeholder group

▶ **Nicola Reinders**
Executive Director Quality and Patient Experience

▶ **Natasha Krajcar**
Director Patient Care Academy

▶ **A/Professor David Anderson**
Medical Director

▶ **A/Professor Dion Stub**
Cardiology Medical Advisor

▶ **Anthony Carlyon**
Executive Director Clinical Operations

▶ **Lindsay Mackay**
Executive Director Operational Communications

▶ **Cindy Joffe**
Executive Director Communication and Engagement

▶ **Joel Marley**
Manager Community and Partner Engagement

▶ **Chris James**
Director Operational Capability

▶ **Michael Ray**
Lead Community & Co-Responder Program

▶ **Susanne Scott**
Director Operational Reporting and Analysis

▶ **Jodie Gilbert**
Director Operational Improvement

▶ **Ross Salathiel**
Regional Director

▶ **Belinda Delardes**
Resuscitation Coordinator

▶ **Dave Garner**
Manager First Responder & Community Programs

International peer review group

▶ **A/Professor Bridget Dicker**
Head of Clinical Audit and Research
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▶ **Dr Siobhan Masterson**
General Manager Clinical Strategy and Evaluation
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▶ **Dr Gareth Clegg**
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▶ **Professor Michael Sayre**
Medical Director
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▶ **David Waters**
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Council of Ambulance Authorities, Australia

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