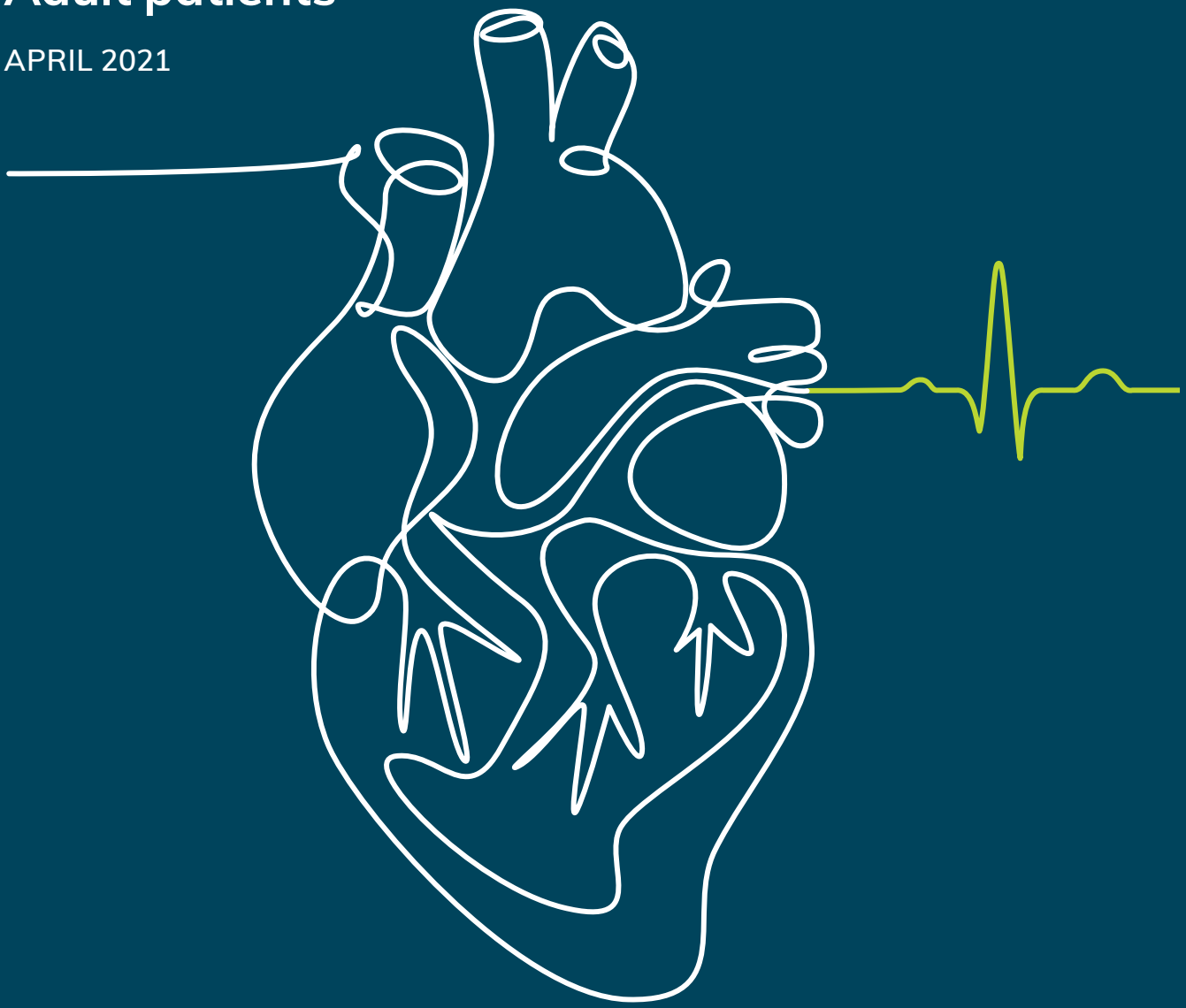
CLINICAL PRACTICE GUIDE

NSW mechanical cardiopulmonary resuscitation (mCPR)

Adult patients

APRIL 2021



NSW GOVERNMENT

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NSW mechanical cardiopulmonary resuscitation (mCPR)

mCPR for adult patients, at a glance

Patients suffering in-hospital cardiac arrest, guiding principles

Good-quality manual chest compressions must remain the gold standard for the delivery of external chest compressions during CPR

Early defibrillation of a shockable rhythm must not be delayed

CPR must be commenced immediately for cardiac arrest with no delay while waiting for a decision on the deployment of a mCPR device

Assess indications and contraindications for mCPR deployment

Indications for mCPR deployment

- Possible reversible cause of the cardiac arrest including but not limited to:
  - a primary cardiac event due to myocardial infarction or cardiotoxic drug overdose
  - pulmonary embolism
  - malignant arrhythmias
  - electrolyte disturbances
  - hypothermia
- Time delay before CPR was commenced
- The length of time manual chest compressions have been undertaken
- Age of the patient

Contraindications for mCPR deployment

- Known wishes of the patient not to receive cardiopulmonary resuscitation
- No reversable cause of cardiac arrest
- Presence of chest trauma as the cause of cardiac arrest
- Active chest bleeding
- Significant patient co-morbidities
- The patient does not fit into the mCPR device
- No trained staff in the deployment of a mCPR device in attendance

Patient eligible for mCPR deployment

YES

Deploy the mCPR device – fit the device to the patient, ensuring correct placement, program the appropriate settings and commence mCPR

A clinician must be dedicated to ensuring correct device positioning and monitoring for device migration during mCPR device deployment

mCPR deployment must be documented in the appropriate local health record

CPR must be recommenced immediately in the event of mCPR device failure

NO

Continue resuscitation with manual chest compressions

Introduction

This document provides a framework to support clinicians in the provision of mechanical cardiopulmonary resuscitation (mCPR) during in-hospital cardiac arrest (IHCA) where a decision to deploy a mCPR device has been made. It should be used to inform local policies and procedures, which should be current and reviewed regularly.

During cardiac arrest, the heart stops beating and can no longer adequately pump blood to the body, including to vital organs such as the brain and lungs. Cardiopulmonary resuscitation (CPR) is comprised of chest compressions and rescue breaths. The quality of CPR is dictated by the rate of compressions, the depth of compressions, allowance for complete chest recoil and minimal interruptions to compressions.[1]

The recommendation for chest compressions in adults dictates the lower half of the sternum should be depressed to a minimum of 5cm with full chest recoil at a rate of 100-120 compressions per minute, using a two-hand technique.[2]

It is well recognised that high-quality, early CPR associated with early defibrillation increases the chance of survival following cardiac arrest. It has been reported that adult survival rates to discharge following an IHCA are between 22.3% and 25.5%.[3]

The challenges of providing high-quality manual chest compressions for prolonged periods during IHCA has seen mCPR devices being utilised internationally in specific clinical scenarios such as a bridge to extracorporeal membrane oxygenation (ECMO), to facilitate organ transplantation, cardiac angiography or during percutaneous coronary intervention (PCI).[4]

The International Liaison Committee on Resuscitation (ILCOR) recommended in 2015 that mCPR devices should only be used as a reasonable alternative to manual external chest compressions for IHCA where sustained high-quality manual chest compressions may not be possible and this position continues to be supported by the current literature.[4-7] The Australian and New Zealand Committee on Resuscitation (ANZCOR) has adopted this recommendation.[8]

Intended audience and application

This guide is intended for use by the NSW Ministry of Health, pillar organisations, local health districts (LHDs) and relevant NSW clinicians.

This information is not a substitute for healthcare providers' professional judgement. Specific information about the individual patient and consultation with other medical authorities must be considered as appropriate.

Background

Systematic evidence reviews conducted on the efficacy of mCPR, have not conclusively demonstrated that the mCPR devices improve survival outcomes.[4,6]

The reported use of mCPR during IHCA suggests that there may be a potential role for mCPR for IHCA when deployed by expert clinicians. High-quality staff training mitigates the risk associated with frequent and prolonged pauses in chest compressions associated with deployment of the mCPR device.[7] The decision to use mCPR during IHCA must be based on appropriate patient selection and consideration of the potential risks involved in its use.

The current literature demonstrates that the quality of evidence for the routine use of mCPR devices during IHCA is low.[4] In the pre-hospital and in-hospital settings, the Australian mechanical CPR, hypothermia, ECMO and early reperfusion (CHEER) trial studied the use of extracorporeal cardiopulmonary resuscitation in adult patients with refractory cardiac arrest and included the use of mCPR.

This study demonstrated better overall rates of chest compressions delivered by mCPR, but there was no evidence that the quality of mCPR was superior to that of manual chest compressions.[9] Further research is required to evaluate the effect on survival with a good neurological outcome following IHCA where a mCPR device is routinely deployed.[4,6,7]

To understand current practice and use of mCPR in NSW, an online questionnaire was administered using the survey function in QARS (quality audit reporting system). The survey was circulated to health professionals in intensive care units, cardiology units and emergency departments through the Intensive Care NSW, Cardiology Network and Emergency Care Institute within the Agency for Clinical Innovation (ACI) (see Appendix A).

A review of the Clinical Excellence Commission NSW Incident Information Management System (IIMS) and Incident Management System plus (IMS+) data from 2010-2020 relating to adverse events associated with the use of mCPR devices during IHCA was also undertaken.

Mechanical cardiopulmonary resuscitation

mCPR is delivered using an automated device that provides the external chest compression component of CPR at a consistent rate and depth.[7] When a mCPR device is used during a cardiac arrest to deliver chest compressions, it is commonly referred to as deployment of the mCPR device.

The two main types of mCPR devices are:

- load-distributing band devices
- pneumatic piston devices.

A load-distributing device has a wide band of material that is placed around the thorax and attached to a short backboard which is placed under the thorax. The device is set to automatically shorten and lengthen the circumference of the band. The change in circumference of the band simulates the external manual chest compressions during CPR.

Pneumatic piston devices work predominately by placing a suction cup over the lower sternum which is attached to a backboard placed under the thorax. The piston actively compresses and decompress the sternum during CPR.[6]

Recommendations

The use of mCPR by LHDs and hospitals should consider the following.

- Good-quality manual chest compressions must remain the gold standard for the delivery of external chest compressions during CPR.
- CPR must be commenced immediately for cardiac arrest with no delay while waiting for a decision on the use or deployment of, a mCPR device.
- CPR must be recommenced immediately in the event of equipment or battery failure.
- The early defibrillation of a shockable rhythm must not be delayed.
- A CPR protocol must be developed to include the indications for use and deployment of a mCPR device.
- Patient selection criteria needs to be developed for the use of mCPR.
- The deployment must be documented in the appropriate local health record.
- A staff training and education program for staff certified in Advanced Life Support should be established based on theoretical and practical aspects in the deployment of a mCPR device, using simulation where available.
- Staff must be assessed and accredited in the deployment of a mCPR device, annually at a minimum. Consideration should be given to incorporate accreditation in the use of mCPR device deployment to align with the local policy on Advanced Life Support re-certification.
- A credentialing process must be developed and documented to ensure staff initiating mCPR are certified in Advanced Life Support, trained and qualified.
- A system of quality assurance must be implemented to ensure optimal device deployment and interruptions to chest compressions are minimised.[7]
- Ensure a maintenance schedule is established in line with the manufacturer's recommendations.

International practice

Current international best practice for deployment of a mCPR device includes:

- no delay in the commencement of manual chest compressions[6,7,10]
- early defibrillation is not delayed[6,7,10]
- a credentialed team leader is present at the IHCA to assess the appropriateness of deploying a mCPR device based on patient selection criteria[11]
- all staff involved in the deployment of the mCPR device are trained and accredited
- a procedure for maintenance and cleaning of the mCPR device is implemented
- an integrated clinical governance process to review the appropriate use of the mCPR device is established.[7]

Current NSW practice

Responses from the QARS survey were received from intensive care units, emergency departments and cardiac catheter laboratories which shows that currently, there is variation in the clinical governance surrounding the use of mCPR devices.

This variation includes:

- the presence of a policy and/or procedure for mCPR
- patient selection criteria
- contraindications for use
- instructions on the specific mCPR device
- the focus of resuscitation remaining on early manual CPR and defibrillation
- device cleaning and maintenance
- staff training
- staff assessment and frequency of assessment in the deployment of a mCPR device
- review following the deployment of a mCPR device at unit-based quality forums.

From the review of the NSW IIMS andIMS+ data there were a total of 36 incidents related to the use of a mCPR device during IHCA.[12] Of the 36 related incidents, 19 incidents did not directly relate to the deployment of the mCPR device.

The incidents directly relating to the deployment of the mCPR device involved:

- pressure areas (bruise, reddened area, broken skin) over the sternum in 13 of these incidents, as a result of prolonged CPR
- a patient with complex comorbidities selected for mCPR device use
- an incident where the deployment of a mCPR device was delayed due to the device being used in another area of the hospital
- two incidents where mCPR was abandoned due to the inability to position the image intensifier with the mCPR device in place during PCI.

Benefits and disadvantages of mCPR

Potential benefits of mCPR

There are two main types of mCPR devices – load-distributing band devices and pneumatic piston devices. The ILCOR recommends that these devices only be used as a reasonable alternative to manual external chest compressions for IHCA where sustained high-quality manual chest compressions may not be possible. This position has also been adopted by the ANZCOR.

While good-quality manual chest compressions must remain the gold standard for the delivery of external chest compressions during CPR, the use of mCPR devices can be beneficial in certain circumstances.

- The continued delivery of high-quality chest compressions during prolonged CPR removes the impact on the quality of compressions due to clinician fatigue, specifically where there is limited staff available to undertake resuscitation.
- Reduces the disruption to compressions from changes in clinicians performing manual chest compressions.
- Defibrillation can be delivered during mCPR, improving safety and reducing the interruption to manual compressions for defibrillation.
- Members of the cardiac arrest team are made available to focus on other tasks involved in resuscitation.[6]
- Reduces the risk of potential physical injury to staff performing manual chest compressions.
- The continued delivery of uninterrupted high-quality chest compressions on transport to, and during, interventional and non-interventional imaging and procedures, such as coronary angiography, PCI, ECMO or CT scan, where the positioning of the imaging equipment may impact the quality of manual chest compressions and the quality of the imaging.[7,13]
- It can provide support where bridging to ECMO is required.[6,7]
- Exposure of staff to radiation during interventional and non-interventional imaging is minimised.
- Improves the loss of compressible force, reported to be up to 40%, due to hospital mattresses.[4,7]
- Piston mCPR devices have been shown not to cause significantly more severe or life-threatening injuries than good-quality manual chest compressions.[11]

Potential disadvantages associated with mCPR

As outlined on the previous pages, good-quality manual chest compressions are the preferred delivery of external chest compressions during CPR. A healthcare provider's professional judgement based on specific information about the individual patient and consultation with other medical staff, as appropriate, will inform the decision to use a mCPR device.

When making this decision, please consider potential disadvantages disadvantages.

- External chest compressions must be paused to deploy the mCPR device which may diminish any potential benefit in the quality of compressions with the mCPR device following early device deployment.[10]
- Early deployment of a mCPR device may delay defibrillation where a shockable rhythm is present.
- Serious or life-threatening injury from load distributing mCPR devices has not been excluded to be higher compared with manual chest compressions.[11]
- There is the potential for increased fatal injury such as liver rupture or tension pneumothorax.[11]
- The device may be placed incorrectly.
- The time and cost of staff training and accreditation to ensure safety.[7]
- The cost of the device, consumables, maintenance and cleaning.
- Equipment or battery failure may further delay delivery of external chest compressions.
- Some load-distributing mCPR devices are unsuitable for use during PCI.

mCPR device deployment

The use of mCPR may be indicated during a cardiac arrest as a reasonable alternative to manual chest compressions in specific situations as a way of reducing factors that may affect the quality of manual chest compressions.[6] (See table 1)

There is wide variation in clinician manual external chest compression technique and the quality of manual compressions declines with prolonged CPR.[10]

Indications for use

The decision to use a mCPR device should consider the:

- known wishes of the patient not to receive cardiopulmonary resuscitation
- presence of a possible reversible cause of the cardiac arrest
- absence of chest trauma as the cause of cardiac arrest
- absence of significant patient co-morbidities
- age of the patient
- ability to fit the patient into the mCPR device
- time delay before CPR was commenced
- length of time manual chest compressions has been undertaken.

Table 1: Factors that may impact the quality of chest compressions

Human	• Provider fatigue due to limited available clinicians or the need for prolonged CPR • Interruption to manual chest compressions to allow for clinician change out to prevent clinician fatigue • Physical effort required to compress the sternum due to the stiffness of the thorax
Environmental	• Underlying compressible surfaces, such as mattresses, which may lead to sub-optimal depth of compressions • Interruption in chest compressions during transport for specialist non-interventional or interventional treatments and imaging within the facility

Source: Couper K, et al, Wang PL, et al, Callaway CW, et al.4, 6, 9

Patient selection criteria

The decision to implement mCPR should be made where there is a potentially reversible cause of cardiac arrest.

Such causes may include but are not limited to:

- a primary cardiac event due to myocardial infarction or cardiotoxic drug overdose
- pulmonary embolism
- malignant arrhythmias
- electrolyte disturbances
- hypothermia.

Other considerations for mCPR:

- age of the patient
- time delay before the commencement of manual CPR
- length of CPR.

Contraindications of mCPR include the points covered in table 2, below.

Table 2: Contraindications of mCPR

Known wishes of the patient not to receive CPR
No perceived reversable cause of cardiac arrest
Existence of significant patient co-morbidities
No trained staff in the deployment of a mCPR device are present
Active chest bleeding
Blunt chest trauma
The patient does not fit in the mCPR device

Health record documentation

The IHCA health record must include the:

- type of mCPR device deployed
- device settings
- time of deployment
- time deployment is ceased
- indications for ceasing the deployment of the mCPR device
- patient outcome
- details of any adverse event associated with the use of the mCPR device.

Governance

Quality assurance

Quality assurance is an integral component of integrated clinical governance across the NSW healthcare system. Data on the use of a mCPR device during an IHCA should be collected to include the following information as a minimum data set:

- appropriateness of patient selection for deployment of the mCPR device
- the length of time chest compressions were interrupted during the deployment of the mCPR device
- the length of time the mCPR device was deployed
- local policy or procedure is followed with the deployment of the mCPR device
- any adverse event attributed to incorrect device placement or device migration or operation should be documented in an incident management system
- the clinical IHCA documentation in the health record
- patient outcome post mCPR cessation and at discharge from hospital.

The data should be collated, shared, reviewed and documented at multidisciplinary meetings, including unit-based team meetings, hospital resuscitation committee meetings, morbidity and mortality meetings and other relevant multidisciplinary meetings, on at least a quarterly basis.

mCPR device maintenance

The mCPR device should be maintained in accordance with the manufacturer's guidelines and local procedures to ensure the device is ready for deployment and the risk of device malfunction is reduced.

Establish a maintenance schedule with reference to the manufacturer's recommendations including:

- checking the device, at a minimum daily
- spare batteries are plugged in and charged when not in use
- batteries are rotated weekly
- all parts, straps and spare battery are packed correctly, ready for use.

After mCPR device deployment:

- the battery must be changed
- all surfaces of the device must be cleaned with a soft cloth, warm water and mild cleaning agent (70% isopropyl alcohol or 45% isopropyl alcohol with added detergent)
- the device must be dry before being repacked, all disposable parts are removed and replaced, including any securing straps, if visibly contaminated with bodily fluids, and the device repacked.[11]

Staff training and accreditation

The deployment of a mCPR device should only be undertaken by trained, accredited and credentialed nursing and medical staff who are certified in Advanced Life Support. Staff training should be based on a protocol where each team member has a specific role in the resuscitation (role defined team approach or pit-crew protocol).[14] The role-defined team approach or pit-crew protocol should include a clinician dedicated to ensure correct device positioning and monitoring for device migration during the deployment of the mCPR device. A record of attendance at training, including continuing education and accreditation in the use of a mCPR device, must be up to date.

When using a mCPR device, the key modifiable risk is the time that manual chest compressions are paused for the device to be deployed.[7] Other risks associated with the deployment of a mCPR device include a delay in early defibrillation and incorrect device placement.[6,10] The role-defined training strategy aims to reduce these risks.[14]

Staff training should focus on:

- identifying the appropriate use of a mCPR device
- understanding how the mCPR device works
- mock resuscitation drills using a role-defined team approach
- methods of deploying the mCPR device with minimal interruption to manual chest compressions[7]
- correct positioning of the device
- emphasis on early defibrillation of a shockable rhythm as a priority[10]
- removal of the device, cleaning and safe storage.

Accreditation in the use of a mCPR device should include a competency-based approach and a simulation component to ensure staff are proficient in all aspects of mCPR device deployment, care and maintenance. Consideration should be given to incorporate accreditation in the use of mCPR device deployment to align with the local policy on Advanced Life Support re-certification.

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Appendix A

Results of QARS online survey to understand current practice and use of mCPR in NSW.

Total number of respondents		35
Number of respondents not using mCPR devices		9
Total number of respondents using mCPR devices		**26**
Departmental representation of respondents using mCPR devices	Intensive care unit	13
	Emergency department	10
	Cardiology	2
	NSW ambulance aeromedical	1
Units with a policy and procedure for the use of the mCPR device		**23 (88%)**
Timing of mCPR device deployment	First line	10
	Following prolonged CPR	16
Staff training packages available		**11 (42%)**
Methods of training	Written module	1
	Training videos	5
	Simulation	10
	Other – procedure with placement diagrams	1
Respondents undertaking staff assessment		**20 (77%)**
Frequency of staff assessment	Annual	3
	Initial	17
	Never assessed	6
Respondents reviewing complications or adverse events related to mCPR deployment		**26 (100%)**
Forums where complications or adverse events related to mCPR deployment are reviewed	Clinical safety huddle	6
	Debriefing following use of mCPR	20
	Departmental meetings	12
	IIMS data review	17
	Management meetings	5
	Mortality and morbidity meetings	19
	Nursing leadership meetings	8
	Rapid emergency response meetings	9
	Root cause analysis clinical review	0
	Medical specialist meetings	1
	Ward meetings	8
	Other – email to staff if any issues	1

Glossary

CPR	Cardiopulmonary resuscitation
CT scan	Computerised tomography scan
ECMO	Extracorporeal membrane oxygenation
mCPR	Mechanical cardiopulmonary resuscitation
IHCA	In-hospital cardiac arrest
ILCOR	International Liaison Committee on Resuscitation
IIMS	Incident Information Management System
IMS+	Incident Management System Plus
LHD	Local health district
PCI	Percutaneous coronary intervention

Acknowledgements

The ACI Intensive Care NSW Network worked with the ICNSW Executive and sought clinician advice and consultation to develop and complete this clinical practice guide.

The Agency for Clinical Innovation (ACI) is the lead agency for innovation in clinical care.

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