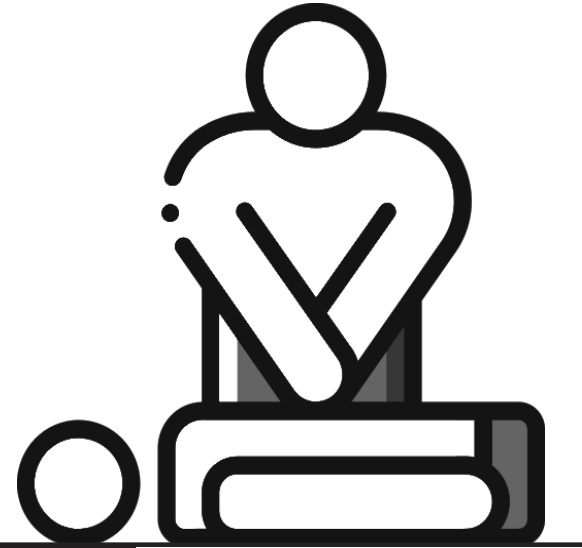


A Project Report On **P3**

Topic: **CardioAssist: CPR Assistive
Device for Adults**



Guide: Prof. BK Chakravarthy

By: Aamod Narkar | 216130013 | Mdes I.D.

IDC School Of Design
Indian Institute of Technology Bombay



Approval Form

This is to certify that the Industrial Design Project entitled "CardioAssist: CPR Assistive Device for Adults" by Aamod S. Narkar is approved for partial fulfillment for the Master of Design degree.



Prof. BK Chakravarthy (Project Guide)



Signature of the Chair Person:

Signature of the Internal Examiner:



Signature of the External Examiner:



Name: Aamod S. Narkar
Roll No.: 216130013
Date: 26/6/23

Declaration Form

I, declare that this written report represents my ideas in my own words, and where other's ideas or words have been included I have adequately cited and referenced the original sources.

I also declare that I have adhered to all principles of academic honesty and integrity and have not falsified, misinterpreted or fabricated any idea, data, facts or source in my submission.

I understand that any violation of the above will be caused for disciplinary action by the Institute and can also evoke penal action from the source, from which proper permission has not been taken or improperly been cited.

Name: Aamod S. Narkar

Roll No.: 216130013

Date: 26/6/23

Acknowledgement

I would like to sincerely thank my guide, Prof. BK Chakravarthy for his invaluable guidance at every stage of the project. Special thanks to my friend Lakshmi for helping me in documenting my process through photography and lab assistants Kailash Sir, Suraj Sir, Nikhil Sir for their help to make the prototypes. I am also grateful to all the faculty, staff and students of Industrial Design Centre (IDC) for their kind help and useful opinions and suggestions. I would like to thank my family for their unconditional support.

Abstract

Cardiac arrest is one of the leading causes of deaths around the world, and as per the news reports that scenario is similar in India. Many articles have reported young people as victims of cardiac arrest, proving that cardiac arrest is not restricted to any particular age, gender or profession.

One of the major issues around cardiac arrest in India is its lack of awareness, and lack of information on measures to be taken after witnessing such a case. CPR is a life saving skill that can revive the victim from the arrested state if provided help correctly within the given time. The bystander CPR rate is very low in India, hardly around 2% of the population are aware about the techniques of CPR.

As major of the cardiac arrests happen outside hospital, it is highly likely that only a lay bystander will witness a victim getting an arrest, and hence a bystander plays a very important role in saving the victim's life.

Creating awareness amongst people about CPR through trainings and seminars is very important, but relying just on these training sessions to create immediate impact on improving the bystander CPR rate in India is ambitious.

Hence my project aims in developing such a design solution that encourages and assists a bystander to provide CPR to the victim. A cost effective, portable and easily available solution that could be operated over the victim by the bystander until the emergency medical service reaches the site.

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Design Methodology



Research:

To understand cardiac arrest and various aspects around CPR



Quick mockups + scenario building:

Scenario was created to understand assembly steps of 5 mockups



Working Rig + User Testing+Final Brief:

User testing for handles and feedbacks



Final user testing

From the feedbacks user test conducted on the final design



Contextual + Product Study:

CPR training sessions and hospital visits to understand products in the market



3 concepts + User Testing:

Refined concepts to check mechanism for chest compressions



Revised Working Rig + Prototyping

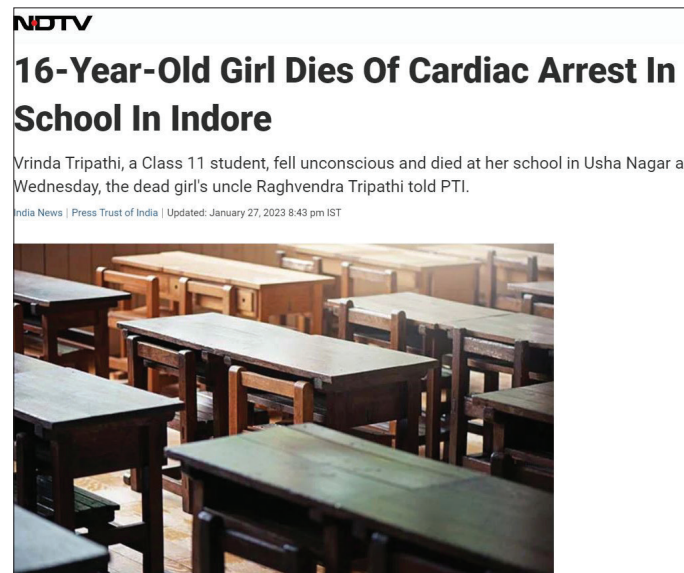
User testing for rescuer position and feedbacks

1. Introduction

Current common news in the medical field:

All of us now a days come across such news where we hear about the victim suddenly collapsing and eventually dying in few minutes. While the victim is walking, running, sitting or even sleeping. Such incidences in the medical language are called as case of cardiac arrest. This term cardiac arrest, most of us are not very well aware about. Most of the people are often assume that cardiac arrests and heart attacks are one and the same.

As seen in these news media articles, cardiac arrest cases are observed from young kids, fitness freaks to even gym enthusiast.



1.1 Cardiac Arrest

What is Cardiac Arrest?

Cardiac arrest occurs when the heart suddenly and unexpectedly stops pumping. If this happens, blood stops flowing to the brain and other vital organs. Cardiac arrests are caused by certain types of arrhythmias that prevent the heart from pumping blood.

Cardiac arrest is a medical emergency. Nine out of 10 people who have a cardiac arrest outside of a hospital die — often within minutes.

A person may be having a cardiac arrest if they:

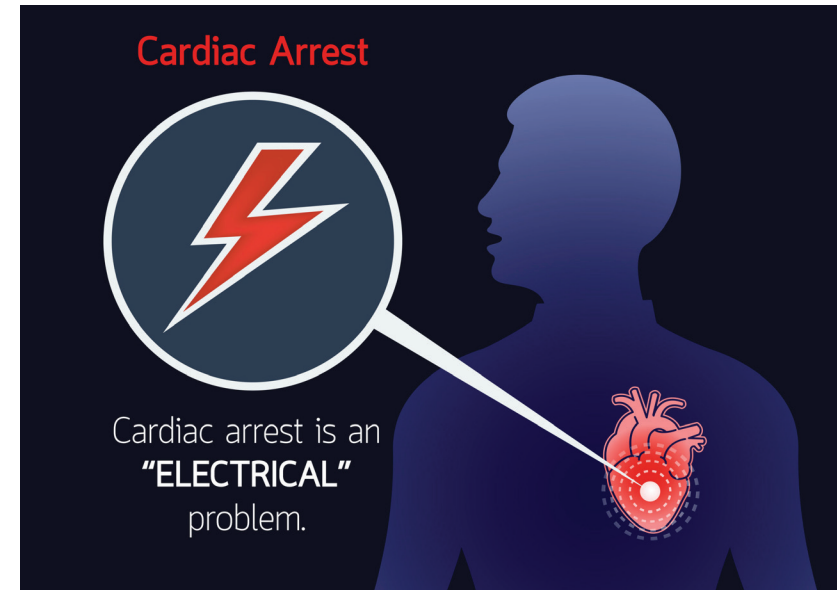
- Collapse suddenly and lose consciousness (pass out)
- Are not breathing or their breathing is ineffective or they are gasping for air
- Do not respond to shouting or shaking
- Do not have a pulse

The main cause of cardiac arrest is ventricular fibrillation or ventricular tachycardia, which are types of arrhythmias. Important risk factors include prior cardiac arrest, coronary heart disease, heart valve disease, congenital heart defects, and arrhythmias caused by faulty gene. However, half of cardiac arrests happen to people who did not know they had a heart problem.

Cardiac arrest is a common cause of death:

- Cardiac arrest causes about 300,000 to 450,000 deaths in the United States each year.
- Cardiac arrest causes about half of the deaths linked with heart attack and stroke.

Calling 911 and immediately treating with cardiopulmonary resuscitation (CPR) and defibrillation can save the life of a person in cardiac arrest. A defibrillator is a device that sends an electric shock to the heart to try to restore its normal rhythm. Most people who have a cardiac arrest do not receive treatment quickly enough to survive.



1.2 Cardiac Arrest VS Heart Attack

What is the difference between Cardiac Arrest and Heart Attack?

CARDIAC ARREST VS. HEART ATTACK

People often use these terms interchangeably, but they are not the same.

WHAT IS CARDIAC ARREST?

CARDIAC ARREST occurs when the heart malfunctions and stops beating unexpectedly.

Cardiac arrest is triggered by an electrical malfunction in the heart that causes an irregular heartbeat (arrhythmia). With its pumping action disrupted, the heart cannot pump blood to the brain, lungs and other organs.



Cardiac arrest is an **"ELECTRICAL"** problem.



A heart attack is a **"CIRCULATION"** problem.

WHAT HAPPENS

Seconds later, a person becomes unresponsive, is not breathing or is only gasping. **Death occurs within minutes if the victim does not receive treatment.**

WHAT TO DO



Cardiac arrest can be reversible in some victims if it's treated within a few minutes. First, call your local emergency number and start CPR right away. Then, if an Automated External Defibrillator (AED) is available, use it as soon as possible. If two people are available to help, one should begin CPR immediately while the other calls your local emergency number and finds an AED.

CARDIAC ARREST is a LEADING CAUSE OF DEATH.

Cardiac arrest affects thousands of people annually with about three quarters of them occurring in the home.

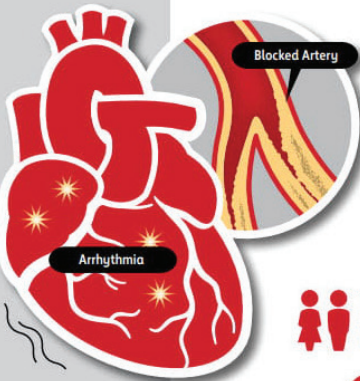


Fast action can save lives.

For more information on American Heart Association CPR training classes in your area go to heart.org/cpr.

Follow us:

[facebook.com/AHACPR](https://www.facebook.com/AHACPR) twitter.com/HeartCPR [#CPRsaveslives](https://www.instagram.com/CPRsaveslives)



A **HEART ATTACK** occurs when blood flow to the heart is blocked.

A blocked artery prevents oxygen-rich blood from reaching a section of the heart. If the blocked artery is not reopened quickly, the part of the heart normally nourished by that artery begins to die.

WHAT HAPPENS

Symptoms of a heart attack may be immediate and may include intense discomfort in the chest or other areas of the upper body, shortness of breath, cold sweats, and/or nausea/vomiting. More often, though, symptoms start slowly and persist for hours, days or weeks before a heart attack. Unlike with cardiac arrest, the heart usually does not stop beating during a heart attack. **The longer the person goes without treatment, the greater the damage.**



The heart attack symptoms in women can be different than men (shortness of breath, nausea/vomiting, and back or jaw pain).

WHAT TO DO

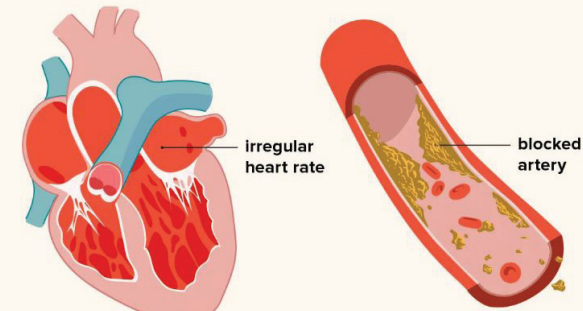


Even if you're not sure it's a heart attack, call your local emergency number. Every minute matters! It's best to call your local emergency number to get to the emergency room right away. Emergency medical services (EMS) staff can begin treatment when they arrive—up to an hour sooner than if someone gets to the hospital by car. EMS staff are also trained to revive someone whose heart has stopped. Patients with chest pain who arrive by ambulance usually receive faster treatment at the hospital, too.



American Heart Association.

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Cardiac arrest happens when your heart stops from an electrical problem.

A **heart attack** happens when you have a lack of blood flow to the heart.

The term "heart attack" is often mistakenly used to describe cardiac arrest. While a heart attack may cause cardiac arrest, the two aren't the same.

Heart attacks are caused by a blockage that stops blood flow to the heart. A heart attack refers to death of heart muscle tissue due to the loss of blood supply. It's a "circulation" problem. A heart attack is quite serious and sometimes fatal.

By contrast, cardiac arrest is caused when the heart's electrical system malfunctions. The heart stops beating properly. The heart's pumping function is "arrested," or stopped.

In cardiac arrest, death can result quickly if proper steps aren't taken immediately. Cardiac arrest may be reversed if CPR is performed and a defibrillator shocks the heart and restores a normal heart rhythm within a few minutes.

Cardiac arrest may be caused by irregular heart rhythms called arrhythmias. A common arrhythmia associated with cardiac arrest is ventricular fibrillation. In ventricular fibrillation, the heart's lower chambers suddenly start beating chaotically and don't pump blood.

Aamod S. Narkar | 216130013

1.3 Symptoms

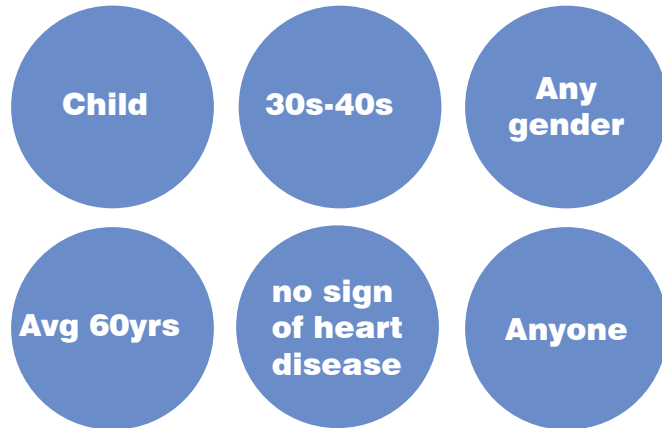
Symptom Comparison between Cardiac Arrest and Heart Attack:

Symptoms of Heart Attack	Symptoms of Cardiac Arrest
Symptoms can increase over time (but not always). Chest pain is the most common symptom.	Symptoms can increase over time (but not always).
Chest pain, heaviness, or discomfort in the center or left side of the chest	Loss of consciousness
Pain or discomfort in one or both arms, back, shoulders, neck, jaw, or above the belly button.	No pulse
Shortness of breath when resting or doing a little bit of physical activity (this is more common in older adults)	Not breathing or difficulty breathing
Heavy sweating for no reason	Shortness of breath
Feeling unusually tired for no reason, sometimes for days (more common in women)	Dizziness
Nausea and vomiting	Nausea and vomiting
Lightheadedness or sudden dizziness	Lightheadedness or sudden dizziness
Rapid or irregular heart rate	Heart palpitations or chest pain

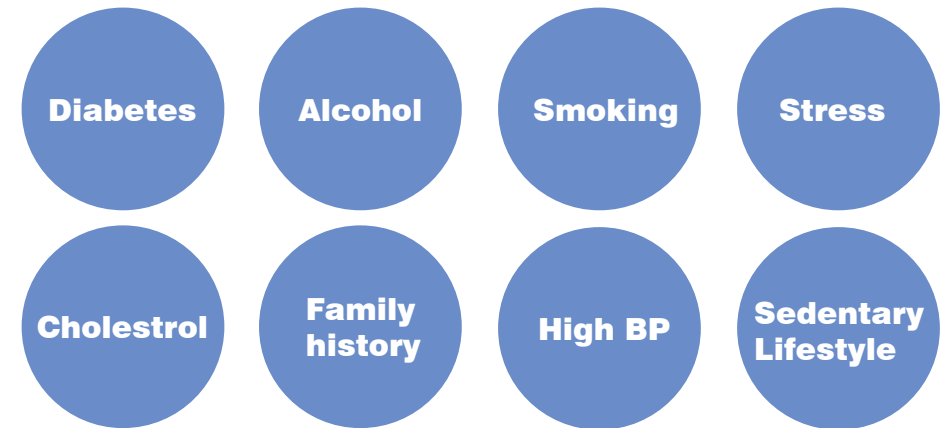
1.4 SCA

SCA stands for Sudden Cardiac Arrest

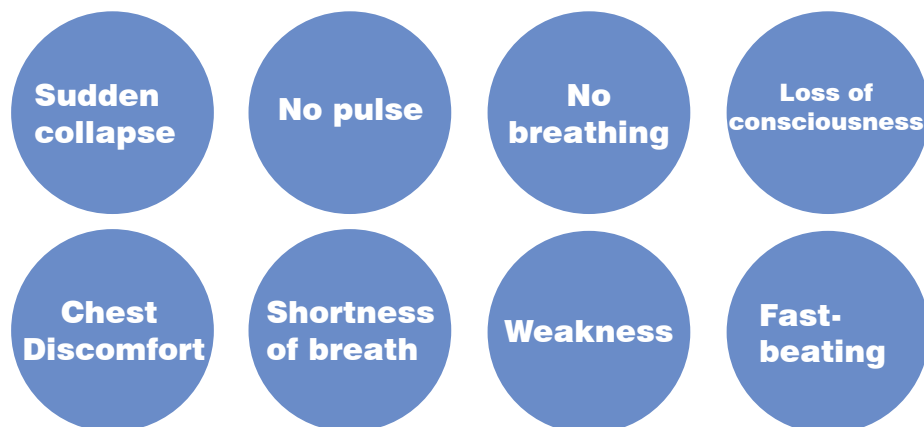
Whom? SCA can happen?



Why? does SCA happen?



What? are symptoms of SCA?



How? to prevent SCA?



1.5 American Heart Association

AHA: American Heart Association

American Heart Association:

The American Heart Association is a nonprofit organization in the United States that funds cardiovascular medical research, educates consumers on healthy living and fosters appropriate cardiac care in an effort to reduce disability and deaths caused by cardiovascular disease and stroke.



The American Heart Association has released Heart and Stroke Statistics - 2022 Update. According to the report, cardiac arrest remains a public health crisis. There are more than 356,000 out-of-hospital cardiac arrests (OHCA) annually in the U.S., nearly 90% of them fatal. The incidence of EMS-assessed non-traumatic OHCA in people of any age is estimated to be 356,461, or nearly 1,000 people each day. Survival to hospital discharge after EMS-treated cardiac arrest languishes at about 10%.

The annual report indicates the incidence of out-of-hospital cardiac arrest (OHCA) in the U.S. remains high and survival remains low. Bystander intervention in the U.S. also remains low. In 2017, laypersons initiated CPR in 39% of cases, used AEDs in just 6% of cases, and delivered a shock in ~2% of cases, based on CARES data.



AHA releases Heart and Stroke Statistics – 2022 Update:

OHCA incidence: Adults

- The incidence of EMS-assessed OHCA in 2015 was 347,322 based on extrapolation of ROC data.
- Based on CARES data, in 2020 the location of OHCA in adults was most often a home or residence (73.9%), followed by public settings (15.1%), and nursing homes (10.9%).
- OHCA was witnessed by a layperson in 37.1% of cases or by a 911-responder in 12.8% of cases. For 50.1% of cases, collapse was not witnessed.

OHCA incidence: Children

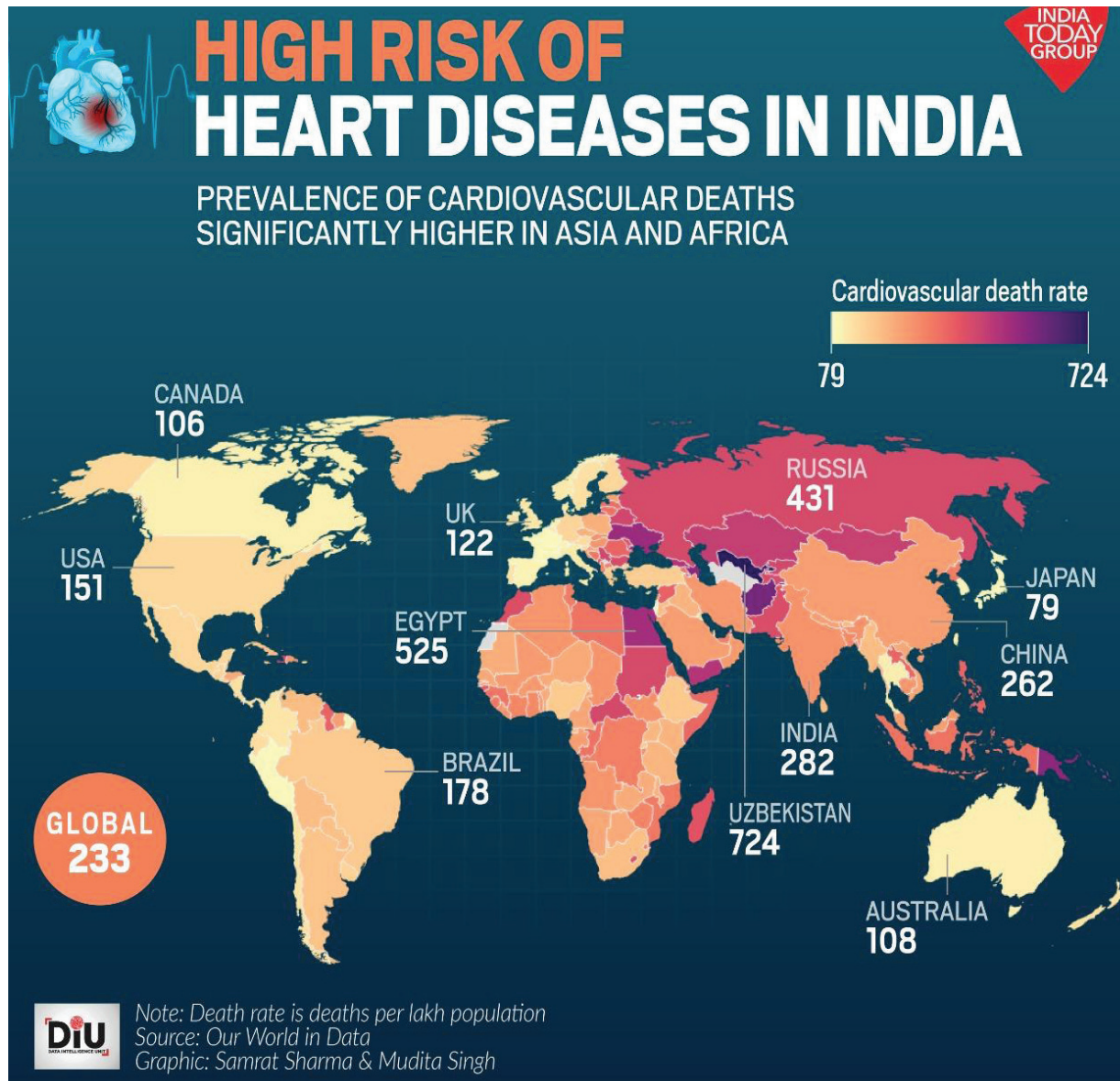
- Based on ROC data, the incidence of EMS-assessed OHCA in children in 2015 was 7,037.
- Based on CARES data, in 2020, the location of OHCA in children was most often home (87.5%), followed by a public place (12.2%).

Sports-related SCA/SCD

- Sports-related SCA accounted for 39% of SCAs among those <18 years of age, 13% for those 19-25 years of age, and 7% for those 25-34 in a prospective registry of 3,775 SCAs in Portland, OR between 2002-2015.
- The incidence of SCD from Lexis Nexis and public media reports during youth sport participation, estimated by the Sport and Fitness Industry Association from 2007-2015, was 1.83 deaths per 10-million athlete years.
- Pre-participation screening of 5,169 middle and high school students (mean age 13 years) from 2010-2017 revealed high-risk cardiovascular conditions in 1.47%.

1.6 World and Heart Risk

World Wide Heart Related Death Statistics:



According to the World Health Organisation, India accounts for almost one-fifth of the 17.9 million cardiovascular disease-related deaths globally, especially in the younger generation.

If there is any truth in the post pandemic rumours, we have a medical emergency on our hands and need urgent intervention.

A big drawback is the lack of awareness when it comes to cardiac issues but doctors are insistent, what they are seeing in the young is no less than an epidemic. The perception has not just been that it afflicts the older generation but also that it targets men.

In reality, women are equally at risk. Their symptoms though have a larger chance of being dismissed as part of a sociocultural conditioning. In the last three decades there has been a 3% increase in cardiovascular diseases among Indian women while it simultaneously declined in global females.

A report in the Times of India says some hospitals have witnessed a 10-15% increase in the rate of sudden cardiac death (SCD) in ostensibly healthy people but with a Covid history. Recent deaths include people in their 20s.

1.7 India and Heart Risk

India and Heart Disease:

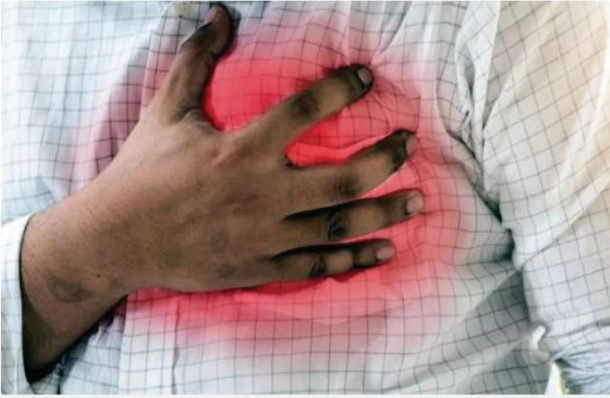
THE HANS INDIA

LATEST NEWS HYDERABAD NEWS ENTERTAINMENT CRICK

Doctor Says India Is Now The Chronic Heart Disease Capital Of The World

Susmita Modak

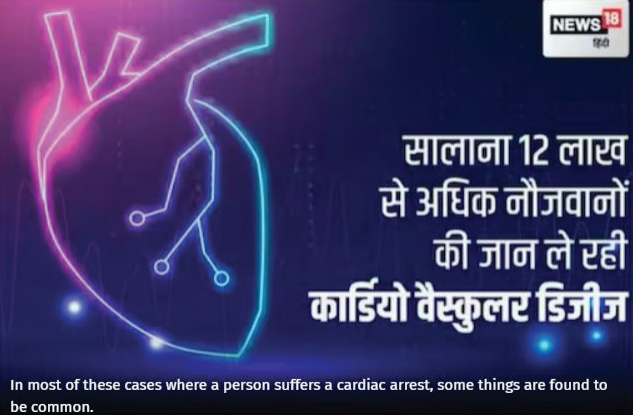
Hans News Service | 6 Oct 2022 7:30 PM IST



There are been a rise in the number of sudden cardiac death in India. (Photo courtesy: Getty Images)

HIGHLIGHTS

- In India, sudden cardiac death (SCD) cases have significantly increased over the past several years, with young individuals suffering the most.
- More than 5,000 doctors across India noted that schoolchildren should be aware of the coming danger of chronic heart disease in addition to young people.



साालाना 12 लाख से अधिक नौजवानों की जान ले रही कार्डियो वैस्कुलर डिजीज

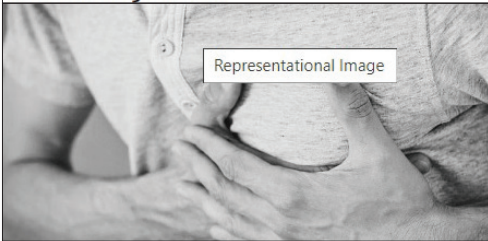
In most of these cases where a person suffers a cardiac arrest, some things are found to be common.

THE NEW INDIAN EXPRESS

NATION WORLD STATES CITIES BUSINESS SPORT GOOD NEWS MO

Home > Cities > Bengaluru

'India will see highest cardiac deaths by 2030'



Representational Image

It was believed that heart-related issues bother only the elderly and that youngsters were not that susceptible to heart attacks. However, this belief now seems to be fading away as more and more youngsters are falling prey to this illness. For instance, a young entrepreneur and founder of Grabhouse, Pankhuri Shrivastava died due to cardiac arrest last December. She was just 32. And before this, actors Amit Mistry and Siddharth Shukla had both died due to the same reason.

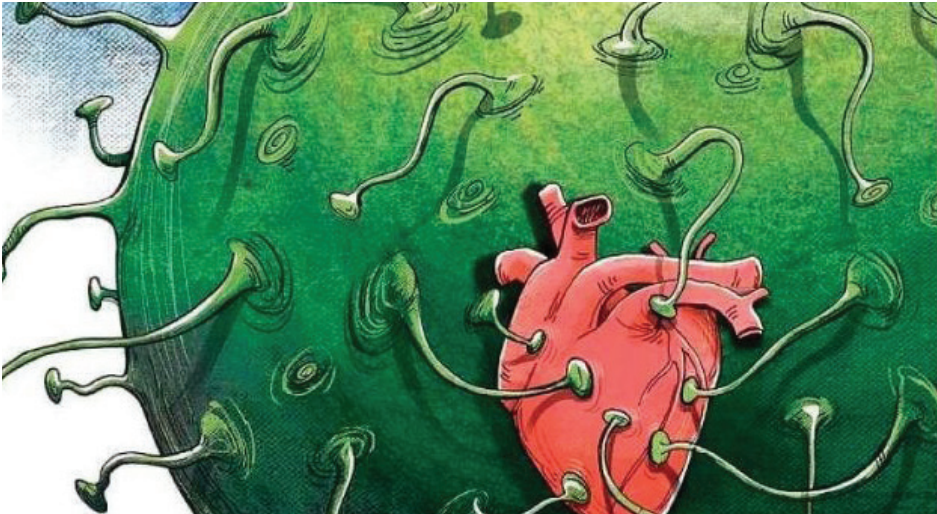
According to Dr Manjinder Sandhu, cardiologist and angioplasty heart Surgeon at Gurgaon's Artemis Hospital, 30% of people who have experienced cardiac arrest were found to be under the age of 45 years. Dr Sandhu claimed that cardiac arrest is the reason for the deaths of around 12 lakh youngsters in India. He further said that this figure has only been increasing in recent years.

In India, only 10.54% of the patients are transported by ambulance personnel, whereas 45.40% patients were transported by their relatives, 36.59% by police personnel and 7.47% by bystanders. Hence, a large number of laypersons need to be trained to provide efficient and timely resuscitation to those in cardiac arrest outside the hospital. Compression-only life support should focus on family members, police personnel, taxi drivers, autorickshaw drivers and bystanders. The survival rates with compression-only cardiopulmonary resuscitation (CPR) are similar to CPR with both compressions and rescue breaths. Compression-only CPR is simple, easy for an untrained layperson to perform and can be easily taught over the telephone by the dispatcher.

1.8 Pandemic and Heart Risk

Covid:

Increase in post-Covid cardiac arrest cases remains a puzzle



Though it is difficult to pinpoint specific effects and their repercussions, serious health issues that have developed subsequent to the infection in recovered patients are a major concern.

Over the past two years of the pandemic, it has been established without doubt that a Covid infection causes serious and far-reaching consequences to one's body. Though it is difficult at present to pinpoint specific effects and their repercussions, serious health issues that have developed subsequent to the infection in recovered patients are a major concern. Of late, the increasing cases of sudden cardiac arrest (SCA) in Covid-recovered patients -- even among youngsters -- have shocked people.

"If we need to link sudden cardiac arrests and Covid, there should be enough evidence to support this. It seems apparent that the two are linked, when studying patients who had Covid infection and those who didn't. While we look at the numbers alone, some people who recovered from Covid infection are seen getting sudden heart attacks. Though there is a connection, we cannot predict who all with Covid will get a heart attack, because the infection is so widespread. When we look at a large number of people, those who recovered from Covid definitely seem to have a slightly higher incidence of heart disease," said Dr. K K Pradeep, a cardiothoracic surgeon based in Kochi.

The rising incidents of cardiac arrest among healthy Covid-recovered patients have created fear among them. "Minor blocks in arteries start to form once over the age of 20. Only when blocks develop to over 70% do they create evident problems, and one seeks medical help. Not everybody with a block gets a heart attack. It happens only when there is a clot in the arteries, on top of the blocks. It is the clots that are responsible for heart attacks. Covid seems to make blood more prone to clotting, and we cannot possibly predict who all are likely to develop a clot and have attacks," said Dr. Pradeep.

Meanwhile, relying on anti-clot medicines is not a viable solution for those who do not fall under patient categories with known risk factors, such as heart ailments, diabetes and hypertension. "It is not possible to give anti-clot medicines to all those who have had Covid. Also, certain blood tests, like the D-dimer tests, are conducted on those who have had the infection to check whether the inflammation is substantial or not. If identified in the tests that there is a risk for the patient, they could be placed on blood thinners. After three-four weeks of the infection, if the D-dimer levels are not coming down and remain elevated, it is a sign that there is an ongoing inflammation in the body and the blood is prone to clotting," said Dr. P Madhukumar, a cardiologist based in Kozhikode.

1.9 Life Saving Technique - AED

What is AED?(automated external defibrillator)



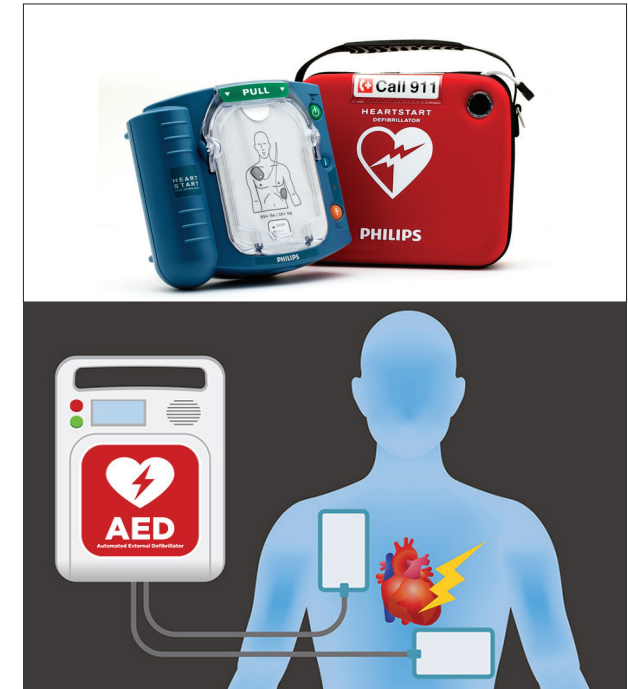
A person who suffers a cardiac arrest in public has more than twice the chance of surviving if a bystander steps in to restart the heart with an automated external defibrillator before an emergency crew arrives at the scene, a new study has found.

Researchers found that 66.5 percent survived with the help of a bystander-administered AED, versus 43 percent who survived after waiting for an emergency medical crew to deliver a shock to their hearts. Similarly, cardiac arrest patients were more likely to return to their normal neurologic levels when assisted by bystanders who used AEDs instead of waiting for emergency technicians.

Steps in AED Operation:

- Complete the CHECK and CALL steps.
- As soon as an AED is available, turn it on and follow the voice prompts.
- Remove clothing and attach pads correctly. Remove all clothing covering the chest. If necessary, wipe the chest dry. Place one pad on the upper right side of the chest. Place the other pad on the lower left side of the chest, a few inches below the left armpit. (Note: If the pads may touch, place one pad in the middle of the chest and the other pad on the back, between the shoulder blades).
- Plug the pad connector cable into the AED, if necessary.
- Prepare to let the AED analyze the heart's rhythm. Make sure no one is touching the person. Say, "CLEAR!" in a loud, commanding voice.
- Deliver a shock, if the AED determines one is needed. Make sure no one is touching the person. Say, "CLEAR!" in a loud, commanding voice. Push the "shock" button to deliver the shock.
- After the AED delivers the shock, or if no shock is advised, immediately start CPR, beginning with compressions.

AED Machine:



Conclusion:

Pros of AED:

- AED machines are intuitive, easy to use.
- AED machines are very portable.

Cons of AED:

- Philips AED machine costs over 1lakh.
- Due to its high cost, the availability of AED machine for the common man is very rare.
- AED machines are mostly installed in international airports, hospitals and few malls.

1.10 Life Saving Technique - CPR

What is CPR?

Cardiopulmonary resuscitation (CPR) is a lifesaving technique. It aims to keep blood and oxygen flowing through the body when a person's heart and breathing have stopped.

CPR is for people experiencing Trusted Source cardiac arrest. A heart attack occurs when blood flow to the heart is blocked, but the person is still conscious and not yet in cardiac arrest. Someone experiencing a heart attack may go into cardiac arrest and should go to the hospital immediately.

According to the American Heart Association (AHA) Trusted Source, CPR can double or triple the chances of survival after cardiac arrest. The primary goal of CPR is to keep blood flow active until medical professionals arrive.

The steps of CPR are a bit different according to whether the person is an adult, child, or infant. The primary difference is whether chest compressions are performed with two hands (adults), one hand (children), or thumbs/fingers (infants).

What are Chest Compressions?

Both hands-only CPR and CPR with breaths involve chest compressions. When a person is in cardiac arrest, the heart has stopped and it cannot pump blood through the body. Chest compressions recreate this pumping motion so the blood circulates to vital organs and the rest of the body.

The compression rate is the number of compressions you should perform in 1 minute. The AHA's recommendation for hands-only CPR is 100 to 120 compressions per minute. It is important to let the chest come back up after every push-down. The AHA also advises people to remember the beat of the song, "Stayin' Alive" to time their compressions.

Types of CPR?

There are two types of CPR and both have a potentially life-saving impact:

Hands-only CPR:

Involves Trusted Source calling for help and then pushing on the chest in a rapid motion. These movements are called chest compressions. Hands-only CPR can prevent a delay in getting blood moving through the body.

Traditional CPR with breaths:

Also called CPR with breaths, this alternates chest compressions with mouth-to-mouth breaths. This type of CPR can give the body more oxygen in the critical moments before help arrives.

Importance of CPR?

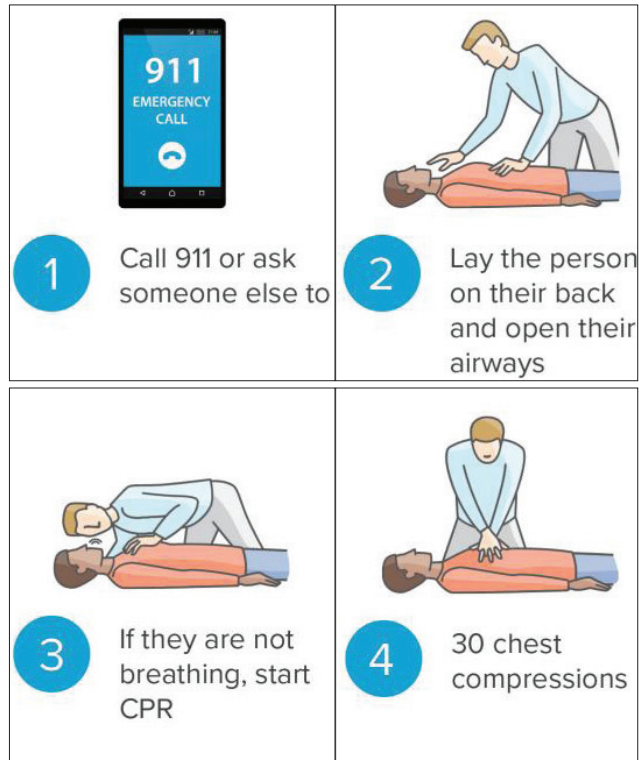
CPR performed within the first few minutes of the heart stopping can keep someone alive until medical help arrives.

Rescue breathing techniques were used to revive Trusted Source drowning victims as early as the 18th century. But it wasn't until 1960 that external cardiac massage was proven Trusted Source to be an effective revival technique, which is when AHA developed a formal CPR program.

The AHA recently recommended Trusted Source that people who haven't received CPR training initiate "hands-only" CPR. This method removes the rescue breathing and is easy to perform and is proven to save lives.

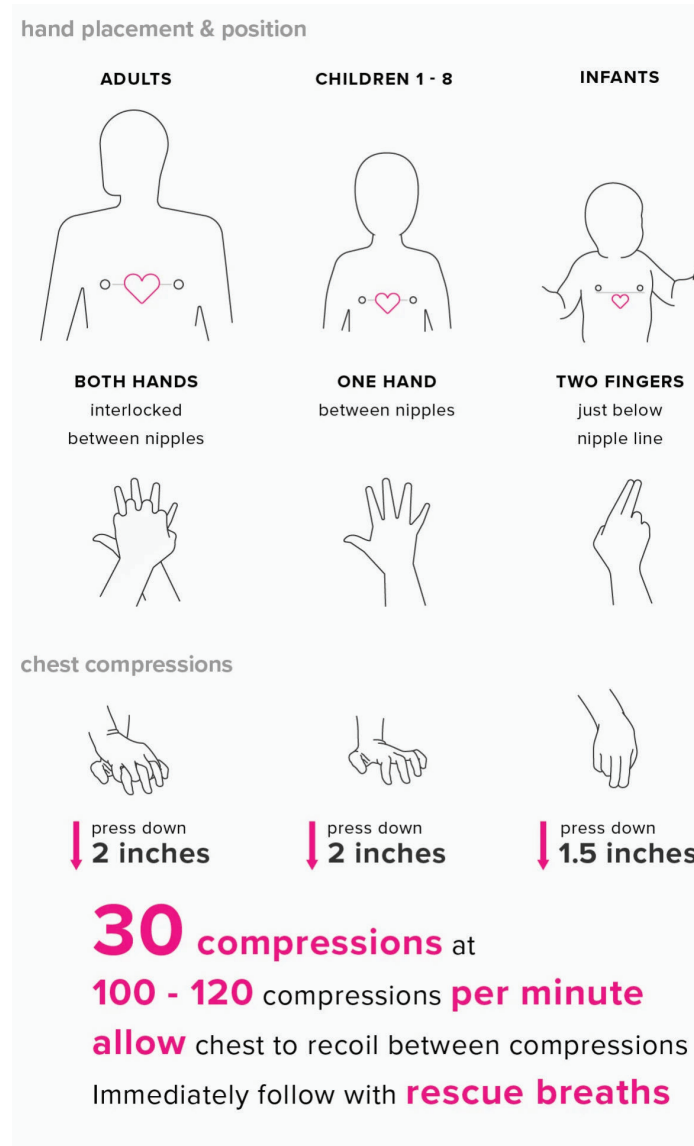
1.10.1 Life Saving Technique - CPR

Steps in initiating CPR:



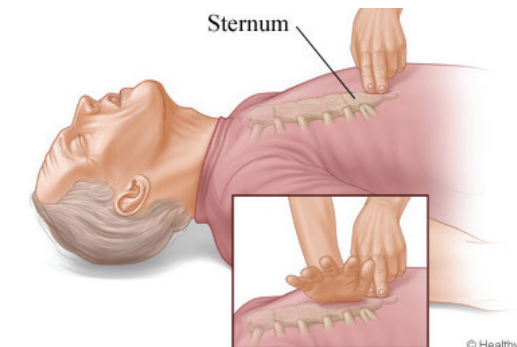
- Call 911 or ask someone else to.
- Lay the person on their back in safe area.
- Check for breathing, pulse and response, if all 3 absent, start CPR.
- Perform 30 chest compressions.
- Repeat until an ambulance or automated external defibrillator (AED) arrives.

Hand gesture detail:



CPR details:

- CPR stands for Cardiopulmonary Resuscitation.
- CPR should be started within **5 minutes** of a person having a sudden cardiac arrest.
- The chances of survival increase if CPR and use of an AED are administered immediately.
- Location: Place two fingers at the tip of the breastbone. Place the heel of the other hand right above your fingers.
- CPR helps to keep blood flowing and may help minimize the damage to the victim.
- CPR should be continued until ROSC or till medical help arrives.



- CPR may be required in case of heart attacks, choking, cardiac arrest, electrocution, stroke, drowning.

1.11 Types of CPR

ACLS

ACLS stands for Advanced Cardiovascular Life Support. CPR training is one technique of the Advanced Cardiac Life Support algorithm. This course teaches all the aspects of what a healthcare professional would do when faced with an emergency.

ACLS training is meant for health care professionals that deal with emergencies related to adults. This includes doctors, nurses, respiratory therapists, and paramedics. Students need to know how to read ECG rhythms and identify the proper medication doses for the patient.

This CPR method is used by professionals which also includes providing of breadths to the victim in the ratio 30:2.

ACLS to be initaited:

1) No response 2) No Pulse 3) No breaths

BLS

BLS stands for Basic Life Support.

BLS training is meant for anyone who works in the healthcare field. That includes doctors, nurses, dentists, EMTs, medical assistants, paramedics, fire fighters, dental assistants, and many more. Any person who is a professional and works with patients will need the BLS course.

This CPR method is by all medical workers including nurses, and public servants like police or fire fighting officials which includes providing of high quality CPR.

BLS to be initaited:

1) No response 2) No Pulse 3) No breaths

COLS

COLS stands for Compression Only Life Support.

COLS is also called as Hands-Only CPR, Hands-Only CPR is a potentially lifesaving option to be used by people not trained in conventional CPR or those who are unsure of their ability to give the combination of chest compressions and mouth-to-mouth breathing it requires. The COLS emphasises on early recognition of cardiac arrest and activation, early chest compression and early transfer to medical facility. The guidelines emphasise avoidance of any interruption of chest compression, and thus relies primarily on chest compression-only CPR by laypersons.

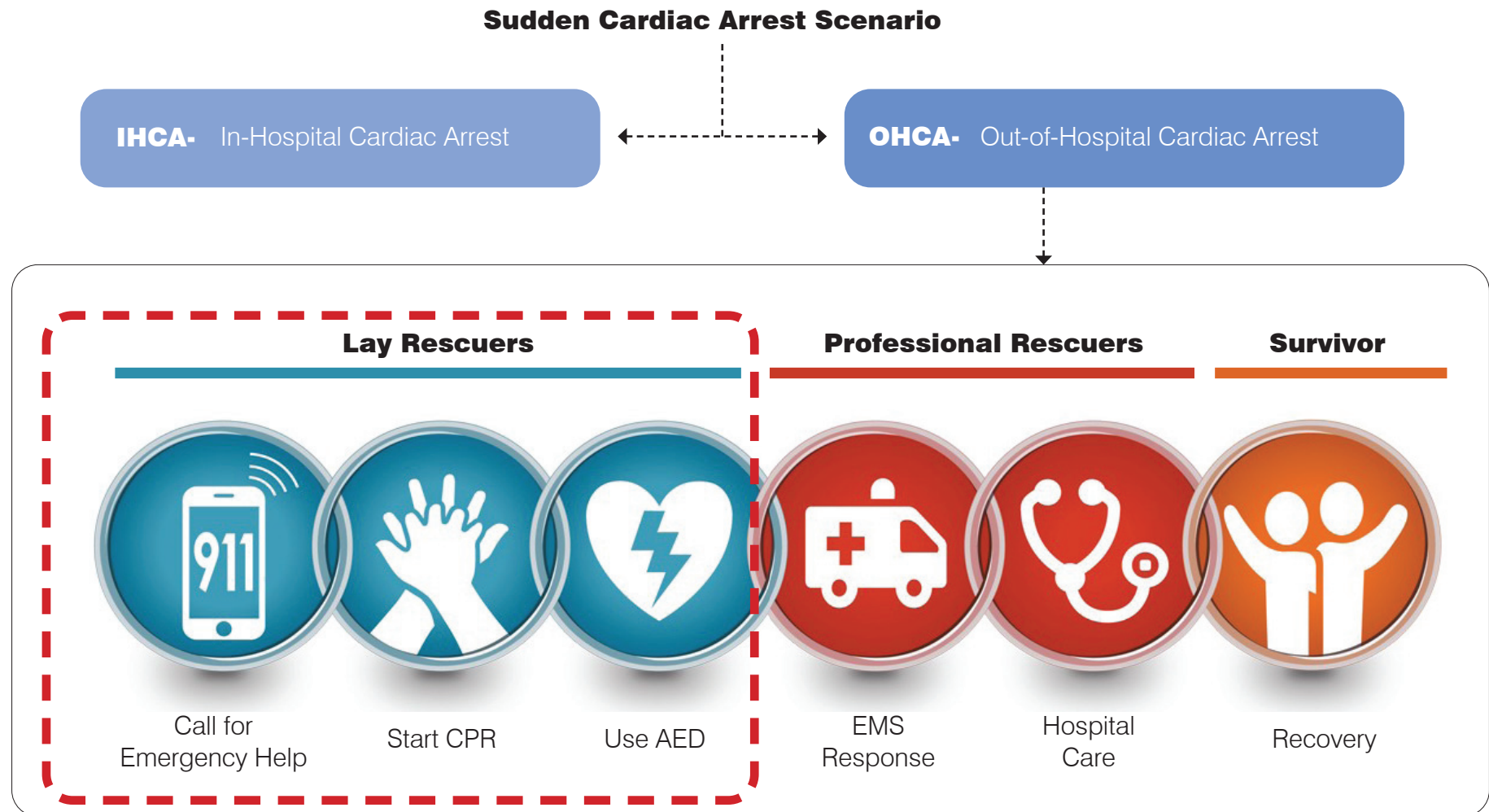
This CPR method is configured by the heart associations for the laypersons to encourage bystander CPR. It is the easiest of all types of CPR.

COLS to be initaited:

1) No response

Considered these two types for my project.

1.11.1 Basic Life Support (BLS)



- As per statistics almost 70% of the SCA happen at homes
- Hence chances of victim to be around laypeople is the most
- First 6 mins crucial
- Medical help receiving within 6min almost impossible in India

1.11.1.1 BLS- High Quality CPR

To achieve a *high quality* chest compression fraction, follow these steps:

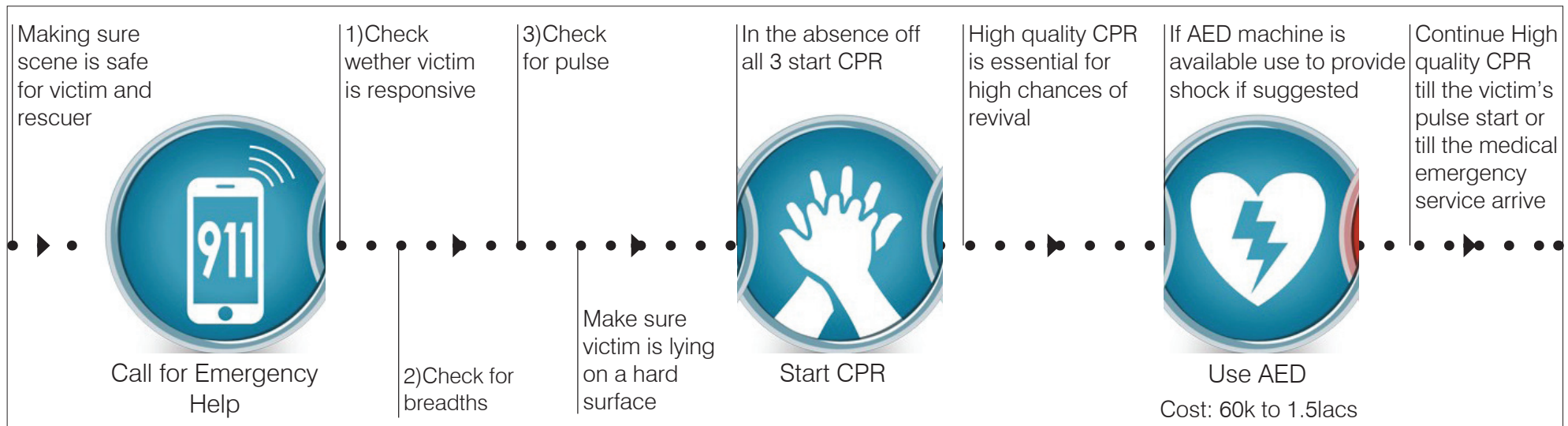
- Kneel by the side of the victim
- Place the heel of one hand in the center of the victim's chest
- Place the heel of your other hand on top of the first hand
- Interlock the fingers of your hands and ensure that pressure is not applied to the victim's ribs. Do not apply any pressure over the upper abdomen or the bottom end of the sternum
- Position yourself vertically above the victim's chest and, with your arms straight, press down on the sternum approximately 5 – 6 cm
- After each compression, release all the pressure on the chest without losing contact between your hands and the sternum
- Repeat at a rate of 100 – 120 chest compressions per minute
- Each compression and release should take an equal amount of time
- You may feel a victim's ribs break when performing high-quality CPR. This is often unavoidable and you should not stop performing continuous chest compressions.
- Ensure your hands are in the correct position and continue delivering high quality CPR until emergency medical services (EMS) take over. Healthcare providers studies show that the majority of cardiac arrest victims sustain at least one rib fracture.

Common CPR Mistakes to Avoid:

- Too shallow chest compressions
- Too slow chest compressions
- Not fully releasing the victim's chest
- Excessive ventilation when giving rescue breaths
- 'Bouncing' on the chest
- Bending the arms
- Rescuer Fatigue
- Stopping to Check for A Pulse

Key Points:

- Learning the correct way to administer high-quality CPR is one of the essential elements of first aider's training.
- High quality CPR is very tiring process as it can continue for 30mins.



1.11.2 Compression Only Life Support (COLS)

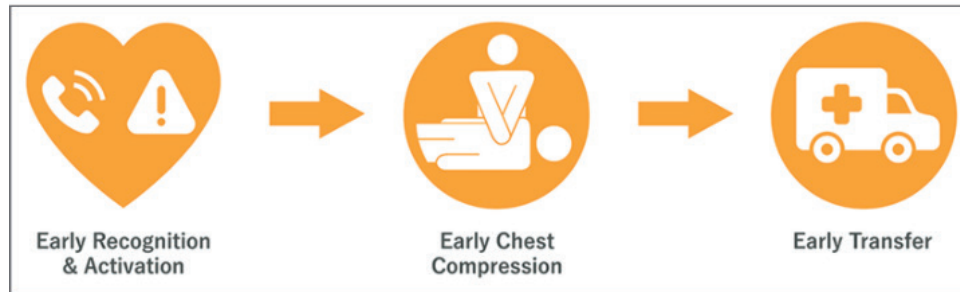


Figure 1: Core links in adult compression-only life support (COLS)

The cardiopulmonary resuscitation (CPR) guidelines of compression - only life support (COLS) for management of the victim with cardiopulmonary arrest in adults provide a stepwise algorithmic approach for optimal outcome of the victim outside the hospital by untrained laypersons. As resuscitation data of the Indian population are inadequate, these guidelines have been based on international literature. The guidelines have been recommended after discussion among Indian experts and the recommendations modified to ensure its practical applicability across the country.

The COLS emphasises on early recognition of cardiac arrest and activation, early chest compression and early transfer to medical facility.

The guidelines emphasise avoidance of any interruption of chest compression, and thus relies primarily on chest compression-only CPR by laypersons.

The target group for Compression-Only Life Supports:
COLS apply to bystanders, who do not know CPR well, or are reluctant to perform rescue breaths.

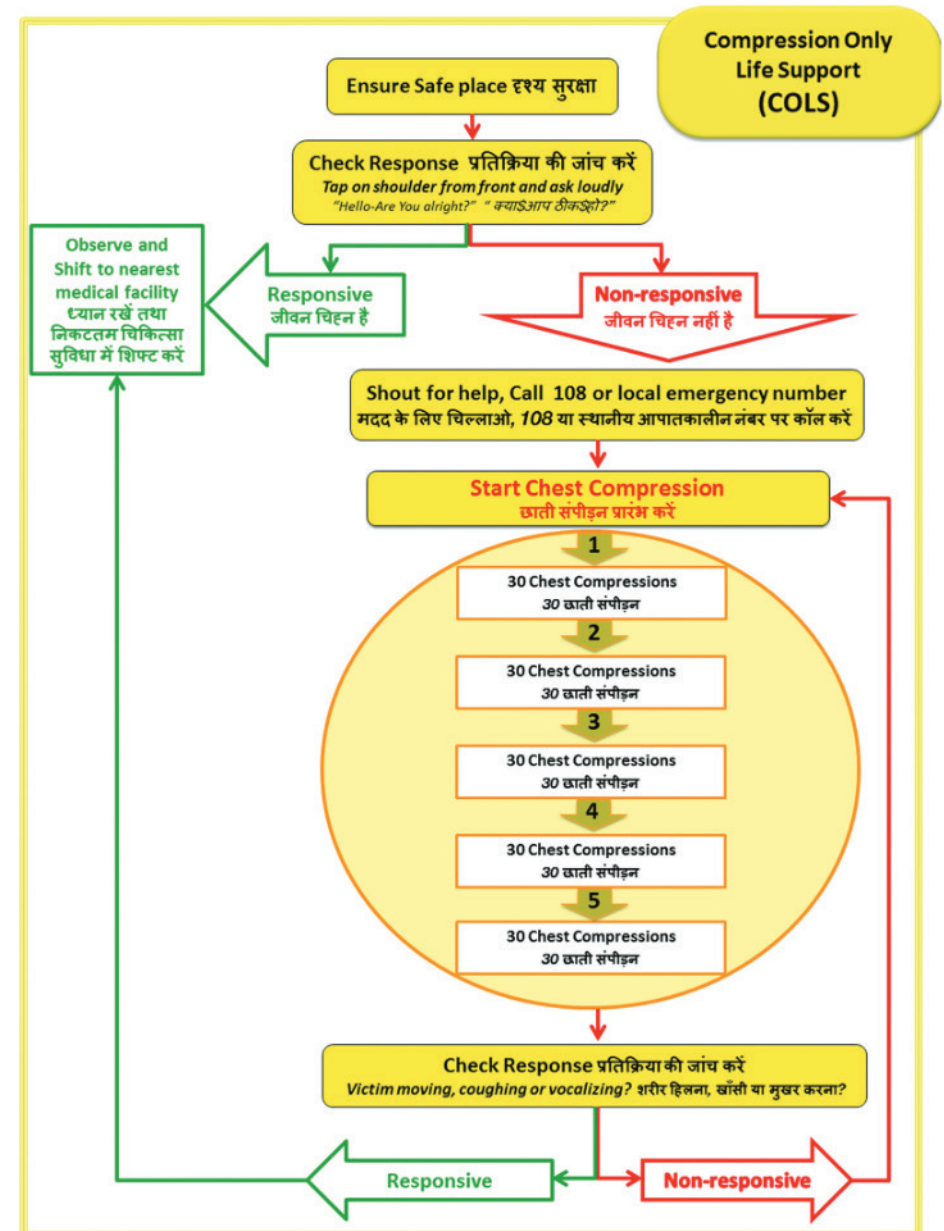


Figure 2: Compression-only life support (COLS) algorithm

1.11.2.1 Compression Only Life Support (COLS)

Steps for Adult Compression-Only LifeSupport (COLS):

1) Safe Place for Resuscitation:

The safety of the rescuer is paramount. In panic situations, mishaps can happen leading to injury to rescuer, if the place is not safe for management of victim with cardiac arrest. It is essential that the rescuer looks around the site for any type of imminent danger.

2) Victim's response Check:

Once the victim has been shifted to a safe place, the victim's response should be checked for further actions. The rescuer should come from front, facing the victim face, tap on the shoulder, speak loudly (e.g., HELLO- Are you alright?) in a language the victim could understand, to elicit the response from the victim.

If the patient responds either by verbal response or by purposeful movement, or is breathing normally, then cardiopulmonary arrest is unlikely. Such victim needs to be monitored constantly and shifted to nearby medical facility at the earliest for further evaluation and management. If no response is elicited, the victim may be having cardiopulmonary arrest and would require further help.

3) Call for EMS Help:

If the rescuer is alone, then he should activate the emergency medical system or ambulance services himself for early transfer of the victim for definitive treatment.

4) Early Chest Compression:

Once cardiac arrest is recognized, the rescuer should place the victim supine with his back over a hard flat surface or over the ground and start providing chest compression immediately.

Some CPR is better than no CPR:

The chest compression-only CPR is easier to teach, learn and perform compared to the fairly complex standard CPR algorithm. Providing high-quality chest compressions in witnessed cardiac arrest rather than to provide oxygenation and ventilation during the 1st min needs to be emphasized. However, compression-only CPR may not be effective in cardiac arrest following drowning, trauma and asphyxia. Traditional CPR may improve the survival in such a case. Similarly, in paediatric out-of-hospital cardiac arrest, where the primary cause is usually of respiratory origin, traditional CPR may be beneficial.

The AHA gave priority to chest compression over airway management and changed the sequence of resuscitation from ABC to CAB in 2010. Further, the AHA was also of the opinion that compression-only CPR is as effective as the full CPR. In fact, the AHA has tried to emphasize more on compression-only CPR to get more people to participate, if they should witness a collapsing victim.

The Australian Resuscitation Council (ARC) guidelines for CPR currently recommend that an untrained or unwilling to perform CPR rescuer should deliver continuous uninterrupted chest compressions. *The ARC is of opinion that any attempt at resuscitation is better than no attempt.* The Canadian Red Cross also recognizes the need of compression-only CPR. They accepted it as an acceptable alternative for those who are unwilling, unable, untrained or are no longer able to perform full CPR. Compression-only CPR is the preferred method for members of the public who witness an adult suddenly collapse.

1.12 Challenges

THE NEW INDIAN EXPRESS

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Lack of CPR awareness a big health challenge in India: Experts

CPR is the manual application of chest compressions and ventilations to patients in cardiac arrest, done in an effort to maintain viability until advanced help arrives.

Published: 27th July 2021 07:53 AM | Last Updated: 27th July 2021 07:53 AM



Among India's population, less than two per cent people are aware of CPR. About 4,280 people per 1 lakh population are getting cardiac arrest per year in the country. Every minute 112 people are succumbing to cardiac arrest. This is a very big problem. CPR is an issue in India because we have never trained the public. We do not have a robust emergency medical system and ambulances can't reach in the first three minutes, when CPR can be life-saving. Remember former President APJ Abdul Kalam who suddenly collapsed at a function. But nobody could do the CPR," said Dr SSC Chakra Rao, chairperson, Indian Resuscitation Council (IRC).

PAPER

BIZZ BUZZ

Home > Bizz Talk

Less than 2% of population in India trained in CPR as against requirement of 30%

International Cardiopulmonary resuscitation (CPR) skill increases survival chances up to 40% in patient experiencing sudden cardiac arrest; Younger generation prone to heart diseases due to change in lifestyle; India becoming a diabetic hub



"If we talk about data then almost **80 to 82 per cent cardiac arrest happens outside hospital**. With each minute the chances of survival decreases by 7 to 10 minutes. If we don't immediately give CPR, the patient will have brain injury. In some countries, with **increasing practice of CPR it has been found that 40-60 per cent people could be saved**. Since time is important, any layman can manually start a heart with a skill which can be learned with a practice of 5-10 minutes and can save a life," Dr Rakesh Garg, scientific director, Indian Resuscitation Council noted. Two to three decades ago, cardiac diseases were seen more in the age group between 50 to 60 years.

In the past one decade, we are seeing rise in cardiac diseases amongst youngsters between the age group of 20 years to 25 years. This is a worrisome situation. Male are more prone to cardiac issues due to change in hormones whereas women, post menopause age, are susceptible to heart diseases. CPR awareness activities have been happening in India for a very long time, but mostly amongst small batches of people. There was no uniformity on this. So, to increase awareness gradually, days such as World Restarter Heart Day, observed on October 16, was introduced. Similarly, CPR Day was started three years ago with a basic purpose that this one day can be observed for its mass awareness. But CRP training is provided throughout the year.

Various studies which indicate that mere chest compression can save 20 to 40 percent of such patients who experience sudden cardiac arrest. There are countries like Sweden that has 100% CPR training of adults.

Conclusion:

- Lack of CPR awareness and slow training programs are the major problems.
- Bystander plays a important role and reponsibility. As only a bystander can save life in these cases.
- As Indians lack awareness, even if they want to go help, they lack the details of high quality cpr.

1.13 Awareness Via Training

Recently, Central Board of Secondary Education (CBSE) has incorporated this resuscitation program for school students. So, we can say that these school students are our ambassador because they will be with us in the community for the next 9 to 10 decades. If we say that the CPR training can be given to age group above 12 years, I think we can generate a pool of generation who will be well versed on this emergency critical service. This is the most mature decision to train young students.



Statement: Kids save lives
Moto: Training school children in cardiopulmonary resuscitation worldwide

A Statement from:

- European Patient Safety Foundation (EuPSF)
- European Resuscitation Council (ERC)
- International Liaison Committee on Resuscitation (ILCOR)
- World Federation of Societies of Anesthesiologists (WFSA).



On Jan 13, 2015, WHO granted approval to endorse the statement on Kids Save Lives". We recommend in this statement that school children be educated in CPR from the age of 12 years or younger for 2 hours per year.

Why introduce CPR training during school education?

All social groups of society can be reached.
The response to instruction is easier and better at a younger age.

Sense of responsibility can be firmly established at an early stage.

Schoolchildren serve as multipliers: at home they teach their brothers and sisters, their parents, their grandparents, etc.

Teachers who have been educated can teach CPR; they do it as well and as effectively as healthcare professionals.

Taking practical action in the real-life situation without fear of making mistakes can be communicated much more naturally and easily during school time.

Training Centres in Mumbai:

- 1) I Care Institute- Holy Cross hospital
I-Care institute is the only training centre in Mumbai that offers CPR training completely free of cost.
- 2) Lifesupporters Institute
Lifesupporters institute conduct workshops (paid) across the state.
- 3) Sun Pharma
Sun Pharma under their CSR activity conduct various training sessions for adults and schools using CPR cube.

Conclusion:

- In a tier 1 city like Mumbai, there are only 2-3 training centres, which are insufficient for the population of city.
- Increasing bystander CPR rate by training every individual is a very slow and ambitious task.
- Training is essential, especially in schools but along with that some immediate solutions are required to tackle the low bystander CPR rate in India.

1.14 Gender in CPR

Women as a cardiac arrest victim:



According to a study released by the Resuscitation Science Symposium, men are more likely to receive bystander CPR in public locations compared to women. Women and men receive similar CPR assistance within the home, but in public 45 percent of men received assistance compared to only 39% of women. Men were 1.23 times more likely to receive bystander CPR in public, and their chance of survival was 23% higher compared to women.

So why the discrepancy?

It could come down to anatomy and a bystander being comfortable enough to perform CPR on a woman.

Dr. Vanita Arora, Director & Head – Max Super Speciality Hospital, Patparganj, says, despite ruling out mouth to mouth breathing as a part of CPR, research has essentially shown that women are less likely to receive CPR than men. International studies have suggested that there is almost no discrepancy in women receiving CPR at home in comparison to men. The rate for women was reported to be 35% and men received CPR 36%. This is because at home we are surrounded by people we know and daily interact with. Therefore, hesitation is less with people familiar to us. However, the same cannot be said in the Indian scenario as many conservative notions surround Indians even in their families. The levels of physical intimacy and ease are much different than what it is in the west.

Dissociate CPR from Sociocultural Notions:

We need to spread awareness on CPR to identify it as purely medical intervention associated with medical and biological science and not social constructs that we have defined around sex. It's an act which prevents the brain from being dead due to lack of oxygen. Be it a known person or a stranger, be the person of any age, be the person of any sex, caste, class or creed, by administering CPR where it is needed we are saving a life, and that what needs to be focused upon.

Women's Lives at Stake:

The differences between the physical bodies of a man and woman make men hesitant to administer CPR on them. A constant apprehension of falling into trouble while helping the opposite gender often stops the men from performing CPR. To eliminate such unease and apprehension, we must understand that CPR does not necessarily require building pressure on the breasts but on the sternum. This boosts the blood circulation and prevents the pulse from sinking.

Good Samaritan Law:

The Good Samaritan Law allows a person, without expectation of payment or reward and without any duty of care or special relationship, voluntarily come forward to administer immediate assistance or emergency care to a person injured in an accident, or crash, or emergency medical condition. Good Samaritan Law protects Good Samaritans from harassment on the actions being taken by them to save the life of the road accident victims.

Conclusion:

- In spite of good samaritan law, people in India would be hesitant to touch a unknown victim.
- Whether male or female victim, both need high quality cpr to revive.
- There is lack of encouragement/guidance for the rescuer to come forward to help victim.

1.15 Research Paper- Indian Heart Journal

Study showing importance of a Bystander in SCA cases:

Of pre-hospital care of out of hospital cardiac arrest victims and their outcome in a tertiary care hospital in India :

Place of Arrest:

Home	116 (56.6%)	←---Home is where most of the arrest take place
In transit	63 (30.7%)	
Road	22 (10.7%)	
Workplace	2 (1%)	
Railway Station	1 (0.5%)	
Restaurant	1 (0.5%)	

Pre Hospital Response:

Witnessed	64 (31.2%)	←---31% people witnessed but did not help
By-stander CPR	20 (9.8%)	
AED used	2 (1%)	

Mode of Arrival:

Ambulance	120 (58.5%)	←---Victim lost the crucial first 5mins in this transport
Personal Vehicle	76 (37.1%)	
3-wheeler	8 (3.9%)	
Bus	1 (0.5%)	

Who Brought:

Bystander:	185 (90.2%)	←---90% of the times bystander got the victim to hospital
Relatives	162 (79%)	
Colleagues/Friends	14 (6.8%)	
Civilians	9 (4.4%)	
First Responder:	20 (9.8%)	
Paramedics	14 (6.8%)	
Police	4 (2%)	
Fire Rescuer	2 (1%)	

- The study included **205 patients** with OHCA presenting to the EM department of a tertiary care hospital
- **only 9.8% (n=20)** patients received bystander CPR and of which **7.3% (n=15)** patients received CPR while being transported in the ambulance
- Amongst the sparse data available from India, the CARO study reported bystander CPR rate of **1.3%**.
- The impact goal of bystander response is **62%** set by the AHA.
- Median ambulance response time was **10 mins**
- Median time of cardiac arrest before arrival to our hospital was **30mins**
- We found that 8.3% had ROSC, 4.9% had 24-h survival and **1.4%(3)** survived to discharge

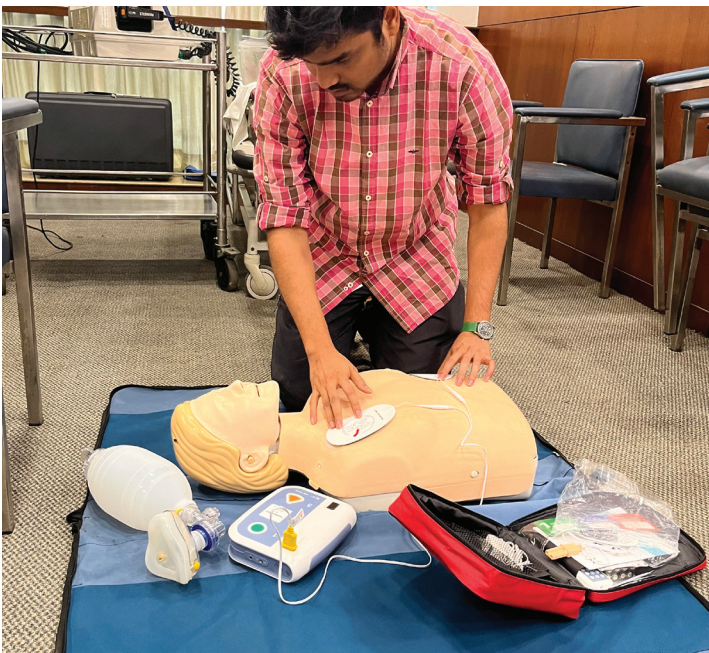
Conclusion:

- As most of the arrest happen outside hospital, bystanders play a very important role in the cardiac arrest cases, and he/she is the only one who can save the victim.
- 31% of the people witnessed but only 9% helped, reasons may be lack of confidence, fear or lack of knowledge of how to help, a design intervention can be helpful in this area.
- Community education and training programs should be encouraged more.
- EMS service should be improved.

2. Contextual Study

BLS Training Programme, Saifee Hospital

Aim: I decided myself to take an official AHA organised BLS training program, to understand the details and right technique of CPR as well as usage of AED machine.



Key Observations:

- People involved in this training were majorly doctors and nurses.
- Lack of CPR training in their education history.
- Doctors attending this seminar to revise and get use to the CPR training, as CPR is not something that they do on a regular basis.
- Trainees were curious and keen to learn, hence seminar was taken seriously.

2. Contextual Study

Training Session 01 | Public Space

Aim: I played a part in training common people basics of CPR, as the target crowd was of varied age group and back ground, plan was to observe their response and involvement.



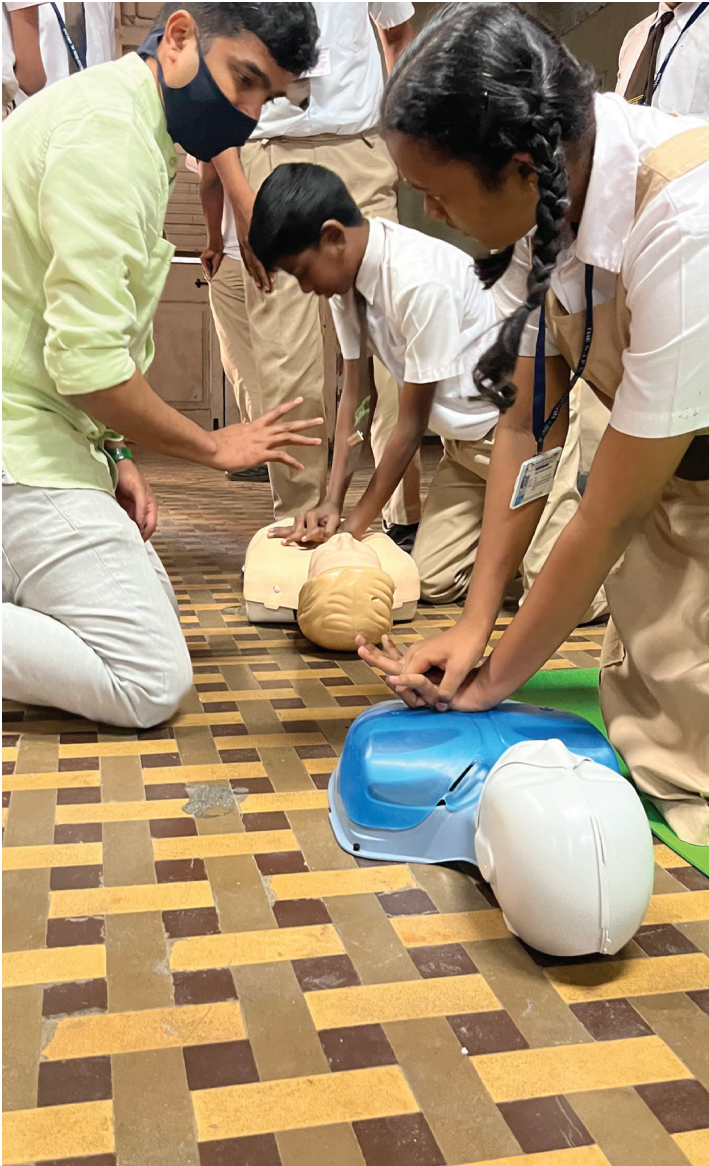
Key Observations:

- People involved in this training were residents(non-doctors) of the area, approx avg age 45.
- None of them had come across CPR training ever before.
- It was difficult to get laypeople involved in learning CPR.
- People loose patience quickly.
- Seriousness towards it unfortunately lacked.

2. Contextual Study

Training Session 02 | School

Aim: I played a part in training school children basics of CPR, as the target crowd was young, plan was to observe their response and involvement.



Key Observations:

- Students involved in this seminar were from 8th and 9th std.
- None of them had come across CPR training ever before.
- Easy analogies were used by instructor to explain students the concept of CPR.
- Approx 50% of the students seemed attentive and interested for trying hands on manikins.
- Many students came to try hands on manikins simply to enjoy pressing on the chest.
- Interested students were keen in following each steps for performing CPR.
- The instructors and teachers were not sure whether how long students would remember the training.

2. Contextual Study

108 Cardiac Ambulance | Sion Hospital

Aim: I interviewed an ambulance doctor of the 108 ambulance in order to understand his experiences and various scenarios of dealing with cardiac arrested victims.

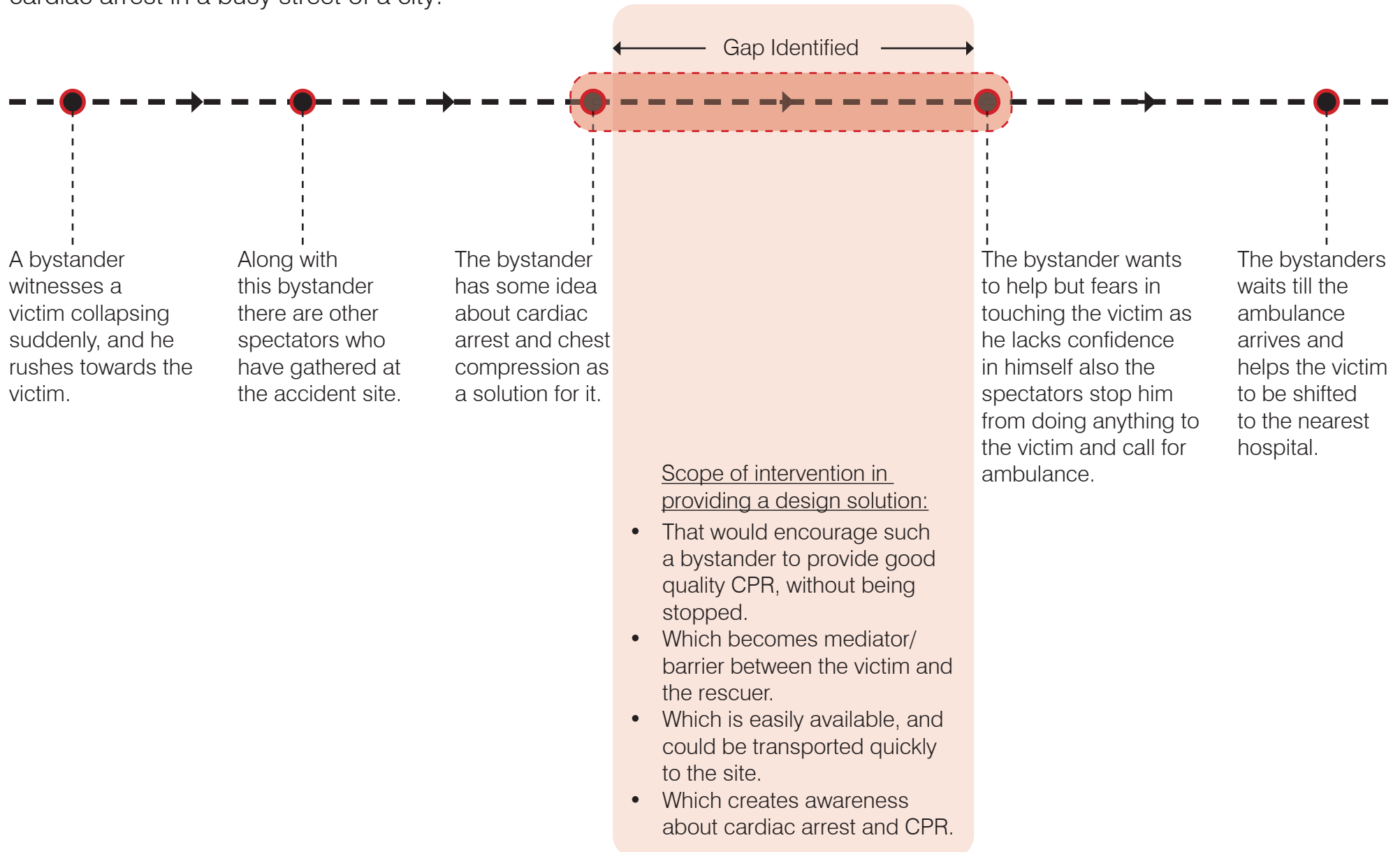


Key Observations:

- Doctor mentioned that he has completed both BLS and ACLS training but still CPR technique shown by the doctor was incorrect.
- When asked about CPR depth and speed details, he was unsure/vague about the answer.
- Once an incidence happened in which the patient died while shifting to another hospital in his ambulance, and the blame later was put on him, leading to interrogation by higher 108 officials, which made him hasitant in taking extra initiative to help the victim.
- He mentioned that the ambulance takes minimum 20-25mins to reach the location of the victim. Time also depends on the distance and the traffic.
- He had never used defibrillator available in the ambulance.

3. Opportunity - Scope Of Intervention

A scenario created of an outdoor case of cardiac arrest in a busy street of a city:

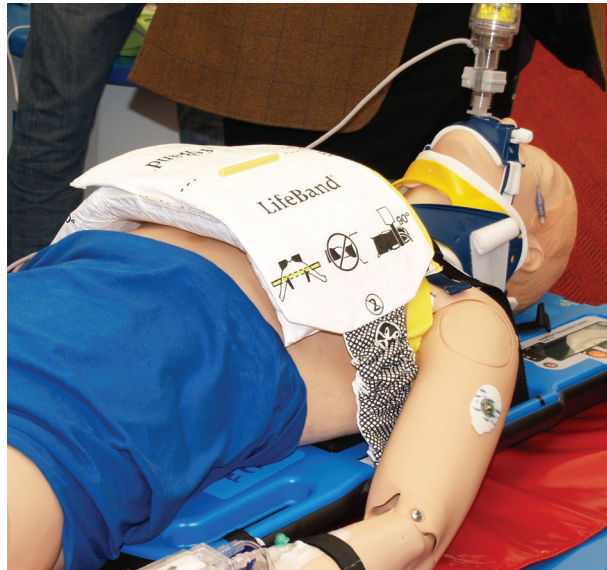


4. Product Analysis

Secondary Research



Thumper Mechanical CPR Device



ZOLL AutoPulse Life Band



Lucas 3



SCHILLER Easy PULSE

Based on the scope of intervention, secondary research was conducted to study the CPR providing devices available. Most of them were battery operated and not designed for layperson to operate. It helped in studying the how these devices work and what are the steps to assemble them around the victim. How are they carried and what are the important components.

Key Observations:

- All the machines are automated, non of them are manual.
- All the machines are designed considering paramedics as its users.
- Avg cost of these machines is xxxxxxx.
- The machines are designed considering minimum 2 or more rescuers.
- All the machines have a back board, which is to be placed under the victim.
- Avg weight of these machine is 7-8 kgs.
- All the machines allow continuous chest compression even while transporting to the hospital.

Conclusion:

- A design intervention could be thought in terms of complete manual operation to provide CPR by a layperson.
- Cost effective and portable.

4. Product Analysis

Primary Research | Saifee Hospital



Curved back board with graphics suggesting victim orientation



Machine with silicon suction cup and frames with locks on either sides



Easy instructions

Portable



Key Observations:

- Lucas 3 mainly consists of two part: Back board and top frame part.
- Completely battery operated, and is mainly designed for paramedics to use it in order to provide constant cpr while victim transportation.
- Lucas 3 weighs almost 8-9 kgs, and so may be difficult for few people to install it.
- It comes in a back pack, for ease in carrying.
- It allows maximum chest width of 45cms.
- It allows maximum chest depth of 30cms.

5. Problem Statements

Following were the few important problem identified from the research conclusions:

Laypeople in India lack the awareness of cardiac arrest and CPR

In case of cardiac arrest, chances of survival of the victim are maximum only in initial 5 minutes after the arrest.

Dependence on ambulance/ EMS cannot be relied, as it takes minimum 25mins for it reach site.

Most of the cardiac arrest cases happen outside hospital, hence only bystander can be helpful

Some bystanders come forward to help but do not know how to help or how to do CPR

Some bystanders resist to touch victim out of fear or the victim being from opposite gender

The automatic CPR machines are difficult for layperson to operate and they are expensive.

There can be a possibility that there is just 1 or 2 max rescuers to help cardiac arrested victim

CPR is tiring and the single rescuer can get tired before victim revives or EMS arrives

6. Insight Summary

Following were the few important insights drawn from the research conclusions:

(Please note all the insights are drawn considering rescuer a layperson)

An intuitive device that can encourage lay rescuers to use it and help victim

Easy action to provide CPR and also to perform CPR for longer duration

Easily available and cost effective solution

An intervention that can allow opposite gender CPR

Device that could be used by 1 rescuer or more

A design that could also help create awareness

A device that do not need prior knowledge on how to use it

An intervention that can provide guidance for good CPR

A device that is portable and easy to maintain

7. Initial Brief

Brief: To design a cost effective manually operated, high quality cpr provider device for untrained bystander allowing him/her to:

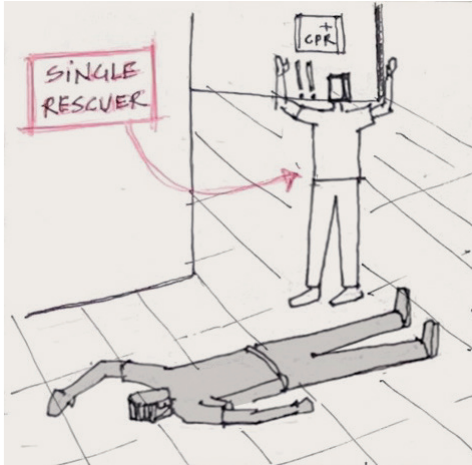
- Provide cpr with intuitive action(up/down), for avg 30mins, without getting much fatigued
- Provide good quality cpr(50mm depth & 120/min speed)
- Easily assemble the device around the victim within 10secs.

Context: Public spaces, gyms, railways

8. Scenario Building

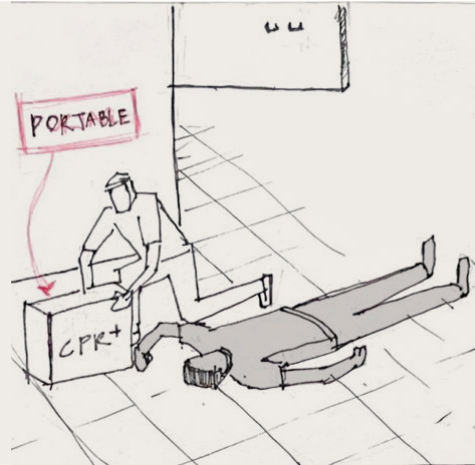
01 | Single Rescuer:

When there is only single person to save the victim.



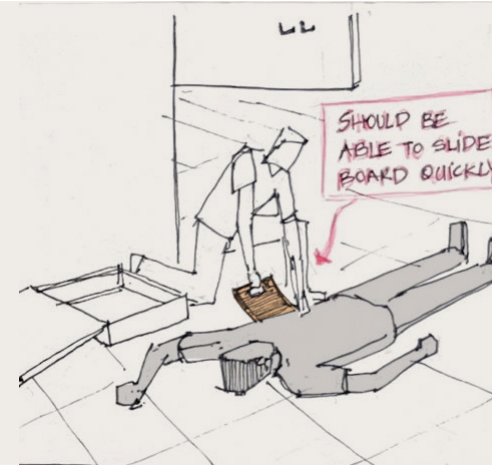
02 | Portable:

CPR Assistant should be portable for one to carry to the site.



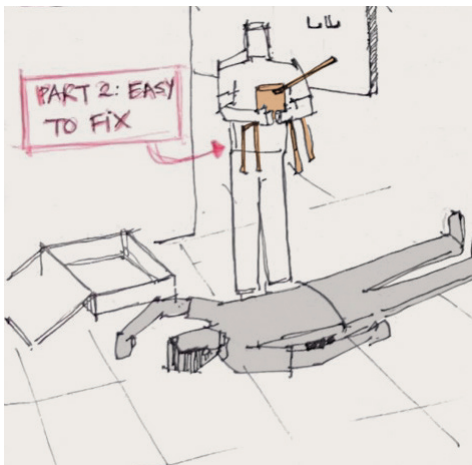
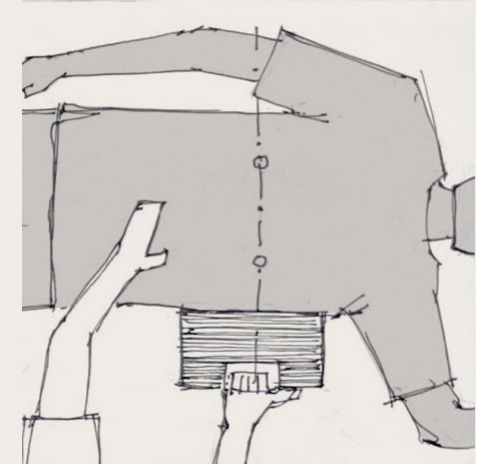
03 | Part-1 Fixing:

Any rescuer should be able to slide the back plate quickly (10sec <).



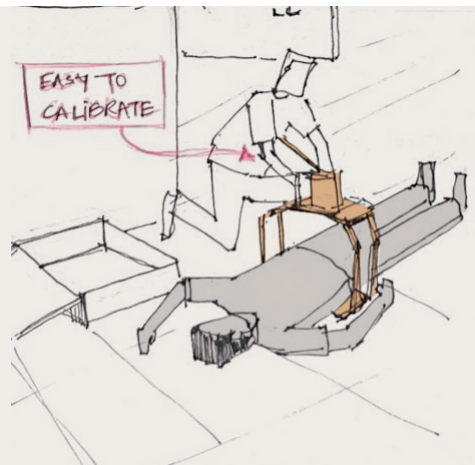
04 | Part-1 Aligning:

Indications for alignment of the back plate.



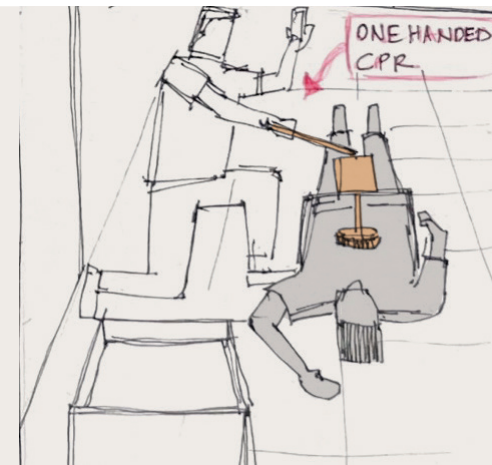
05 | Part-2 Fixing:

Simple and quick fixing of the top part on the bottom part.



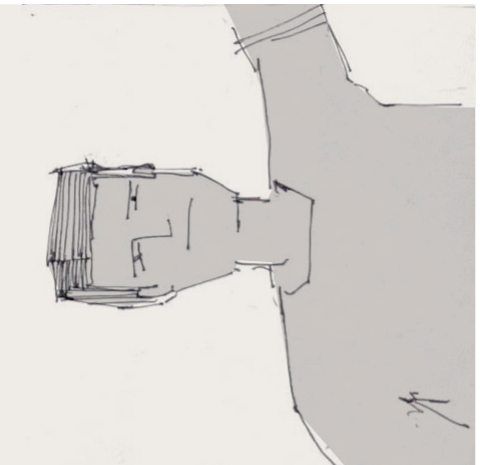
06 | Calibration:

Calibration of the machine for better quality CPR



07 | Start CPR:

Rescuer providing CPR by one hand and calling assistance from other.



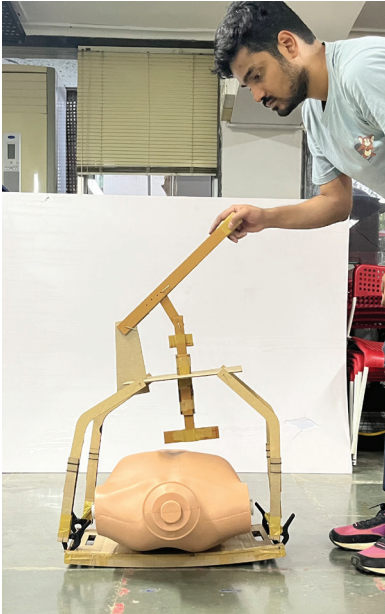
08 | Stop CPR:

Stop providing CPR once victim shows signs of consciousness.

9. Mockups

Quick mockup models, 1:1 scale, were explored in material like corrugated sheets.

Mockup 01:



- Mockup 01 was inspired from Lucas 3 design.
- It consists of 2 parts.
- Part 01: Back board
- Part 02: Mechanism and four frames.
- Calibration is done by adjusting the telescopic frames.
- Chest compression is carried out with the help of lever mechanism.

Mockup 02:



- Mockup 02 was designed in order to divide weight of the device evenly.
- It consists of 2 parts.
- Part 01: Back board and sliding frames
- Part 02: Mechanism
- Calibration is done by adjusting the telescopic frames.
- Chest compression is carried out with the help of lever mechanism.

Mockup 03:



- Mockup 03 was designed in order to reduce the weight of the device.
- It consists of 2 parts.
- Part 01: Back board and fixed frames on one side.
- Part 02: Mechanism
- Calibration is done by adjusting the sliding frames.
- Chest compression is carried out with the help of rotational mechanism.

Mockup 04:



- Mockup 04 was designed in order to cut down time of installation.
- It consists of 1 part.
- Part 01: Side board and fixed frames.
- Calibration is done by adjusting the sliding frames.
- Chest compression is carried out with the help of lever mechanism.

Mockup 05:



- Mockup 05 was designed in order to eliminate back board.
- It consists of 2 parts.
- Part 01: Side foot plates with sliding frames.
- Part 02: Mechanism
- Calibration is done by adjusting the telescopic frames.
- Chest compression is carried out with the help of lever mechanism.

9.1 Mockup 01 - Scenario Study

Aim: A scenario was conducted to understand the various steps of assembly.

01 | Single Rescuer



A single rescuer observes the victim collapsing, after confirming no response and no breathing from the victim, rescuer realises it is a cardiac arrest.

02 | Portable



The rescuer wants to help but not aware of the cpr technique, quickly runs and gets the portable mechanical cpr device from the nearest location.

03 | Part-1 Fixing + 04 | Aligning



The rescuer follows the instruction on device and slides the back board(part01) underneath the victim, making sure it is in correct chest alignment.

04 | Part-2 Fixing



The rescuer follows the instruction and fixes the mechanism with frames(part02) over part01. The snap sound assuring the rescuer firm locking.

05 | Calibration



Once both the parts are fixed, the rescuer calibrates the pad, by adjusting the telescopic frames, so that the pad touches the chest and locks.

06 | Start CPR



Then immediately the rescuer starts chest compression by moving the lever up and down, until the victim gains consciousness or EMS arrives.

9.2 Mockup 02 - Scenario Study

Aim: A scenario was conducted to understand the various steps of assembly.

01 | Single Rescuer



A single rescuer observes the victim collapsing, after confirming no response and no breathing from the victim, rescuer realises it is a cardiac arrest.

02 | Portable



The rescuer wants to help but not aware of the cpr technique, quickly runs and gets the portable mechanical cpr device from the nearest location.

03 | Part-1 Fixing + 04 | Aligning



The rescuer follows the instruction on device and slides the back board+frames(part01) underneath the victim, making sure it is in correct chest alignment.

04 | Part-2 Fixing



The rescuer follows the instruction and fixes the mechanism(part02) over part01. The snap sound assuring the rescuer firm locking.

05 | Callibration



Once both the parts are fixed, the rescuer callibrates the pad, by adjusting the telescopic frames, so that the pad touches the chest and locks.

06 | Start CPR



Then immediately the rescuer starts chest compression by moving the lever up and down, untill the victim gains consciousness or EMS arrives.

9.3 Mockup 03 - Scenario Study

Aim: A scenario was conducted to understand the various steps of assembly.

01 | Single Rescuer



A single rescuer observes the victim collapsing, after confirming no response and no breathing from the victim, rescuer realises it is a cardiac arrest.

02 | Portable



The rescuer wants to help but not aware of the cpr technique, quickly runs and gets the portable mechanical cpr device from the nearest location.

03 | Part-1 Fixing + 04 | Aligning



The rescuer follows the instruction on device and slides the back board(part01) underneath the victim, making sure it is in correct chest alignment.

04 | Part-2 Fixing



The rescuer follows the instruction and fixes the mechansim(part02) over part01. The snap sound assuring the rescuer firm locking.

05 | Callibration



Once both the parts are fixed, the rescuer callibrates the pad, by adjusting the sliding frames, so that the pad touches the chest and locks.

06 | Start CPR



Then immediately the rescuer starts chest compression by rotating gears, untill the victim gains conciousness or EMS arrives.

9.4 Mockup 04 - Scenario Study

Aim: A scenario was conducted to understand the various steps of assembly.

01 | Single Rescuer



A single rescuer observes the victim collapsing, after confirming no response and no breathing from the victim, rescuer realises it is a cardiac arrest.

02 | Portable



The rescuer wants to help but not aware of the cpr technique, quickly runs and gets the portable mechanical cpr device from the nearest location.

03 | Part-1 Fixing + 04 | Aligning



The rescuer follows the instruction on device and slides and locks the side supports underneath the victim, making sure it is in correct chest alignment.

04 | Callibration



Once the part is fixed, the rescuer callibrates the pad, by adjusting the sliding frames, so that the pad touches the chest and locks.

05 | Start CPR



Then immediately the rescuer starts chest compression by moving the lever up and down, untill the victim gains conciousness or EMS arrives.

9.5 Mockup 05 - Scenario Study

Aim: A scenario was conducted to understand the various steps of assembly.

01 | Single Rescuer



A single rescuer observes the victim collapsing, after confirming no response and no breathing from the victim, rescuer realises it is a cardiac arrest.

02 | Portable



The rescuer wants to help but not aware of the cpr technique, quickly runs and gets the portable mechanical cpr device from the nearest location.

03 | Part-1 Aligning



The rescuer follows the instruction on device and aligns the side supports on the sides of the victim, making sure it is in correct chest alignment.

04 | Part-2 Fixing



The rescuer follows the instruction and fixes the mechanism(part02) over part01. The snap sound assuring the rescuer firm locking.

05 | Callibration



Once both the parts are fixed, the rescuer callibrates the pad, by adjusting the telescopic frames, so that the pad touches the chest and locks.

06 | Start CPR



Then immediately the rescuer starts chest compression by rotating gears, untill the victim gains conciousness or EMS arrives.

9.6. Evaluation

Scoring is out of 5

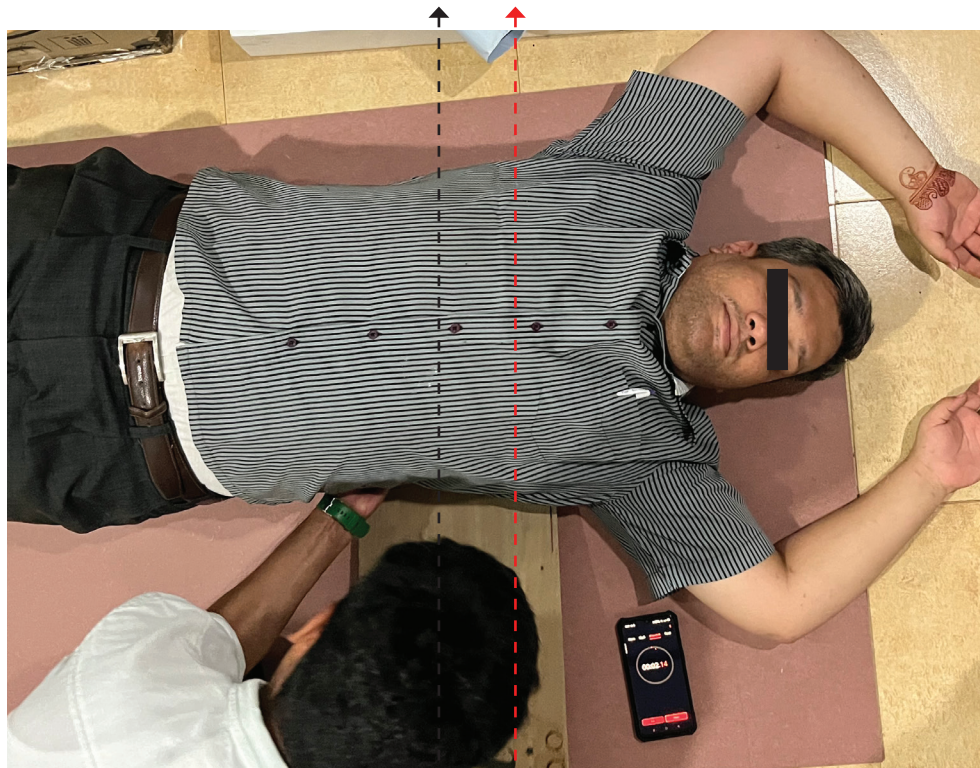
	Option 01:	Option 02:	Option 03:	Option 04:	Option 05:
					
Ease in carrying/ compactness of device	2	3	3	2	4
Ease in fixing/sliding part-1 (base plate)	2	2	2	3	4
Ease in entire assembly/ fast in initiating CPR	2	2	3	4	3
Ease in calibration	2	3	3	3	2
Comfort while providing CPR	3	3	2	3	3
Total	11	13	13	15	16

Conclusion: Out of all option 05 was further selected. Major reason for the selection was the elimination of the back board which lead in reduction of assembly time.

9.7. Exercise

Aim: The aim of conducting this exercise was to calculate the time taken for a single rescuer to slide back board under a victim and also to check the accuracy of the board placement.

Conclusion: As the single rescuer took more than 10sec to slide the back board under the victim, the exercise concluded with eliminating the back board to save the assembly time.



Center line of back board ↓

↓ Center line of chest



Center line of back board ↓

↓ Center line of chest

- Found it difficult to slide the ply board under a health dummy dead victim.
- It took approx 18secs to slide the board under the victim.
- Found it difficult to align the board center line the with the chest center line while sliding the board under the victim.
- In the hurry to slide the board under the victim, the center lines did not match.
- It was difficult to move the board laterally later in order to align.
- Found it even more difficult to slide the ply board under a health dummy dead victim while trying to maintain the alignment of the board and chest.
- It took approx 24 secs to slide the board under the victim.
- It was a more tiring process.
- It helped to conclude that eliminating the back board would help the rescuer save very crucial time and allow to process cpr quicker.

9.8. External Evaluation

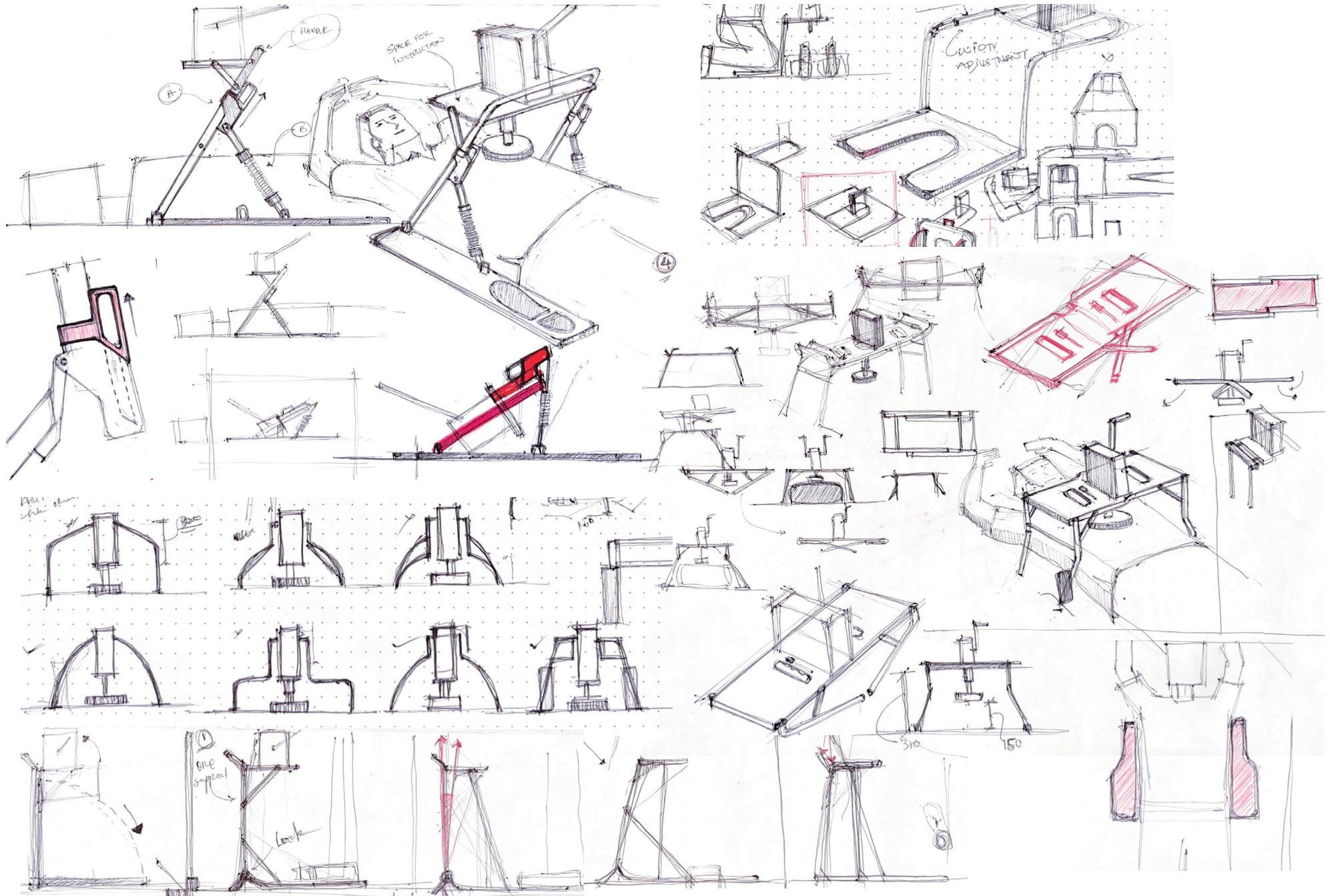
Aim: All the mockups were externally evaluated by Dr. Tasneem from Saifee Hospital.

Comments from Dr. Tasneem:

- Transportation of the device to the site.
- Ribs Restriction- for 4th Option
- Assembly of the device around the victim should be less than 10secs.
- Accomodation of all body sizes
- The rescuer must have some guidance for the depth and the speed of the compressions.
- Action for CPR should be intuitive.
- Easy Callibration for varied chest depths
- CPR should be provided atleast till 30mins till the EMS arrives.

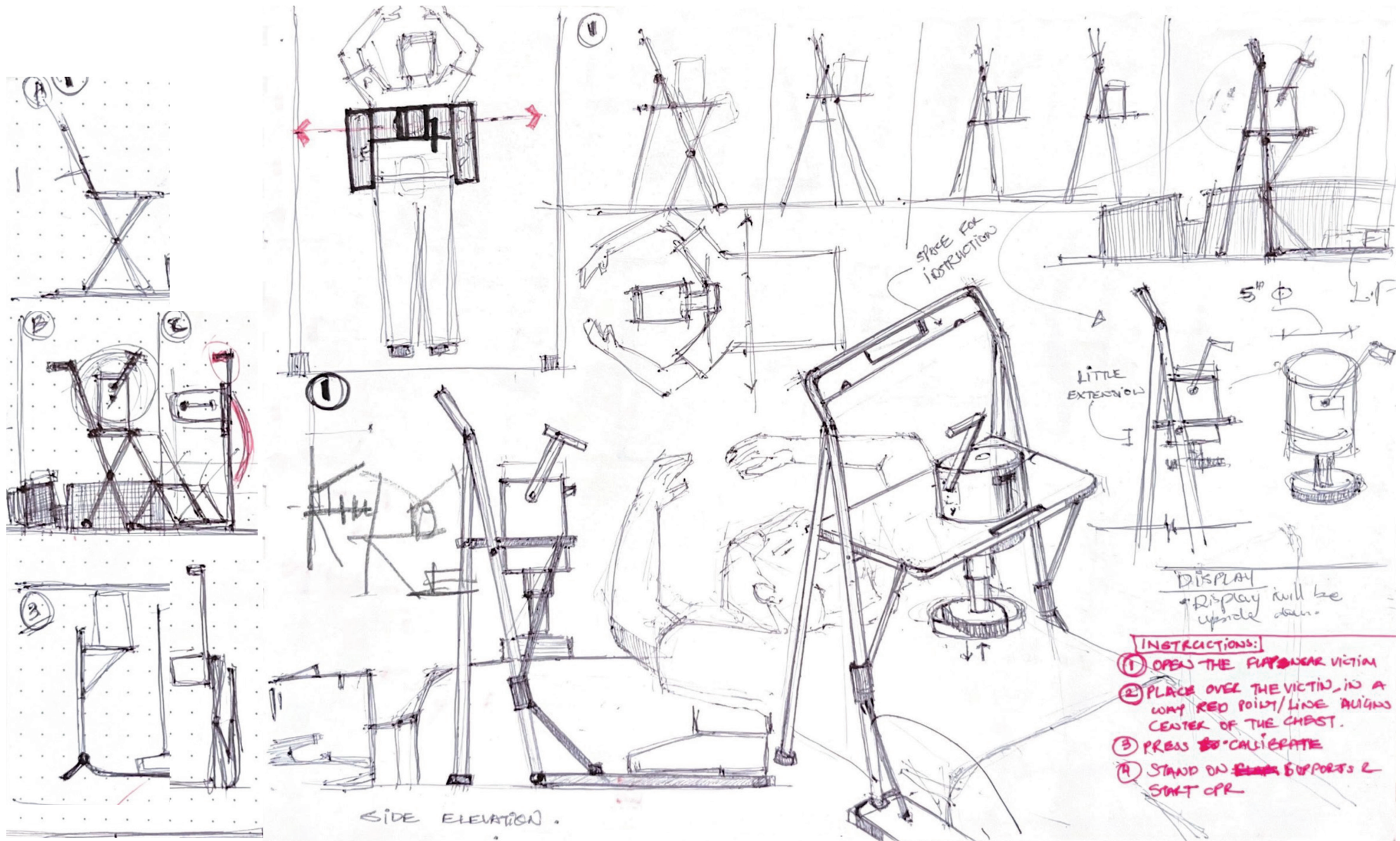


10. Ideations



10.1 Concept 01

Sketch:



10.1.1 Concept 01- Lever Mechanism

Description:

The assembly of this concept was inspired from a folding chair. The simple lever mechanism was fixed on the top flat part, allowing the rescuer to quickly unfold and place the device over the victim. There was a separate lock provided at the bottom of the chair to allow calibration as per the chest size. The linear motion of the cylinder caused by the lever motion was restricted in a way that it moves down by maximum 5cms. The foot supports were thought such a way that would slide open only when chair is unfolded.



Instructions:

(After the device is brought near the victim)

- 01:** Pull the flap
- 02:** Place and align the red cross line along the center of chest
- 03:** Stand on the foot supports
- 04:** Unlock and lock the slider to calibrate
- 05:** Start CPR

Making:



10.1.2 Concept 01- Scenario Study

Aim: A scenario was conducted to understand the various steps of assembly.

Step 01:



A single rescuer observes the victim collapsing, after confirming no response and no breathing from the victim, rescuer realises it is a cardiac arrest.

Step 02:



The rescuer wants to help but not aware of the cpr technique, quickly runs and gets the portable mechanical cpr device from the nearest location.

Step 03:



The rescuer follows the instruction on device follows the first step of unfolding the device as he brings it near the victim.

Step 04:



The rescuer follows follows the second step of placing the device over the victim, in such a way that it aligns with center of the chest.

Step 05:



After that the rescuers bends down to callibrate the compression pad, such a way it touches the center of the chest and locks the pad.

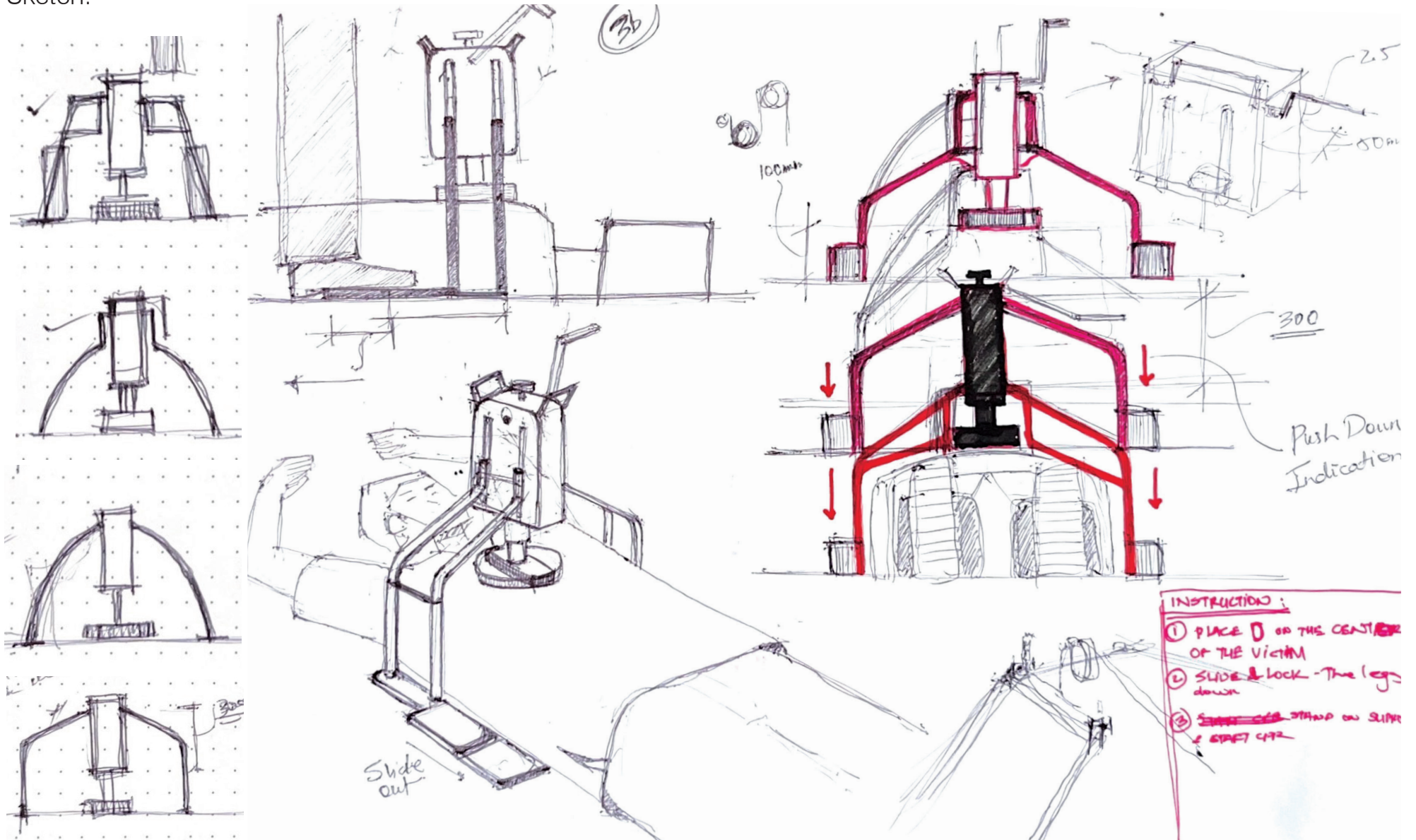
Step 06:



Then immediately the rescuer starts chest compression by moving the lever up and down, untill the victim gains conciousness or EMS arrives.

10.2 Concept 02

Sketch:



10.2.1 Concept 02- Rotational Mechanism

Description:

The assembly of this concept was inspired in order to eliminate the step of calibration. It was planned in such a way its starts with placing the pad on the chest center first and then sliding the frames down as per the chest depth. Once the frame touch ground, the device can be locked, and chest compressions can start using rotational mechanism. The gears are designed in such a way that the up down action is restricted to 5cms. The foot supports were provided in such a way that it ties both the frames on each side and give a strong base.

Making:



Instructions:

(After the device is brought near the victim)

- 01:** Place the pad on the center of the chest
- 02:** Slide frame down till ground
- 03:** Lock
- 04:** Stand on the foot supports
- 05:** Start CPR



10.2.2 Concept 02- Scenario Study

Aim: A scenario was conducted to understand the various steps of assembly.

Step 01:



A single rescuer observes the victim collapsing, after confirming no response and no breathing from the victim, rescuer realises it is a cardiac arrest.

Step 02:



The rescuer wants to help but not aware of the cpr technique, quickly runs and gets the portable mechanical cpr device from the nearest location.

Step 03:



The rescuer follows the instruction on device follows the first step of placing the pad on the center of the chest, as per the instructions.

Step 04:



The rescuer follows follows the second step of sliding the frames down in order to callibrate the device as per the chest depth and lock the same.

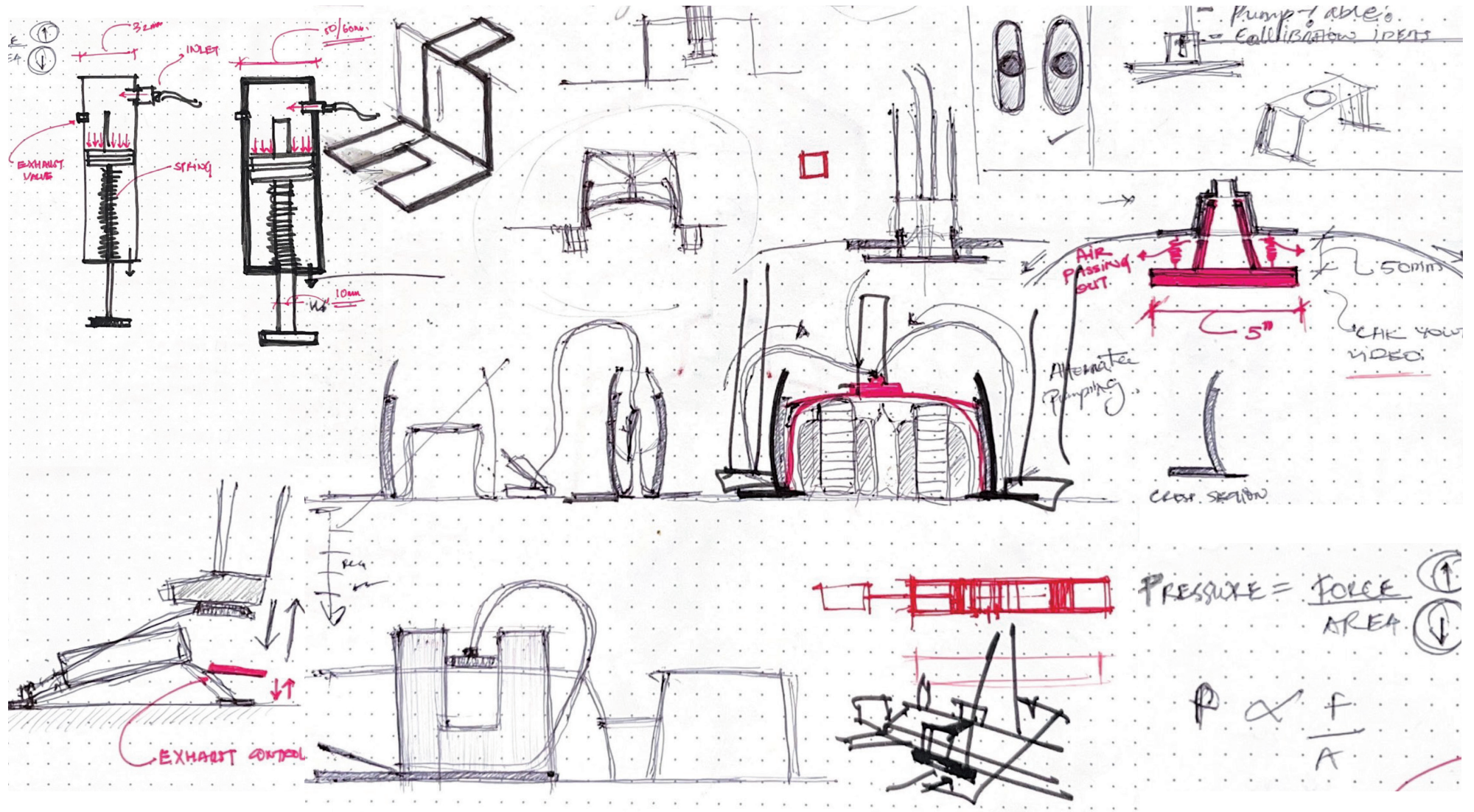
Step 05:



Then immediately the rescuer starts chest compression by rotating the handle, untill the victim gains conciousness or EMS arrives.

10.3 Concept 03

Sketch:



10.3.1 Concept 03- Pneumatic Mechanism

Description:

This concept was inspired in order to make the operation of the device completely hands free, and hence foot operated air pump was taken into consideration. The dimensions of the piston and the strength of the spring were selected as per the 5cm stroke output which was required. At the top of the cylinder just below the supply, an exhaust valve was designed which would open after every compression to release the air in order to allow quick recoil between every chest compression. The foot air pump was thought to be part of the device itself.



Instructions:

(After the device is brought near the victim)

- 01:** Place one side flange aligning to chest center
- 02:** Stretch and snap second flange on the other side
- 03:** Stand on the foot supports
- 04:** Start CPR

Making:



10.3.2 Concept 03- Scenario Study

Aim: A scenario was conducted to understand the various steps of assembly.

Step 01:



A single rescuer observes the victim collapsing, after confirming no response and no breathing from the victim, rescuer realises it is a cardiac arrest.

Step 02:



The rescuer wants to help but not aware of the cpr technique, quickly runs and gets the portable mechanical cpr device from the nearest location.

Step 03:



The rescuer follows the instruction on device follows the first step of placing one flange of the device on one side of the victim.

Step 04:



The rescuer follows the instruction on device follows the second step of strching and placinf the other flange on the other side of the victim.

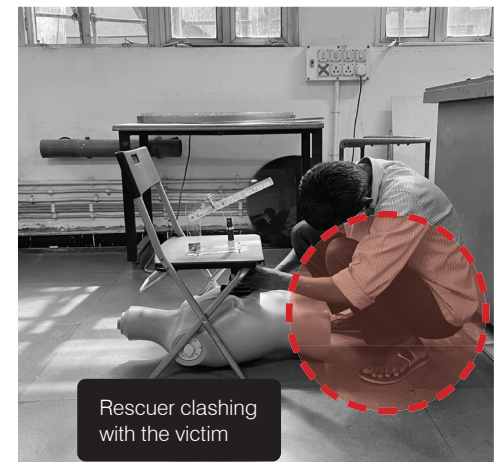
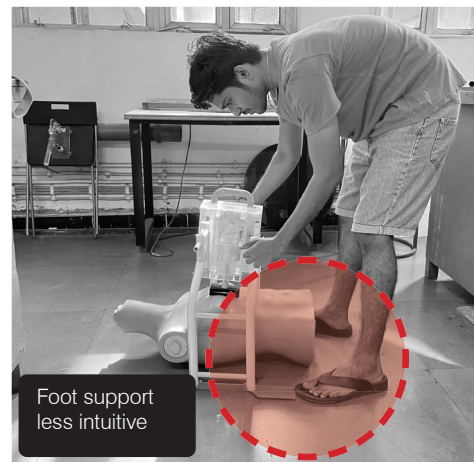
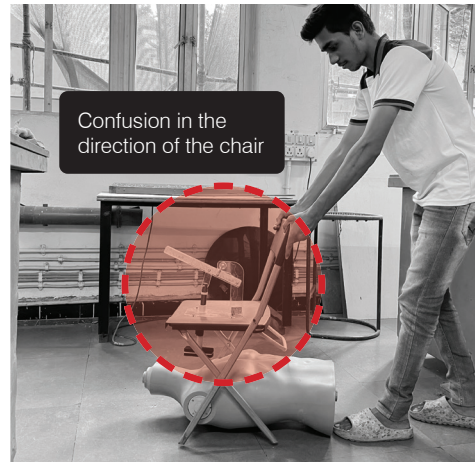
Step 05:



Then immediately the rescuer starts chest compression by pumping with his foot, untill the victim gains conciousness or EMS arrives.

10.4 Analysis

Problem Identification



10.4 Analysis

Assembly Time

This analysis was conducted to understand which concept out of the three was the fastest in assembly or closest to 10 secs.

Two sets of timings were conducted with each of the participant. The average time for each participant was calculated first, and later average was taken across all users for each respective concept.

Note: Promptness lacked in most of the users.

Concept 01:



1st attempt/2nd attempt

Concept 02:



1st attempt/2nd attempt

Concept 03:



1st attempt/2nd attempt

Suraj Sir(Lab Assitant)	25/17	20/15	15/10
Manish(Tea vendor)	35/12	25/18	12/10
Deepak Sir(Lab Assitant)	34/20	22/19	15/10
Vishwas(Sweeper)	50/30	32/22	16/12
Nawale Sir(Lab Assitant)	35/25	27/22	17/12
Sukhdev(Student)	31/14	20/15	12/10
Avg Time	28 sec	22 sec	13 sec

10.4 Analysis

Portability

Short people scenario:

Concept 01- Due to its height being xxxmm, while the carrying concept 01, the rescuer has to fold her hand so that it does not hit the ground, which can be inconvenient to carry.

Concept 02- Due to its height being xxxmm, while the carrying concept 02, the rescuer do not need to fold her hand, which can be convenient to carry.



Tall people scenario:

(Points discussed for short scenario apply to tall as well)

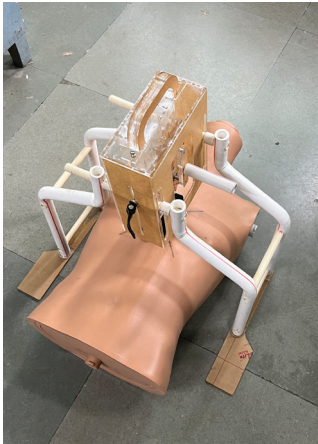
Concept 01- has extruded parts on either side which might be a reason of obstruction for the rescuer to carry the device in an emergency situation.

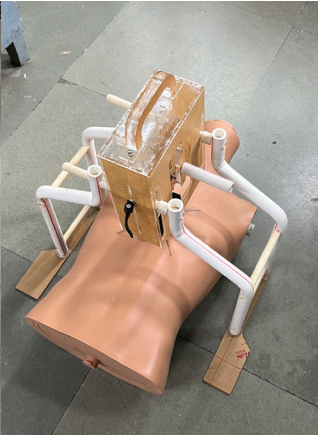
Concept 02- has extruded part on just side which can be avoided as obstruction, proving easier for the rescuer to carry the device in an emergency situation.



10.5 Evaluation

Scoring is out of 5

	Concept 01:	Concept 02:	Concept 03:
			
Ease in assembly <i>(based on assembly time)</i>	2	3	4
Ease in action <i>(intuitive)</i>	4	2	2
Comfort in carrying	2	3	3
Visibility	1	3	4
Life Span <i>(dicussion with Prf. Anirban G.-Mech)</i>	4	4	1

Conclusion: The points highlighted in the above table(in green) encouraged that the mechanism of the concept 01 and the assembly method of the concept 02 could be taken forward as a combination, and concept 03 could be explored separately.	Concept 01 + Concept 02 : Concept A 	Concept 03 : Concept B 
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11. Working Rig

Concept A:



A working rig for concept A was fabricated in order to validate it further. The existing mechanism of the drill stand was used for linear action. A track behind was designed to calibrate the device as per the victim's chest.

Concept B:



A working rig for concept B was fabricated in order to validate it further. A pneumatic cylinder powered by foot pump was designed to achieve the linear action. The cylinder was mounted on a stand for firm support.

11.1 Concept A

Position 01:



This is position 01, in which the rescuer stands over the victim, with his legs over the foot supports on both sides of the victim. With the left hand he hold the device in place and the right hand operates the chest compression. Problem faced is that the right hand is too close to the rescuer's body.

Position 02a:



This is position 02a, in which the rescuer stands on one side of the victim, with his legs over the foot supports on either side of the victim. With the left hand he hold the device in place and the right hand operates the chest compression. Problem faced is that the rescuer needs to apply more force as grip axis do not align with the body axis.

Position 02b:



This is position 02b, in which the rescuer stands on one side of the victim, with his legs over the foot supports on either side of the victim. With the left hand he hold the device in place and the right hand operates the chest compression. Longer handle helps in reducing the amount of force applied by the rescuer.

11.1.1 Concept A - User Testing

Aim: User test was conducted over concept A, across different genders and age groups, to observe:

- 1) Preferred position (side or front)
- 2) Handle preference
- 3) Time taken for assembly

User 01:



User 02:



User 03:



User 04:



User 05:



User 06:



User 07:



User 08:



User 09:



User 10:



User 11:



User 12:



11.2 Evaluation - Round 02

Concept A:



Time Taken for Assembly(in secs):

Lakshmi	: 18
Nikhil Sir	: 16
Alka ma'am	: 20
Rohit Sir	: 15
Ashish Sir	: 17
Isha	: 20
Vinay Sir	: 18
V Sir	: 15
Paterkar Sir	: 19
Madhuri	: 16
Deepak Sir	: 20
Shelar Sir	: 22

Avg Time : 18secs

If rig errors are solved and users become prompt, avg time can improve

Observations:

- Users prefer adequate space between the handle grip and their body.
- Use of both hands is also preferred.
- Standing with legs spread wide allowed more balance.
- Long handle allows less force application.
- Calibration was not intuitive.

Concept B:



Observations(Reasons for not working):

- Manual air pump insufficient to provide the pressure requirement for 5cm compression.
- Load required to keep the assembly stable is not possible for single rescuer.

Result:

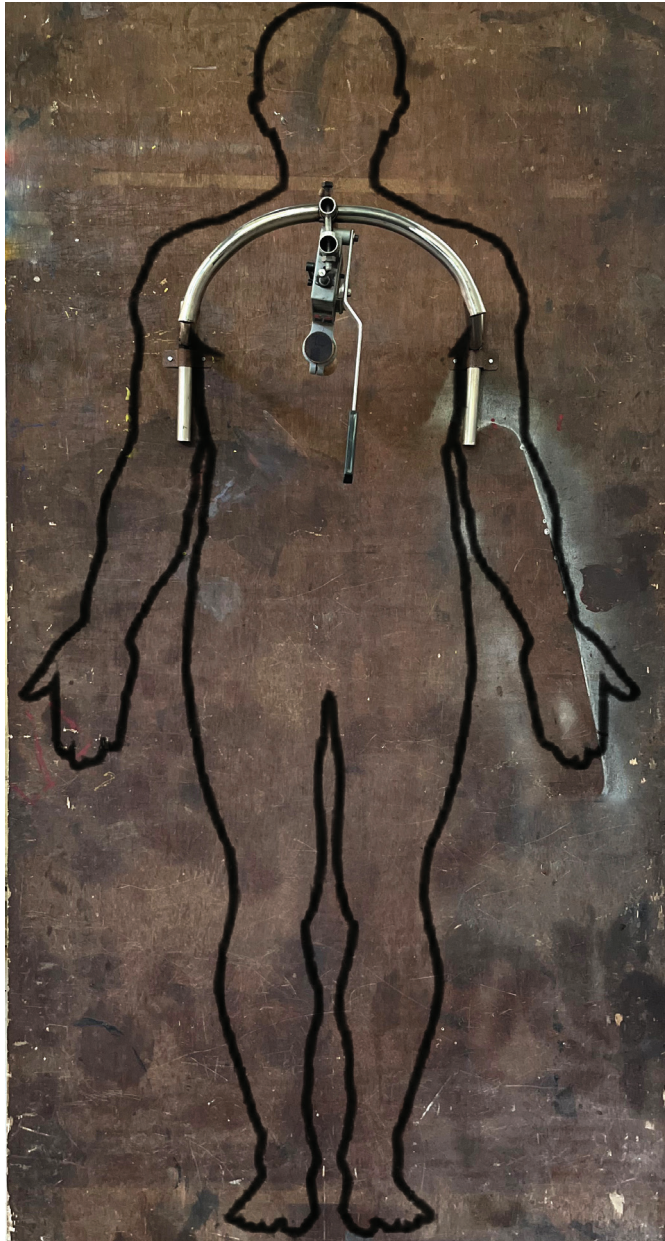
Concept A selected.

12. Deployment

Side Elevation:



Front Elevation:



View:



- The plan is to deploy the device in such a way that it creates awareness about cardiac arrest and what does this device do.
- So the device is fixed on a wall over a human outline, in order to make people subconsciously aware about how this device would be assembled over the victim.
- It can have roof at the top in order to protect it from different weather conditions.

13. Revised Brief

To design a *manually* operated CPR assistive device which enables a *single or more(ideal) bystander* to provide *continuous* and *good quality* CPR for avg 30mins.

A solution which is:

- Cost Effective
- Easy to assemble with instructions(within 10secs)
- Portable

A solution that can be deployed:

- Public Spaces
- Gyms
- Residential Buildings
- Railways

14. Concept A Revision

Handle Options:



- The length of the handle was increased.
- The handle was angled to the right side of the rescuer to avoid clashing with the rescuer body.
- Not an ambidextrous design.
- Wrist well supported.
- This handle was not preferred because it did not allow the use of body weight, to the fullest advantage, to give compressions.



- The length of the handle was kept short in order to avoid clashing with the rescuer body.
- The handle was also tilted upward to allow less bending for the rescuer.
- Ambidextrous design.
- Wrist not well supported.
- This handle was not preferred because it was short in length causing rescuer to apply more force which could hamper the rescuer performance when required for long durations.

Earlier Working Rig:



Revised Working Rig:



→ Frames extended

→ Handle extended

→ Elevated foot supports added

- The frames were extended in order to allow space between rescuer and the handle grip when in position.
- The extension of the handle allowed the rescuer to apply lesser force, compared to short handles.
- Bold foot supports to give rescuer good grip and hold the device from lifting up while providing compressions.

14.1 User Testing

Aim: User test was conducted over revised concept A, across different genders and age groups, to observe:

- 1) Preferred position
- 2) Time duration of providing CPR in both positions(side and front)

(Note: Between two positions of providing CPR, user was given a 2-3 hour break)

01: Male, Age:24



Side Position: 9mins
Front Position: 11mins

02: Male, Age:25



Side Position: 7mins
Front Position: 7mins

03: Female, Age:26



Side Position: 4mins
Front Position: 8mins

04: Male, Age:29



Side Position: 6mins
Front Position: 10mins

05: Male, Age:31



Side Position: 8mins
Front Position: 9mins

06: Female, Age:26



Side Position: 5mins
Front Position: 6mins

07: Female, Age:35



Side Position: 7mins
Front Position: 9mins

08: Female, Age:25



Side Position: 5mins
Front Position: 9mins

09: Male, Age:29



Side Position: 7mins
Front Position: 12mins

10: Male, Age:26



Side Position: 4mins
Front Position: 8mins

11: Female, Age:25



Side Position: 5mins
Front Position: 8mins

12: Male, Age:38



Side Position: 5mins
Front Position: 12mins

14.2 User Test Observations

Rescuer Position- front(over victim):



Not preferred

Hands going backwards while performing CPR



Preferred

Hands going straight down while performing CPR



Preferred

Front position allows three grips(alternate or both together)



Not preferred

Foot not supported correctly

Rescuer Position- side of victim:



Not preferred

Only one grip position + Other hand(left) is under more pressure than right hand



Not preferred

Less stability for legs

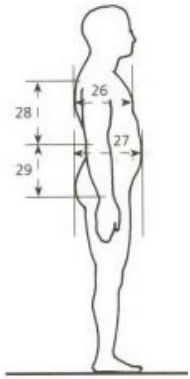
Conclusion:

- Avg time duration from the front position was more than the side.
- Front positioning allows three gripping ways which allows longer CPR action.
- In case of using both hands(front), compressions can be given by hands movement as well as waist movement.
- Hence front position preferred over side position.
- The rescuer should stand at adequate position to avoid his hand clashing with his body while providing cpr.

15. Anthropometry Data

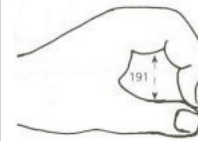
(Note: All dimensions are in mm)

95th percentile selected for chest depth: This data was used to know the maximum height adjustment when placed around victim.



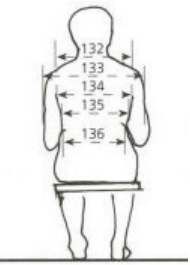
Parameters		Percentiles				
		5th	25th	50th	75th	95th
Chest Depth	Male	185	200	214	231	258
	Female	160	190	207	237	293
	Combined	181	198	214	231	265

50th percentile selected for hand grip: This data was used to know the diameter of the grip.



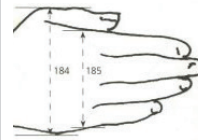
Parameters		Percentiles				
		5th	25th	50th	75th	95th
Grip Inside Dia	Male	42	46	49	51	56
	Female	40	42	46	49	52
	Combined	41	46	49	51	56

95th percentile selected for chest width: This data was used to know the maximum width of the device when placed around victim.



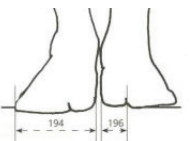
Parameters		Percentiles				
		5th	25th	50th	75th	95th
Chest Width	Male	259	282	298	319	356
	Female	217	255	277	293	313
	Combined	249	276	295	314	354

95th percentile selected for hand width: This data was used to know the length of the grip.



Parameters		Percentiles				
		5th	25th	50th	75th	95th
Hand Breadth	Male	86	93	99	104	111
	Female	77	82	86	90	95
	Combined	81	89	95	102	109

95th percentile selected for foot width: This data was used to know the maximum width for the foot supports.



Parameters		Percentiles				
		5th	25th	50th	75th	95th
Foot Breadth	Male	83	89	94	99	105
	Female	75	79	84	89	95
	Combined	77	86	92	98	104

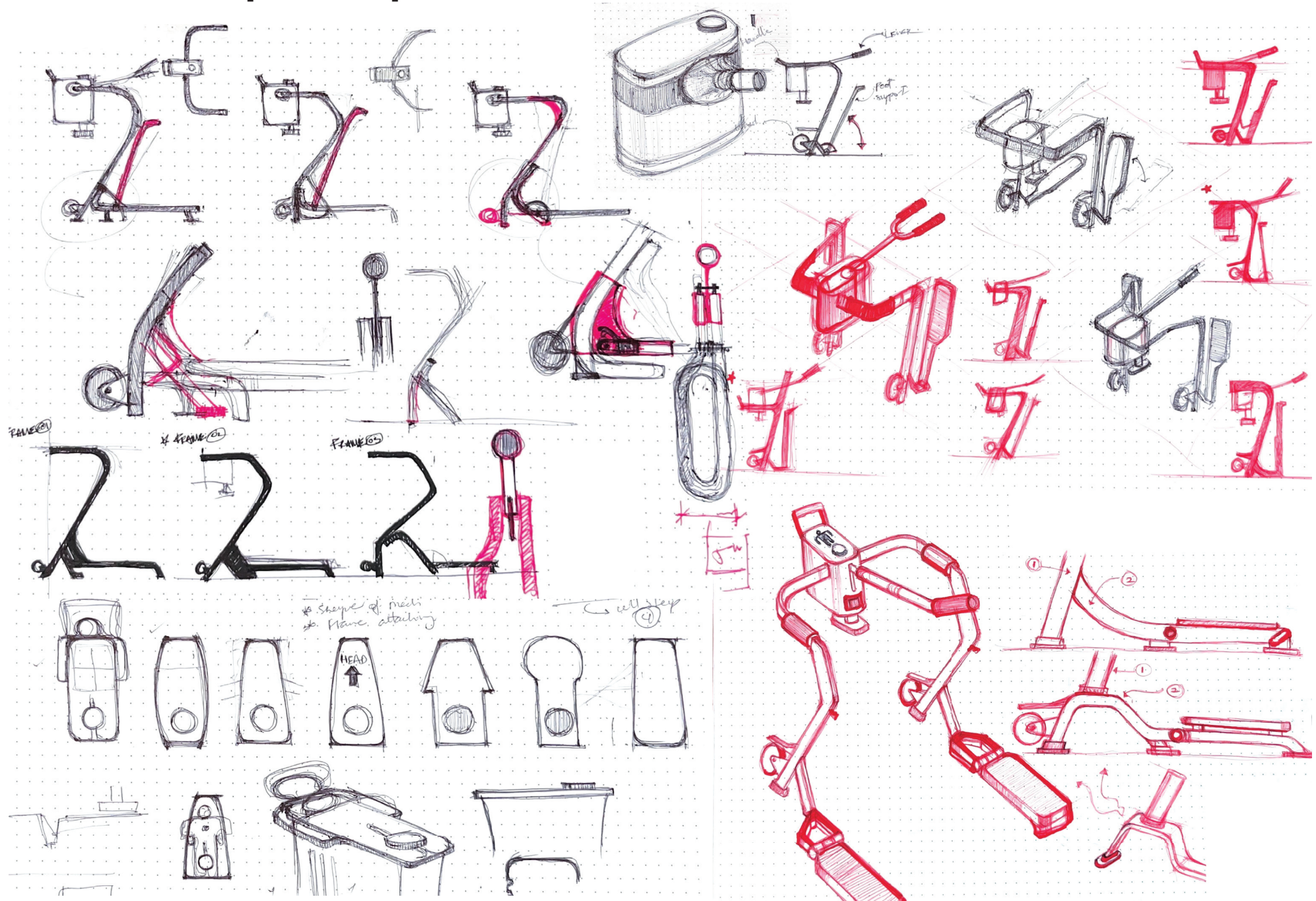
95th percentile selected for foot length: This data was used to know the max. length for the foot supports.

  				
US Men	US Women	UK	EU	CM
13	14	12.5	48	29.7

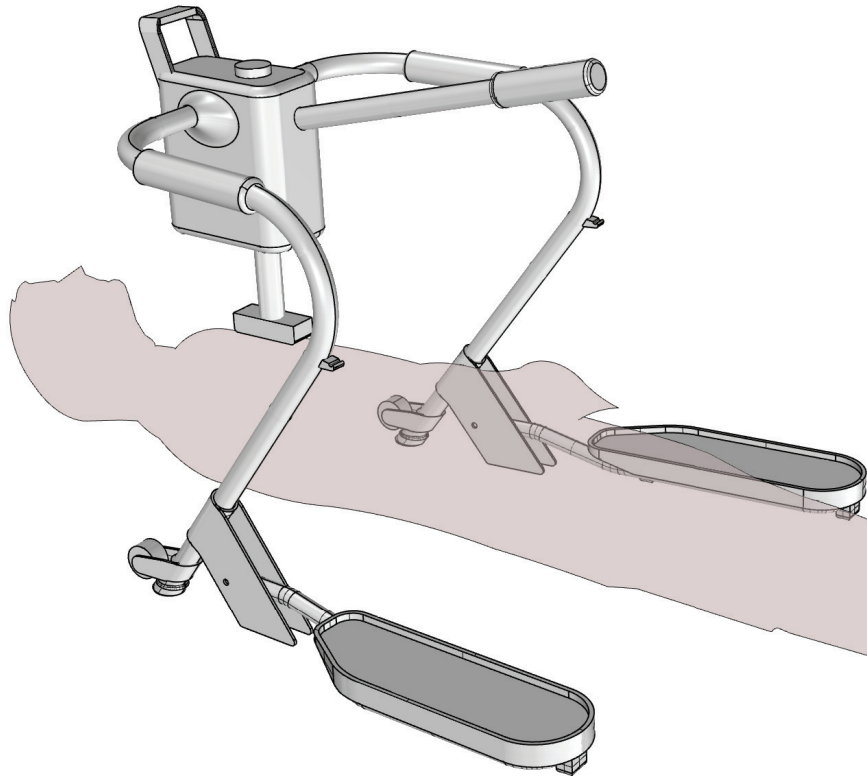
16. Mood Board



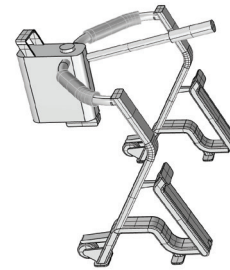
17. Final Concept Development



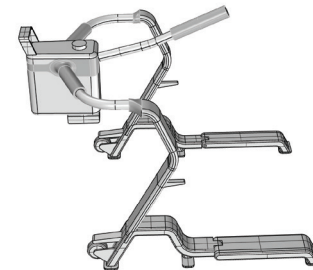
18. Final Concept 3d Model



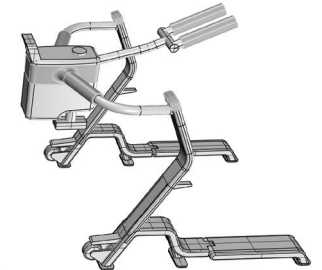
Handle:



Straight handle

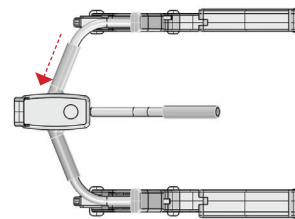


Handle with a bend upwards

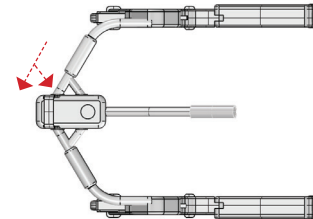


Double gripped handle with a bend upwards

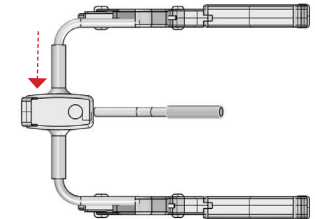
Frame Connection:



Connection at an angle

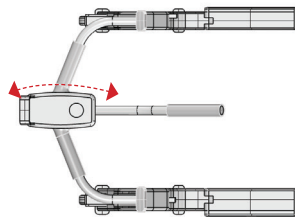


Branch connection at an angle

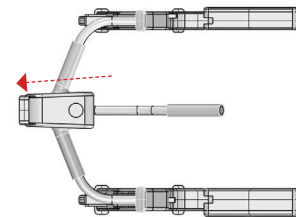


Straight connection

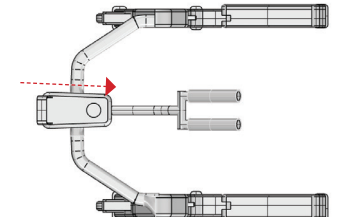
Central Fom:



Soft curvature



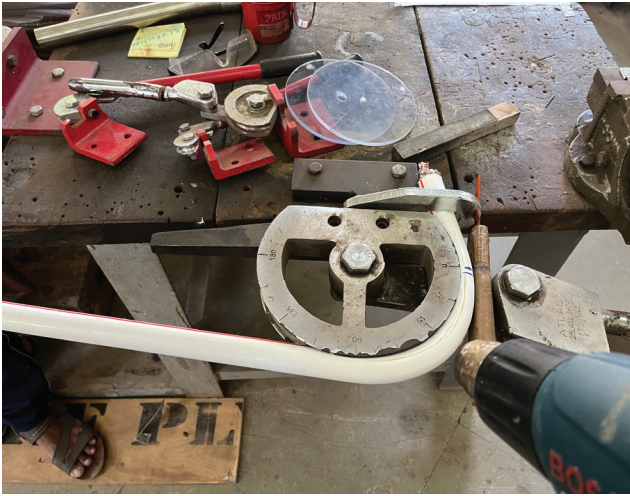
Slope in forward direction



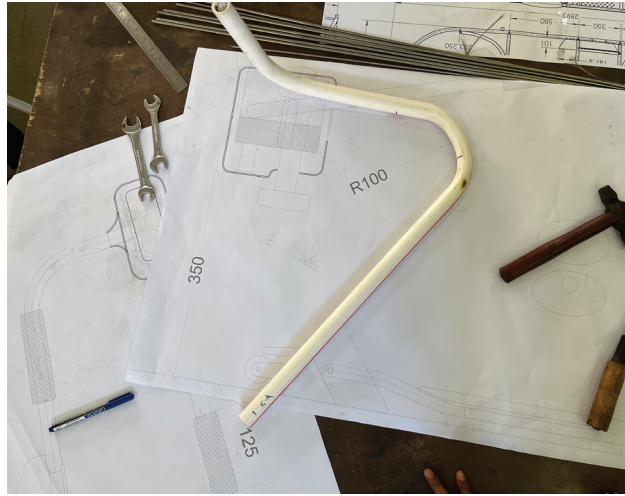
Slope in backward direction

19. Prototyping

Further the form was developed and refined by working on the final 1:1 prototype made from light weight pvc pipes and thermocol.



25mm dia pvc pipes were bent using heat gun in order to achieve desired curvatures.



Bent pipes were cross checked with the drawing and necessary changes were adapted.



Footrest pad area was marked on the drawing by checking various shoe sizes.



The central mechanism unit was carved out of thermocol, different shaped were explored.



The radii of the curvatures were carved in order to achieve the best look and feel.



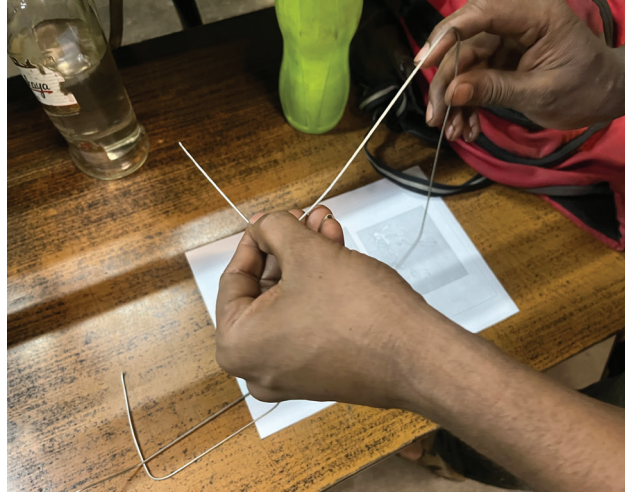
The bracket cut from styrene sheets were bent on the pipes using heat gun.

20. Final Working Rig

To validate the final design, working rig was made of the same. Metal pipe bending was executed by outdoor vendor.



25mm dia and 2mm thick ms pipes were cut as per the desired sizes.



The bend of the pipe was explained to the worker with the help of this thin bending wire.



Data was feeded in the machine, which executed the bending.



The bend degrees were crossed checked as per the drawings.



2mm thick ms sheets were laser cut and bend to form the brackets.

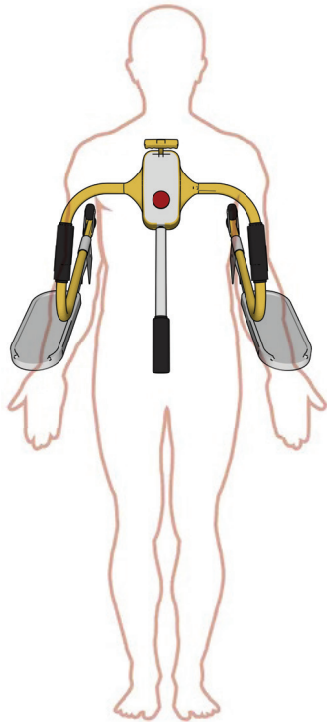
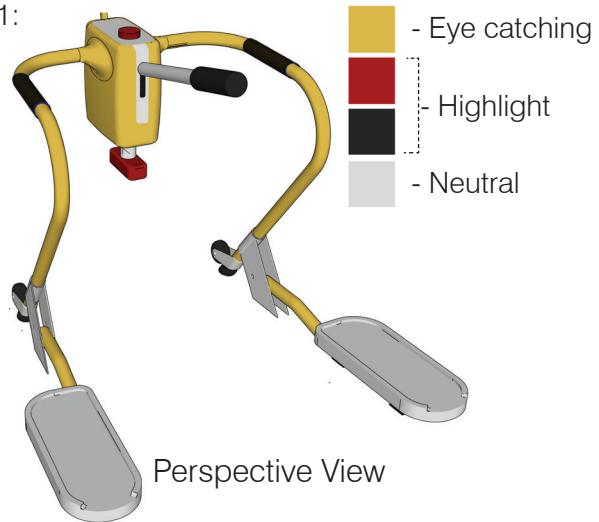


Meg welding was used to fix all the parts.

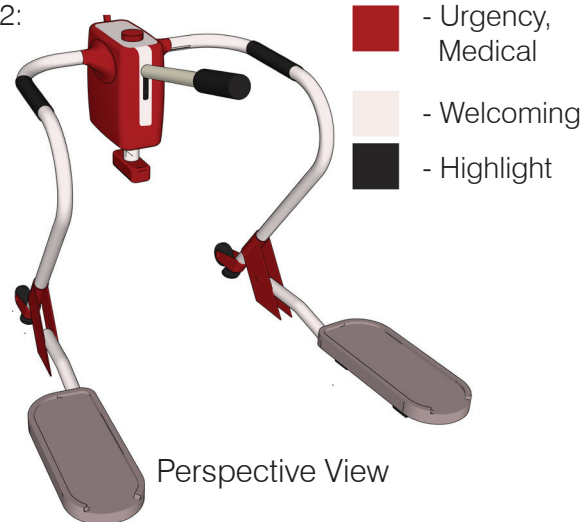
21. CMF

Colour explorations:

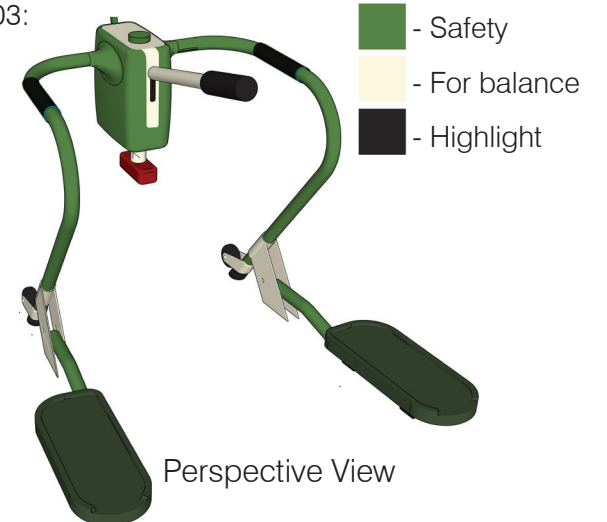
01:



02:



03:

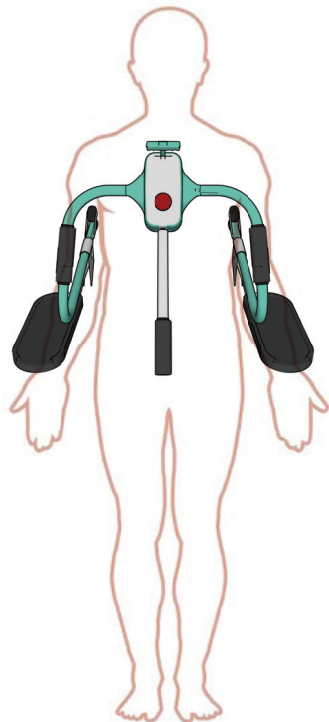
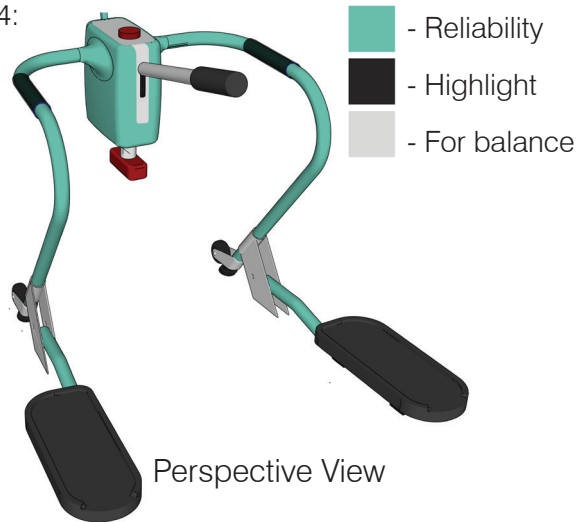


Elevational View(Hung on wall)

21. CMF

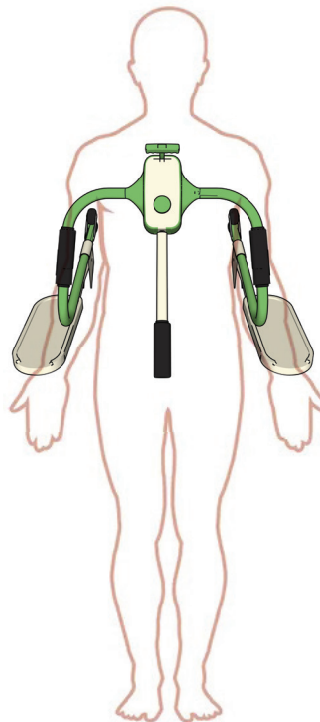
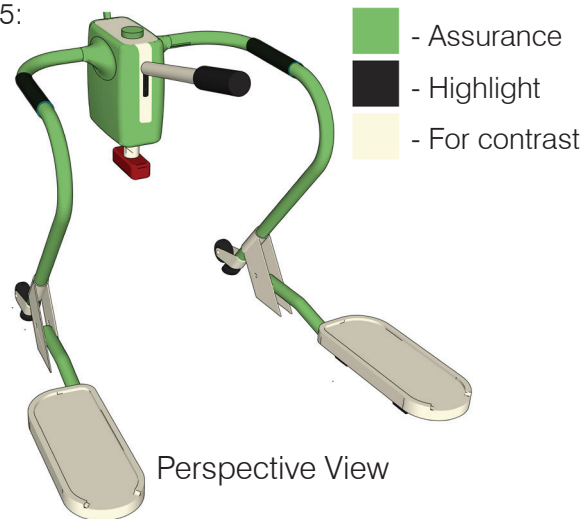
Colour explorations:

04:



Elevational View(Hung on wall)

05:



Elevational View(Hung on wall)

All the 5 colour options were reviewed on the basis of three criterias:

- 1) Intuitive/friendly feeling
- 2) Medical product feeling
- 3) Spotting it easily incase of emergency

Feedbacks:

Option 01: Yellow colour makes it look more towards a constructional device
Score: 3/5

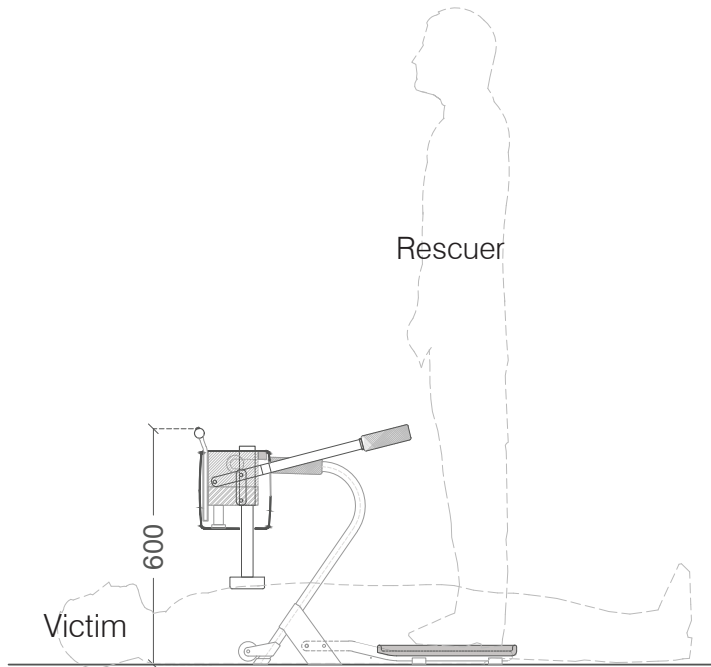
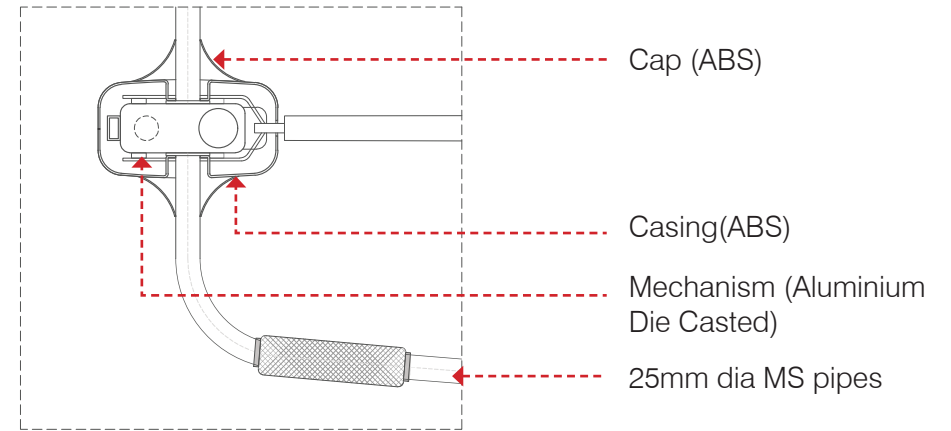
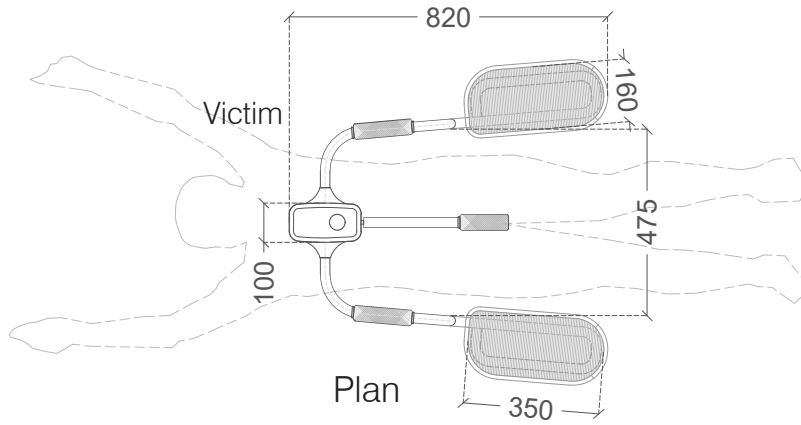
Option 02: Red looks alarming, might confuse with existing fire devices
Score: 4/5

Option 03: Might get camouflaged with landscape
Score: 1/5

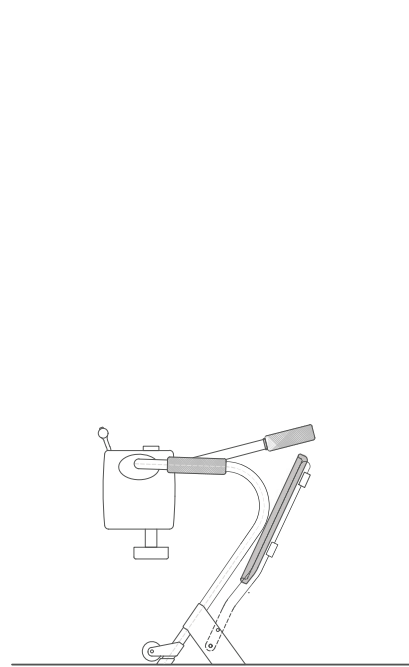
Option 04: Looks intuitive, but not medical
Score: 4/5

Option 05: Might get camouflaged with landscape
Score: 1/5

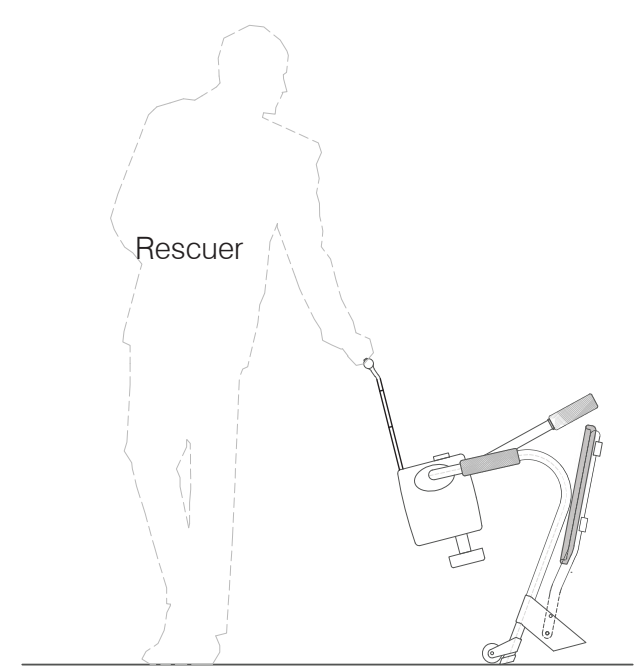
22. Final Technical Drawing



Side Elevation - While in use



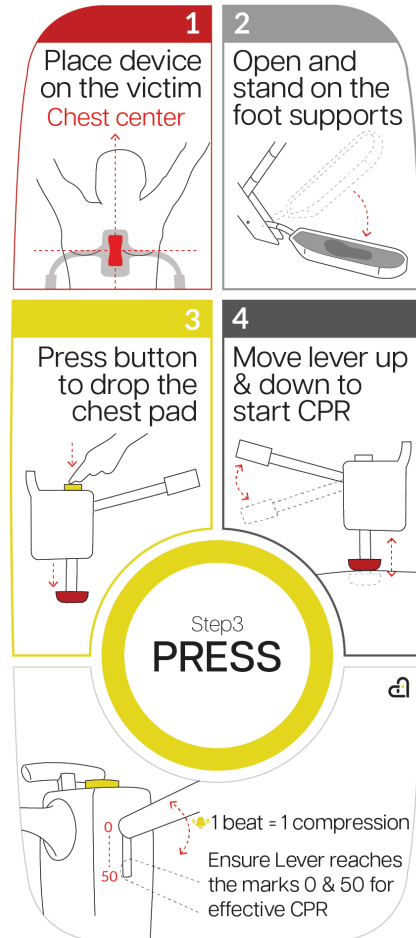
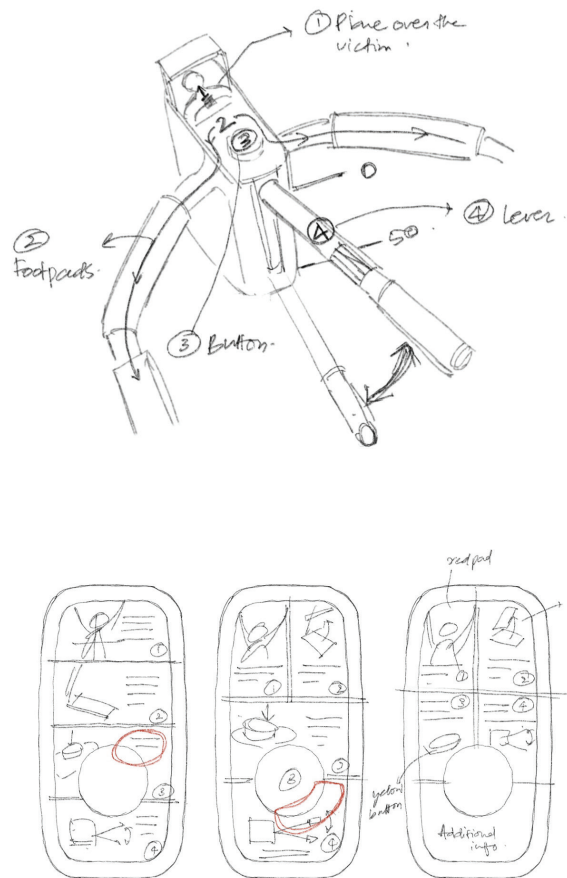
Side Elevation- Folded



Side Elevation- While transporting

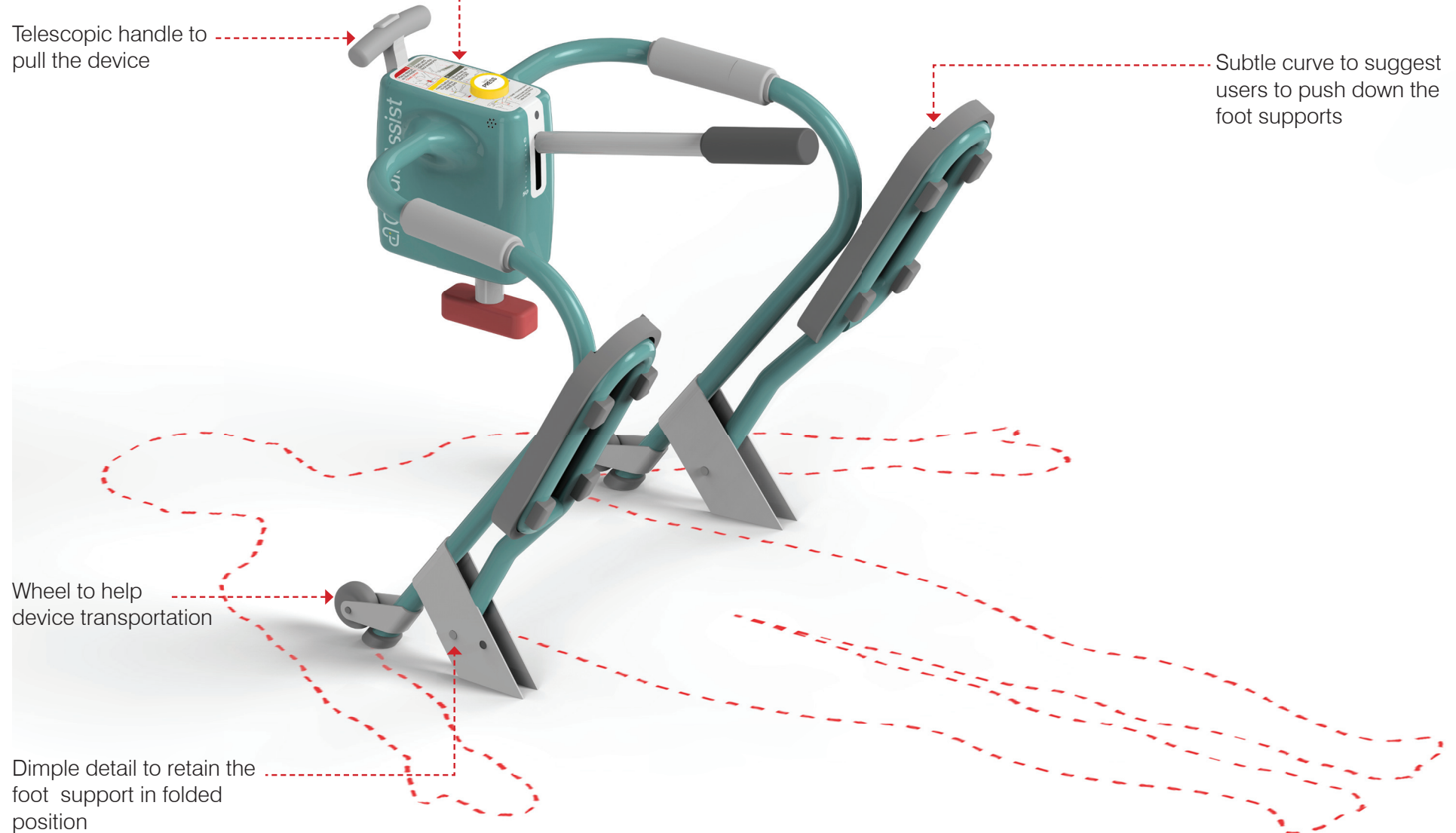
23. Instructions

Instructions were curated to be as descriptive as possible through graphics and texts in simple 4 steps:



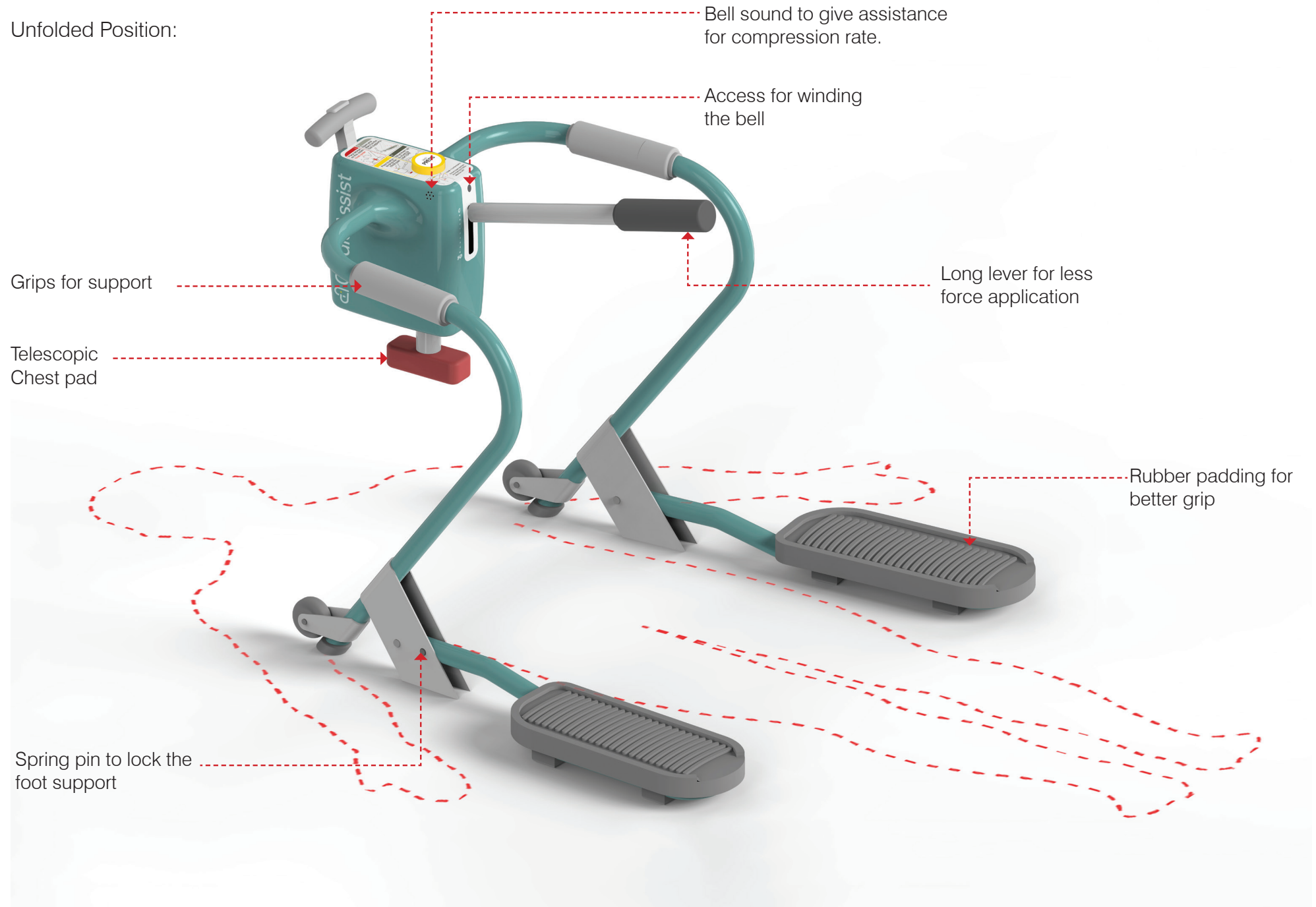
24. Final Model

Folded Position:



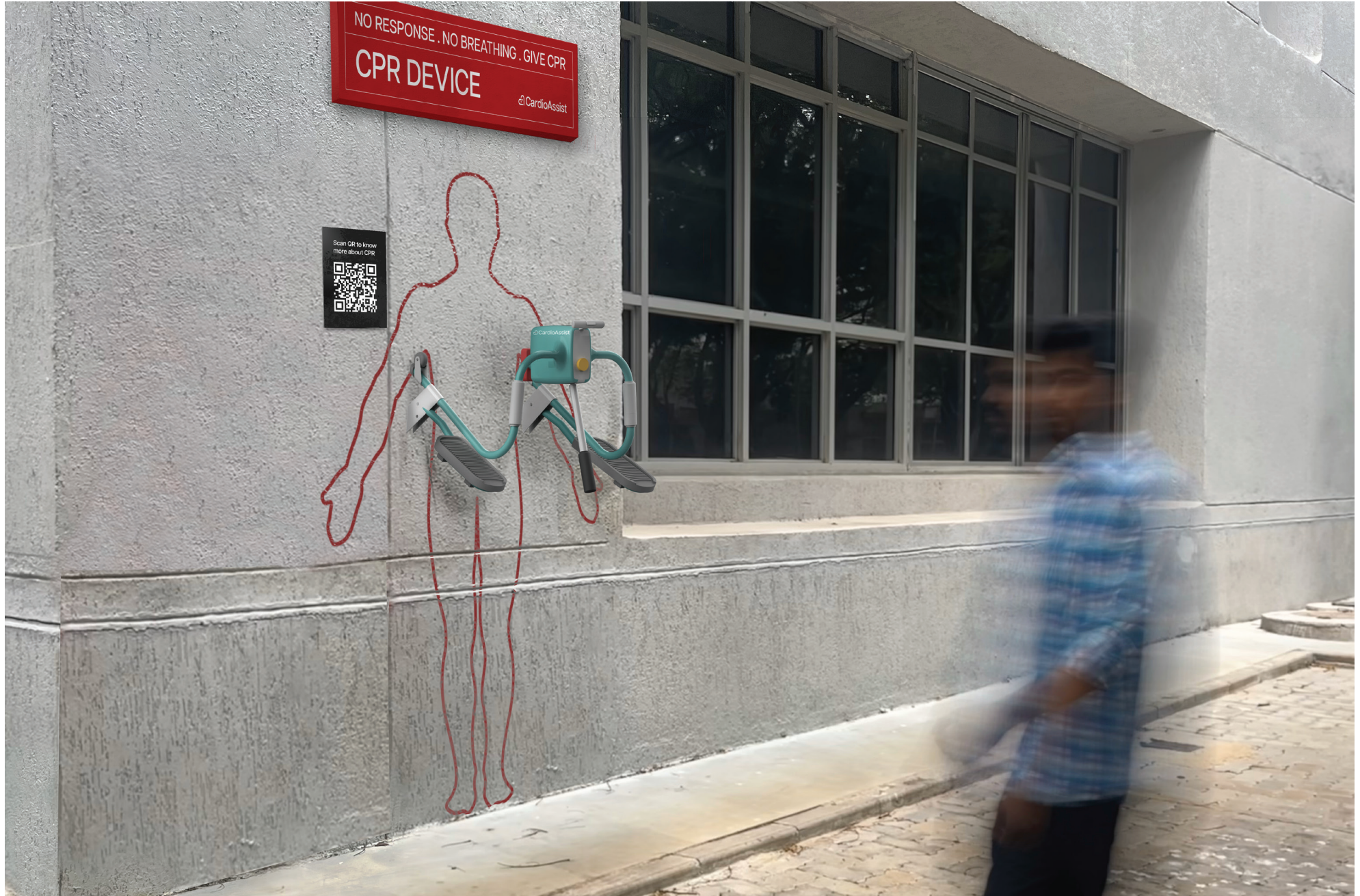
24. Final Model

Unfolded Position:



25. Exterior Deployment

Deployment was planned such a way that it creates awareness:



26. Final User Testing

Final user test was conducted to take feedbacks from the users:



Feedbacks:

- The handle could be hindrance while carrying.
- Instruction 01- center of the chest for pad placement could be more specific, for example center of the nipple line.
- Number of instruction could be reduced further.
- Grip could be longer in length, so that people can hold as per their convenience.
- Bell winding back after its used can be a problem if not done before placing it back.
- Foot supports were little wider for short heighted people.

27. Final Models

Final Working Rig:



Final Prototype:



28. Comments and Feedbacks

Final Jury:

- Instructions could be made simpler.
- Deployment of the device could be given more thought. Height of the device fixed on wall could be reduced.
- Design for unwinding of the bell should be given thought, because unwinding of the mechanical bell for 30mins is difficult.

DDS Exhibition:

- Size of the chest pad could be bigger.
- There has to be a better reference for the rescuer to align the device over the victim.
- Spirit level could be added over the device to get correct alignment.
- Instructions could be further reduced or made simpler. It would be difficult for a layperson with no prior experience of this device to assemble it within ten secs.
- The device could be made foldable to allow ease of portability.
- Weight of the device has to be reduced to make it easy to carry.

29. Conclusion

Main object of the project was to design an assistive device for providing CPR to increase the bystander CPR rate in India. The idea was to keep the design as frugal and robust as possible.

It was challenging to make sure, how the device could be intuitive and easy to use for any layperson in the panic situation. The entire scenario including the clamping of the device, transportation of the device to the site, its assembly over the victim and finally its use to give CPR, all were addressed in order to achieve the best design output.

This device could be further user tested in order to improve in the areas of portability, weight and assembly time.

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