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COMP3004 - Team 5 Project

Use Cases

Use Case 1 (UC1): Using the AED

Primary Actor: Device user
Precondition: User has the device and a victim is in need of treatment (victim is unconscious, not breathing, doesn't show a pulse). User has received at least basic training in life support.
Success Guarantee: The user is able to successfully treat the victim using the device.
Main Success Scenario:

1. If time and resources permit, User Performs Set-up and Check out Procedure (UC2).
2. User presses the ON/OFF button to boot up the device.
3. Device performs AED Self Test (UC3).
4. Device notifies user to stay calm.
5. Device Responsiveness Indicator flashes and device notifies user to check victim's responsiveness.
6. User checks victim responsiveness.
7. Device Help Indicator flashes and device instructs user to call for help.
8. User calls or sends somebody for help.
9. User affixes PASS (Passive Airway Support System) under victim's shoulders.
10. Device Attach Electrodes Indicator flashes and device instructs user to attach defib pads.
11. User begins Applying Electrodes to Victim (UC4).
12. Device Analysis Indicator flashes and user is warned to stand clear and leave victim untouched.
13. User stands by, ensuring victim is still and untouched.
14.Device notifies user it is analyzing victim's heart rhythm to detect ventricular fibrillation or ventricular tachycardia.
15. Device detects ventricular fibrillation or ventricular tachycardia.
16. Device Shock Indicator flashes and device notifies user a shock will be delivered shortly.
17. Device emits shock tone and shock is delivered to victim.
18. Device CPR Indicator flashes and notifies user to start CPR.
19. User Performs CPR on Victim (UC5).
20. Device Analyzing Indicator flashes and restarts analysis, repeating from step 14 as necessary.

Postcondition: The victim has been treated successfully.
Extensions:

*a. Device shows red "X" in Status Indicator window or device beeps while OFF.
    *a1. User checks that cable is correctly attached.
    *a2. If device is still inoperable, user removes AED from service.

*b. Device shows red "X" in Status Indicator window when device is ON.
    *b1. User turns the device OFF and then ON again.
    *b2. If device is still inoperable, user removes AED from service.
*c. Device communicates "Change batteries" prompt.
    *c1. User replaces all batteries.
*d. Device emits "Plug in cable" prompt.
    *d1. User checks cable connection between device and electrodes.
*e. Electrode Disconnection (UC5).
4a. Device has audio recording option installed and configured.
    4a1. Device begins audio recording.
3a. Device fails self test.
    3a1. User attempts to repair device by replacing batteries or electrodes.
    3a2. If self test fails again, AED is removed from service and ZOLL technical service is called.
6a. Victim is conscious.
    6a1. User refrains from using device.
6b. Victim is breathing.
    6b1. User refrains from using device.
6c. Victim has a detectable pulse or other sign of circulation.
    6c1. User refrains from using device.
9a. Victim has head or neck trauma.
    9a1. User does not affix the PASS.
10a. Device has audio recording option installed and configured.
    10a1. Device clears old audio data after 10 seconds.
13a. Device notifies user "Analysis is halted. Keep victim still".
    13a1. User ensures victim is kept still.
    13b1. User in moving vehicle ensures vehicle is halted before performing analysis.
14a. Device does not detect ventricular fibrillation or ventricular tachycardia.
    14a1. Device CPR Indicator flashes and notifies user to start CPR.
    14a2. After 2 minutes of CPR have elapsed, device Analyzing Indicator flashes and device notifies user to stop CPR.

Use Case 2 (UC2): User Performs Set-up and Check out Procedure

Primary Actor: Device user
Precondition: User has device.
Success Guarantee: Device is in operable state.
Main Success Scenario:

1. User inspects all external device surfaces for damage or missing parts.
2. User verifies new CPR-D-padz and Pedi-padz II are included in device and within their expiration date.
3. User removes any old batteries.
4. User inserts 10 new batteries into device.
5. User presses button in battery well.

6. User inspects electrode connector for damage or missing pins, then connects electrode cable and packs electrodes into device cover, closing cover when completed.
7. User turns device on.
8. Device communicates "Unit OK" message to user, as well as "Adult Pads" or "Pediatric Pads" message.
9. User turns device off.
10. User waits 2 minutes and verifies green check status in indicator window, and that device does not emit beeping tone.
11. User places device into service.
12. User once again checks to verify green check status in indicator window.

Postcondition: The device has been set up and approved for use.
Extensions:

10a. Device emits beeping tone or shows red "X" in Status Indicator window.
10a1. User checks that cable is correctly attached.
10a2. If device is still inoperable, user removes AED from service.
12a. Device shows red "X" in Status Indicator window.
12a1. User checks that cable is correctly attached.
12a2. If device is still inoperable, user removes AED from service.

Use Case 3 (UC3): AED Self Test

Primary Actor: AED device
Precondition: Device has been powered on or ON/OFF button has been held for more than 5 seconds.
Success Guarantee: All steps pass self-inspection.
Main Success Scenario:

1. Device verifies adequate battery capacity shown by battery usage indicator.
2. Device verifies defibrillation electrodes are properly connected.
3. Device verifies ECG signal acquisition is functional.
4. Device verifies operation of defibrillator electronics can charge and discharge at 2 joules.
5. Device verifies hardware and software integrity.
6. Device verifies operation of CPR circuitry and sensor.
7. Device verifies audio functionality.

Postcondition: The device has been approved for safe use.
Extensions:

1a. Device does not have adequate battery capacity.
1a1. Device self test fails and unit emits "Unit failed" voice message.
2a. Defibrillation electrodes are not properly connected.
2a1. Device self test fails and unit emits "Unit failed" voice message.
3a. ECG signal acquisition has malfunctioned.
3a1. Device self test fails and unit emits "Unit failed" voice message.
4a. Defibrillator electronics are not working correctly.
4a1. Device self test fails and unit emits "Unit failed" voice message.
5a. Hardware or software is damaged.

5a1. Device self test fails and unit emits "Unit failed" voice message.

6a. CPR circuitry or sensor are not operating correctly.

6a1. Device self test fails and unit emits "Unit failed" voice message.

7a. Audio functionality is not working.

7a1. Device self test fails and unit emits "Unit failed" voice message.

Use Case 4 (UC4): Applying Electrodes to Victim

Primary Actor: Device user
Precondition: The device is powered on and has passed the self test.
Success Guarantee: Electrodes have been successfully applied to victim's chest.
Main Success Scenario:

1. User removes clothing covering the victim's chest.
2. User ensures victim's chest is dry.
3. User clips or shaves excessive hair on victim's chest.
4. User unpacks and unfolds CPR-D-padz electrodes, placing them on victim according to package.
5. User places sensor on middle of victim's breastbone, between the nipples.
6. User presses CPR sensor with right hand from center out to adhere electrode to skin, pulling number 2 tab to peel back protective backing.
7. User presses CPR sensor with left hand from center out to adhere electrode to skin, pulling number 3 tab to peel back protective backing.

Postcondition: The victim is ready for treatment.
Extensions:

4a. User determines victim is a child.

4a1. User unpacks and unfolds Pedi-padz II electrodes, placing them on victim according to package.

4a2. User removes round electrode from backing material and places it on victim's chest.

4a3. User places hand on electrode edge, using other hand to roll electrode onto victim's chest and push out any air underneath it.

4a4. User rolls victim onto their chest and removes square node from package, placing it on victim's back.

4a5. User places hand on electrode edge, using other hand to roll electrode onto victim's chest and push out any air underneath it.

4a6. User rolls victim onto their back and follows device's prompts.

7a. Victim is large or there is a need to place electrode under breast.

7a1. User tears lower pad at perforated line and extends it.

7a2. User places the pad slightly to the victim's left and below their left breast.

7b. Victim has an implanted pacemaker or defibrillator in the upper right chest.

7b1. User angles electrodes to avoid placing them over the device.

7b2. User ensures CPR sensor maintains position over lower half of breastbone.

Use Case 5 (UC5) - User Performs CPR on Victim

Primary Actor: Device user
Precondition: The device has informed the user to start CPR.
Success Guarantee: CPR has been successfully applied to victim.
Main Success Scenario:

1. User begins chest compressions on victim.
2. Device prompts user to continue CPR.
3. After 2 minutes of CPR have elapsed, device prompts user to stop CPR.

Postcondition: The victim has had CPR performed on them.
Extensions:

2a. User's compressions are consistently less than 2 inches deep.

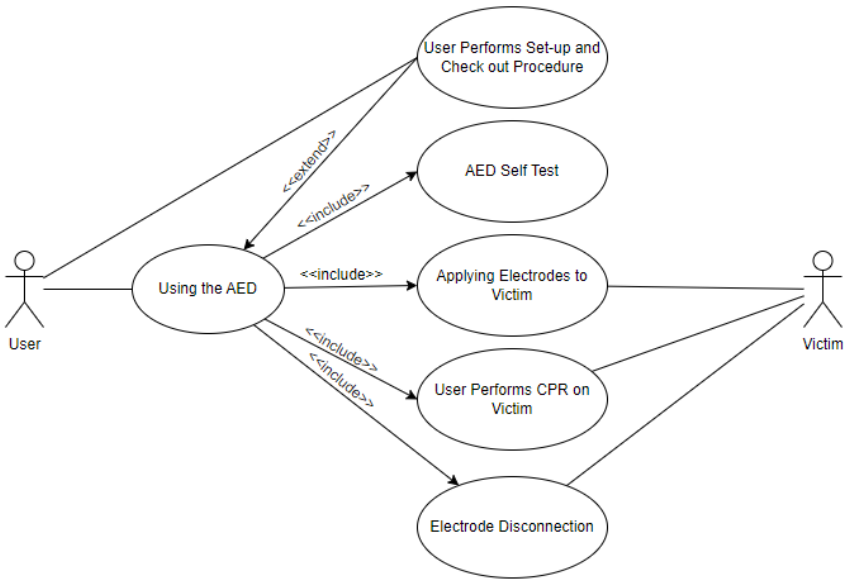
2a1. Device warns user to push harder.
2a2. User pushes harder.
2a3. Device notifies user they are performing good compressions.

Use Case 6 (UC6): Electrode Disconnection

Primary Actor: Device user
Precondition: The device is powered on and electrodes have been attached to victim.
Success Guarantee: Electrodes are re-secured to victim's chest.
Main Success Scenario:

1. Electrodes become dislodged from victim's chest.
2. Device detects electrode disconnection and notifies user to "Check electrode pads".
3. Device powers off and enters status failed state.
4. User reattaches electrodes and secures connection.

Postcondition: The AED is ready for operation and the victim is ready for treatment.



Design Decisions

Our design decisions in implementing our AED simulator were dictated by the nature of how the device actually operates in the field. Given its sequential progression between differing stages, we concluded that the State design pattern provided the best structure to manage the AED's state specific behaviour. Specifically, we abstracted the device's differing states into the abstract parent class `AEDStage,` and its distinctly implemented child classes with their own stage-specific behaviour. In doing so, not only were we able to handle the AED's stage transitions in an explicit fashion, but we also benefited from localizing the individual stages from one another. This cleanly partitioned our code base and also made our workflow both extensible and isolated, allowing us to cooperatively expand the behaviour of the AED in distinct components.

In addition to using the State design pattern, we also harnessed the Observer pattern and its seamless integration into the `Qt` framework. Namely, we make extensive use of `signals` and `slots` to both dynamically update our UI and communicate between classes. As a result, we were able to successfully manage the many state updates native to the AED, in addition to its interactive user flow.

Throughout the development process, our team was forced to make important choices in deciding how to translate the physical AED and its real world behaviour to a virtual simulation. One such decision was the choice to translate all of the AED's voice prompts into visual cues; by amalgamating the LCD commands with the voice commands into one UI display, our application is able to present a consistent UX workflow. Another decision we made had to do with the electrode stage. Since the AED waits for the user to apply all electrodes to the patient in the real world, we decided to adapt this functionality into UI buttons. In order to proceed from the electrode stage to the analysis stage, the user must first apply all electrodes using the respective electrode buttons. This step greatly contributes to simulating

the interactive exchange between the AED and its user. On the other hand, there were many other small victim conditions to simulate that can occur in the real world (for example, the victim has a pacemaker, etc.). To handle these cases, we opted to introduce randomization to our simulation. In doing so, we were able to replicate a real world emergency scenario where circumstances can be very unpredictable. Finally, we held many discussions to determine the AED workflow's terminating case. During a real emergency situation, the AED continues cycling between analysis, shock, and CPR until either the patient is revived or emergency services take over. In this sense, we decided to add a button to allow the user to dictate when the application should terminate (i.e., when the patient wakes up or when help has arrived). Thus, we were able to define end-to-end behaviour for our AED simulator.

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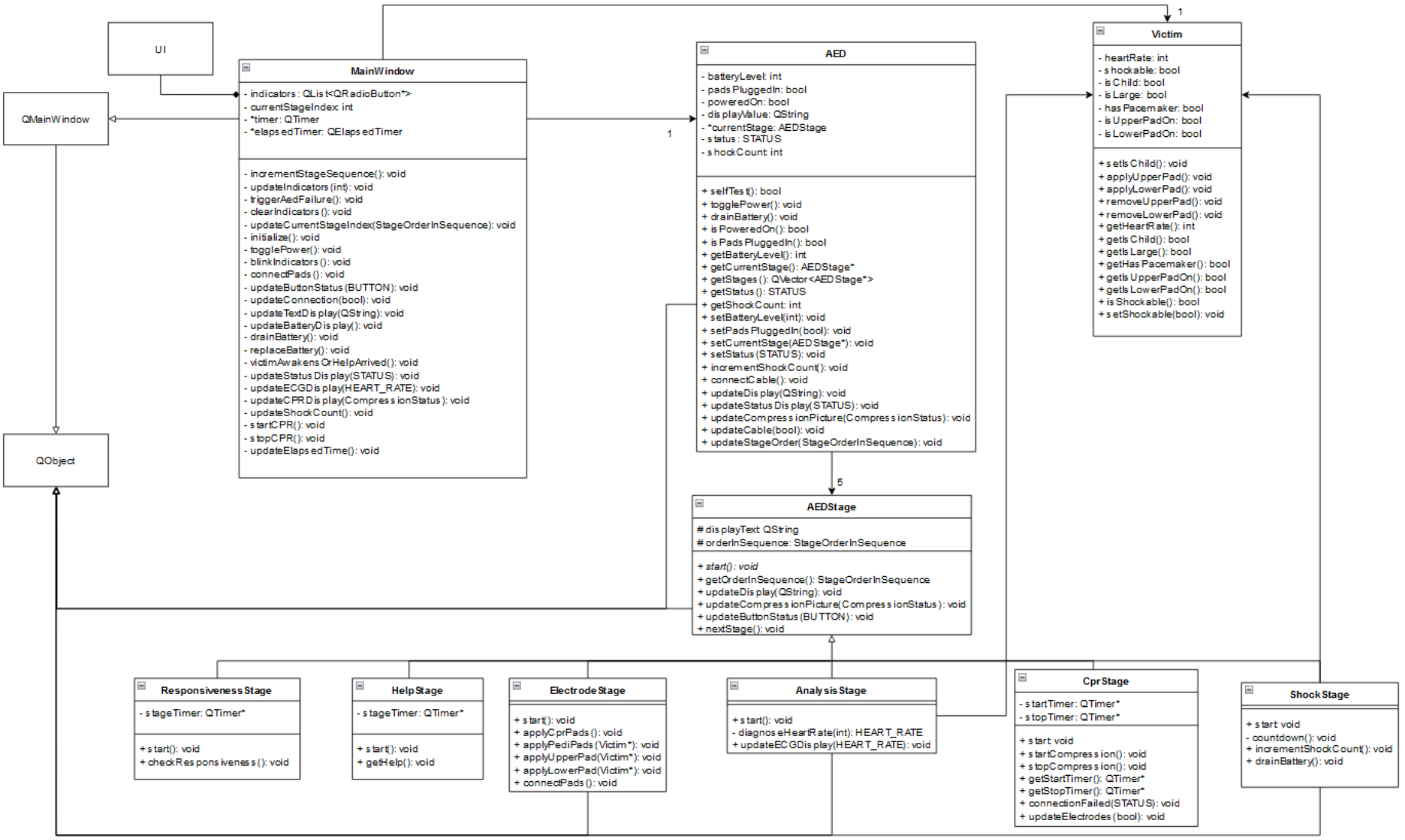
UML Class Diagram



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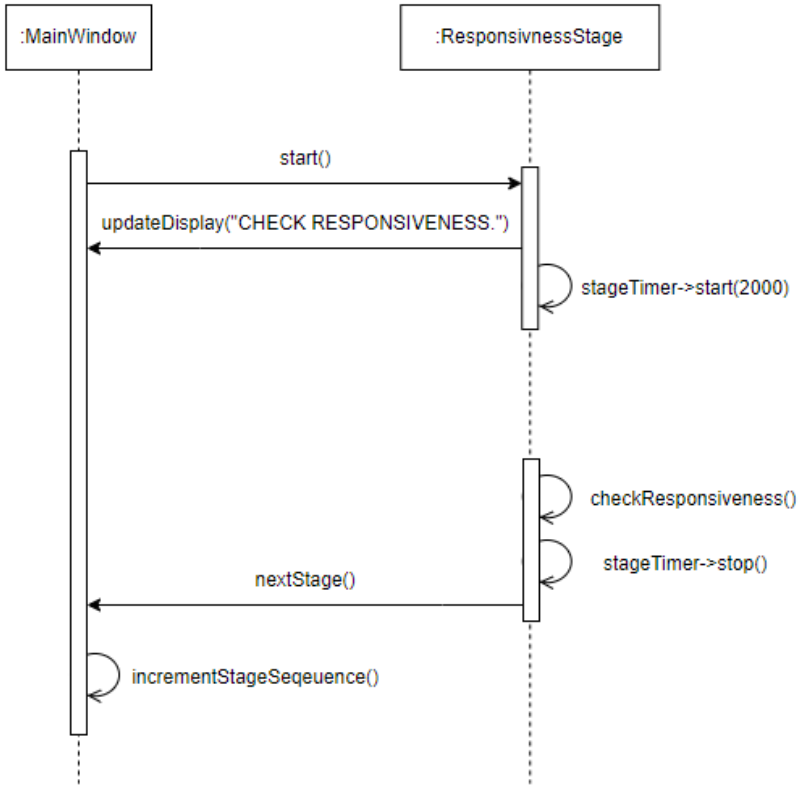
Sequence Diagrams

Main Success Scenario 1

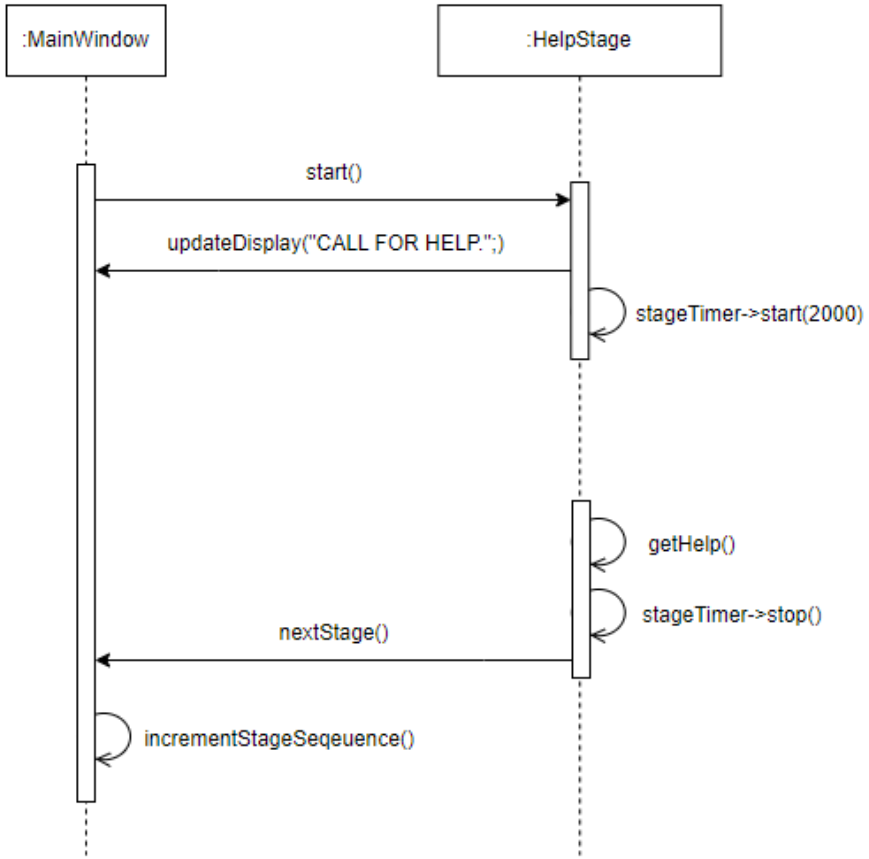
1-1 - Responsiveness Stage

Precondition: AED has passed the self-test.
Once the AED is on and the self-test is passed, It will automatically update the display and prompt the user to check the victim. After 2 seconds the AED will transition into the next stage via the nextStage() signal. Please note the time for this stage was made shorter for the simulation.



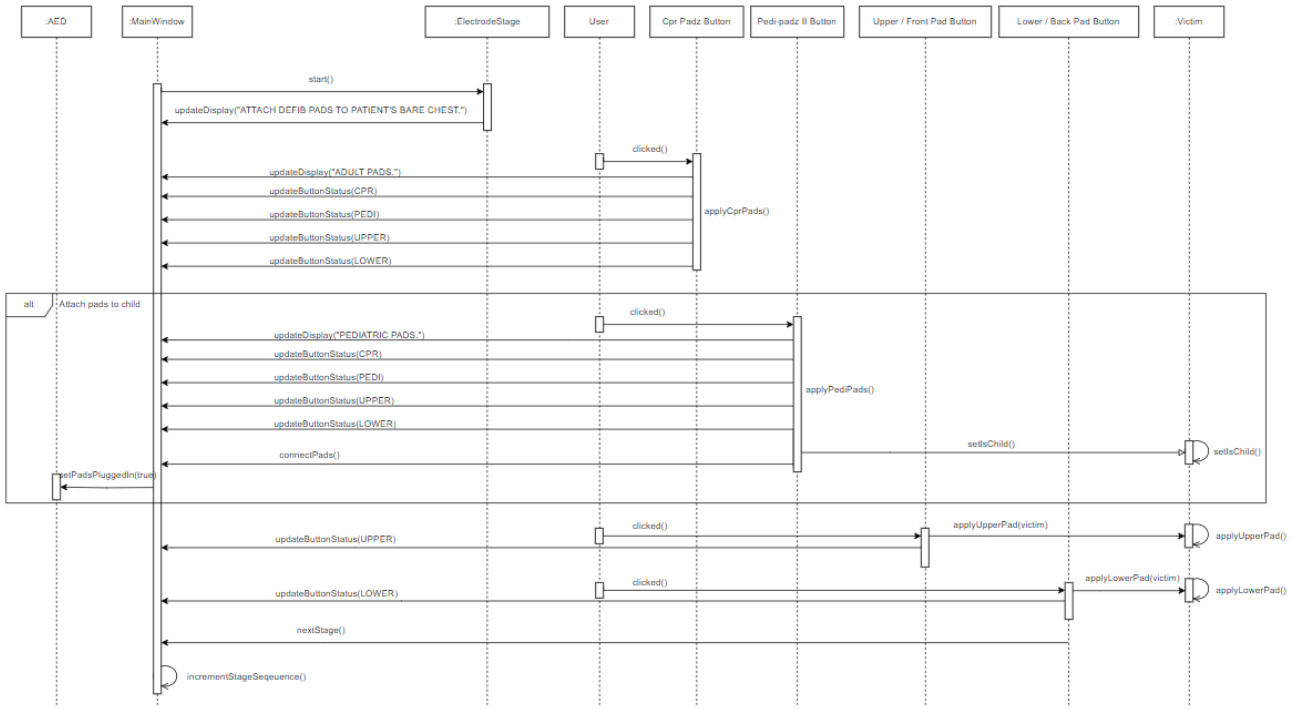
1-2 - Help Stage

Precondition: AED has finished the Check Responsiveness Stage
Once the AED has completed the Check Responsiveness Stage, It will automatically update the display and prompt the user to call for help. After 3 seconds the AED will transition into the next stage via the nextStage() signal. Please note the time for this stage was made shorter for the simulation.



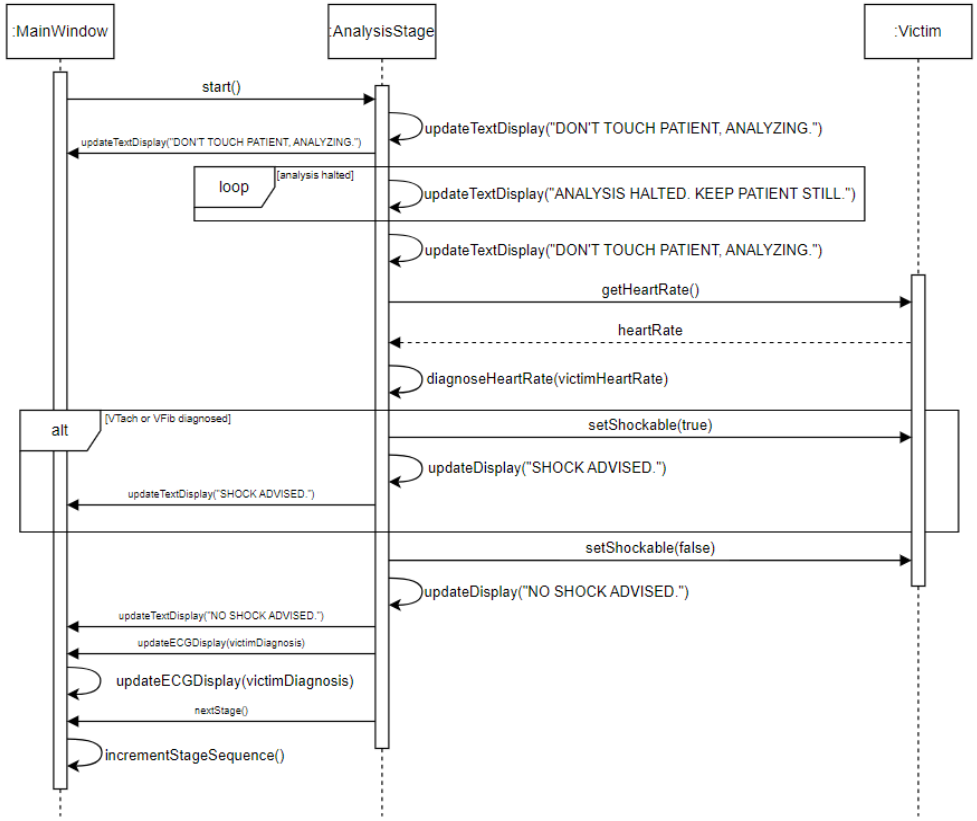
1-3 - Electrodes Stage

Precondition: AED has finished the Help Stage
After the AED has completed the Help Stage it will transition to the Electrode Stage, where it will automatically prompt the user to “ATTACH DEFIB PADS TO THE PATIENT'S BARE CHEST”. The user can choose to apply the CPR-D pads if the victim is an adult with the “Cpr Padz Button” or the PEDI pads for a child with the “Pedi Padz II Button”. After selecting the pads, the AED will update the display with the appropriate message, “ADULT PADS” or “PEDIATRIC PADS”, and then will disable these buttons using the updateButtonStatus() . If the PEDI pads are connected the user will automatically connect the cable into the AED using the connectPads(). The user can now attach the Upper/Front and the Lower/Back electrode onto the victim using the “Upper / Front Button” and “Lower / Back Button”. Each button will apply the pads onto the victim using the applyUpperPad() and applyLowerPad(), and then these buttons will also be disabled with the updateButtonStatus(). Once both pads are connected the nextStage() signal is sent which will trigger the incrementStageSequence() to transition to the next stage.



1-4 - Analysis Stage

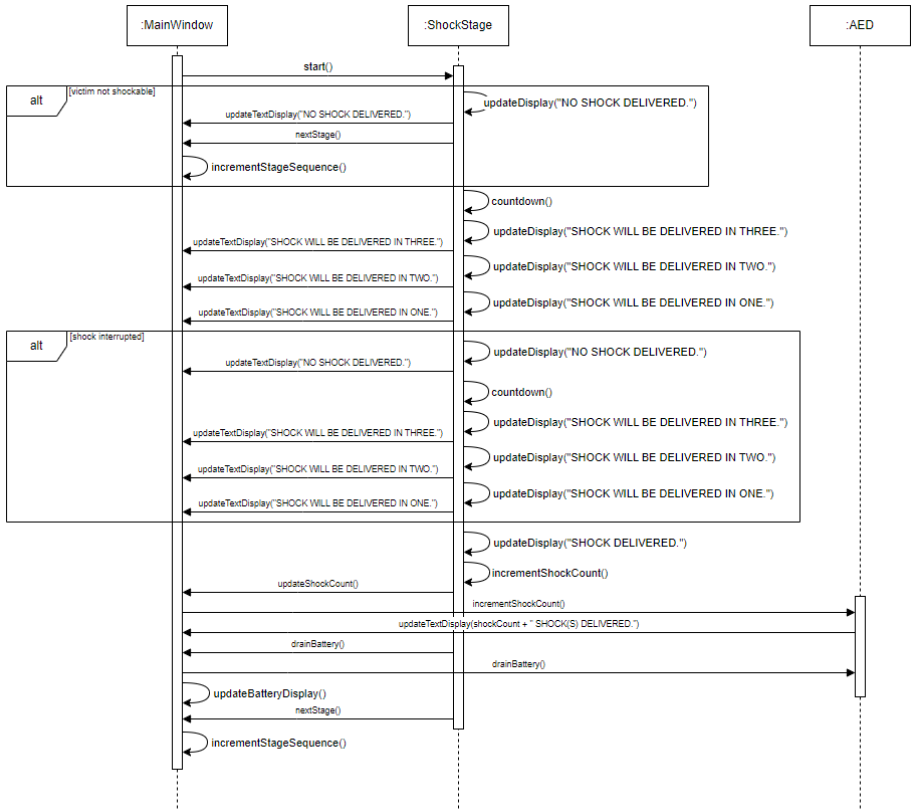
Precondition: electrodes have been applied to the victim and the AED has called `incrementStage()`, incrementing from the electrode stage.
Beginning the analysis stage, the device notifies the user “DON’T TOUCH PATIENT, ANALYZING”. If the analysis is halted, then the AED will loop, notifying the user “ANALYSIS HALTED. KEEP PATIENT STILL” until the condition is met. Once the analysis is permitted to proceed, it diagnoses the victim based on their heart rate. Depending on the diagnosed condition, the victim is either shockable and “SHOCK ADVISED” is displayed , or not shockable and “NO SHOCK ADVISED” is displayed. Finally, the victim’s respective ECG diagram is displayed to the screen. Once completed, the stage increments to the next stage.



1-5 - Shock Stage

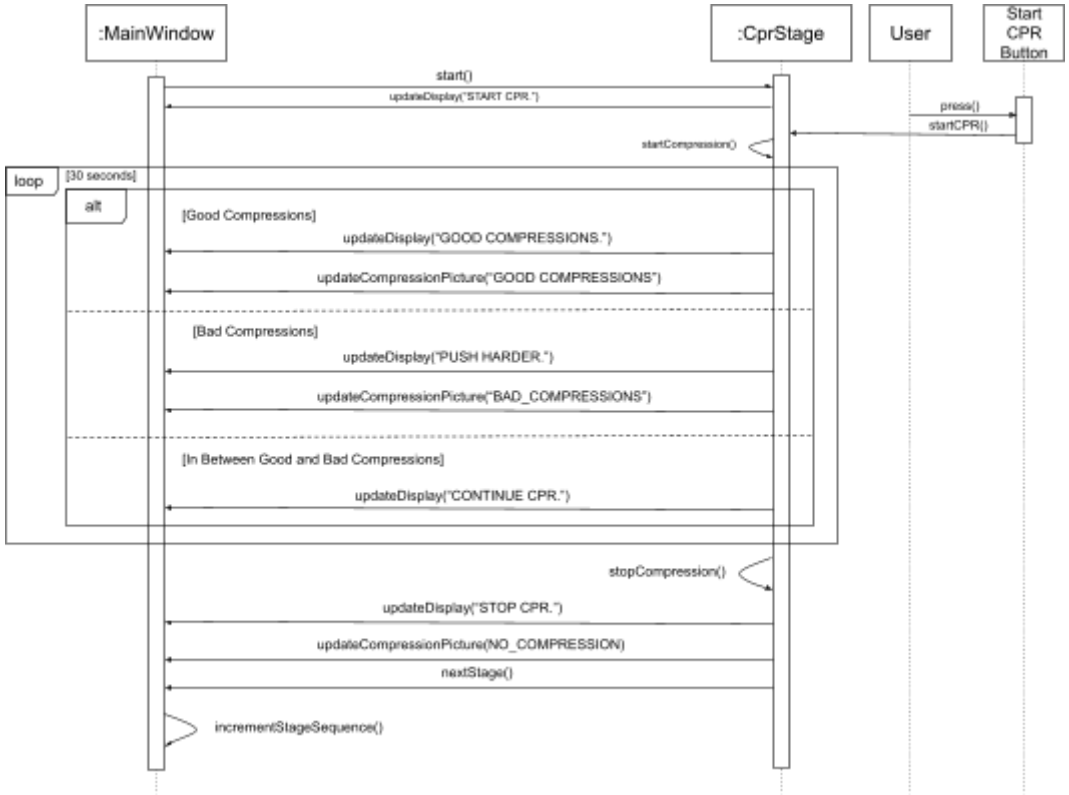
Precondition: AED has called `incrementStage()`, incrementing from the analysis.

If the analysis stage has determined the victim to be “not shockable”, the shock stage will skip the shocking process and display “NO SHOCK DELIVERED”, incrementing immediately to the CPR stage. If the victim has been determined to be shockable, the AED will countdown to the user, displaying “SHOCK WILL BE DELIVERED IN THREE”, “SHOCK WILL BE DELIVERED IN TWO”, “SHOCK WILL BE DELIVERED IN ONE”. If the shock has been interrupted due to an error condition, the AED will loop and display “NO SHOCK DELIVERED” until the error has been resolved. Once resolved, the device counts down once more and delivers the shock. Shock count display is then incremented on the UI, battery drained slightly, and notifies the user of total shocks delivered in the current session. Once completed, the stage increments to the next stage.



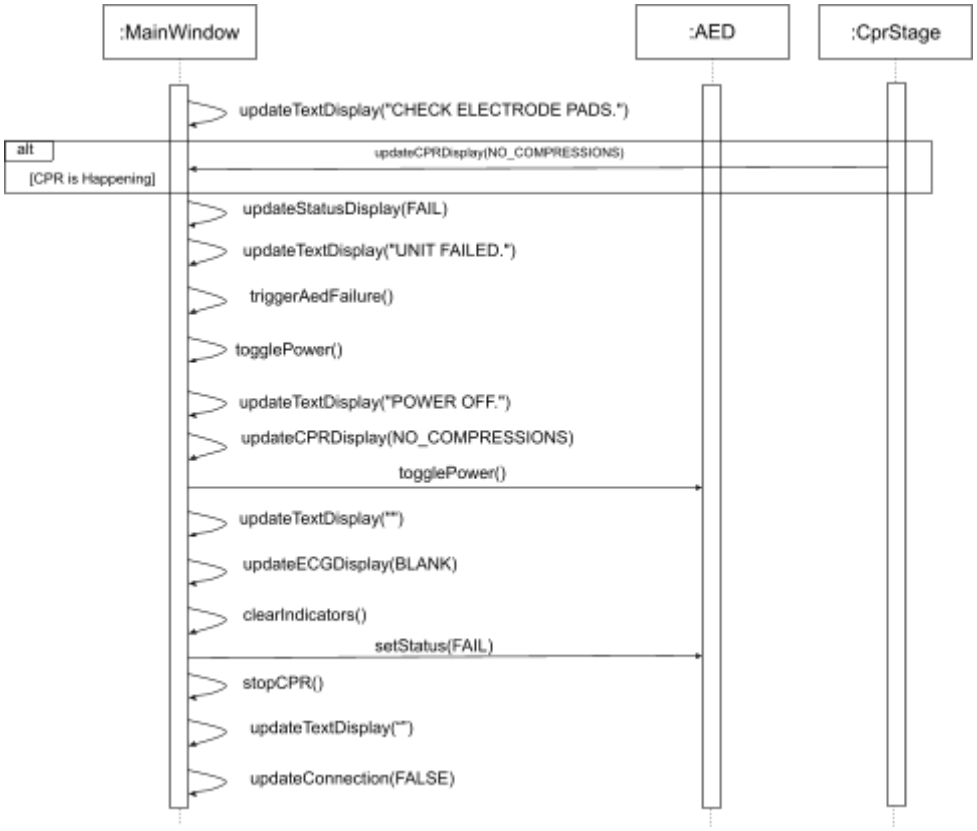
1-6 - CPR Stage

Precondition: AED has finished the Shock Stage
The UI informs the user to Start CPR. The user presses the Start CPR button then the compressions start and go on for 30 seconds. Compressions are simulated by random number generation, and different UI output will show depending on what the value is generated by the random number. If the random number lands on good compressions then the display updates the display text and compression meter to show good compressions. If the random number lands on bad compressions then the display updates the display text and compression meter to show bad compressions/push harder. If the random number lands on continue compressions then the display updates the display text to continue compressions. Once compressions stop, the display updates the display text to say to stop CPR and the compression meter stops displaying compressions. Once completed, the stage increments to the next stage.



Electrodes Disconnection Scenario

Precondition: Pads are already on, and have pads disconnected during stage transition or during CPR compressions.
The electrodes disconnection scenario can happen during runtime as long as the pads are connected. Electrode disconnection has a 5% chance of happening when transitioning between stages and a 3% chance of happening when CPR compressions are being done. The only difference between the two is if CPR is currently happening then the UI compression meter is updated to show that the compressions have stopped. The status display shows fail, the text display shows unit failed. The AED failure is triggered. The UI displays a power off message. The UI updates the display to show no compressions are happening. The AED gets powered off: the text display goes blank, the ECG display and all radio buttons go blank, the UI triggers a red failure square with a status fail, CPR is stopped, the text display goes blank. The Fix Connection Button on the UI is enabled again.



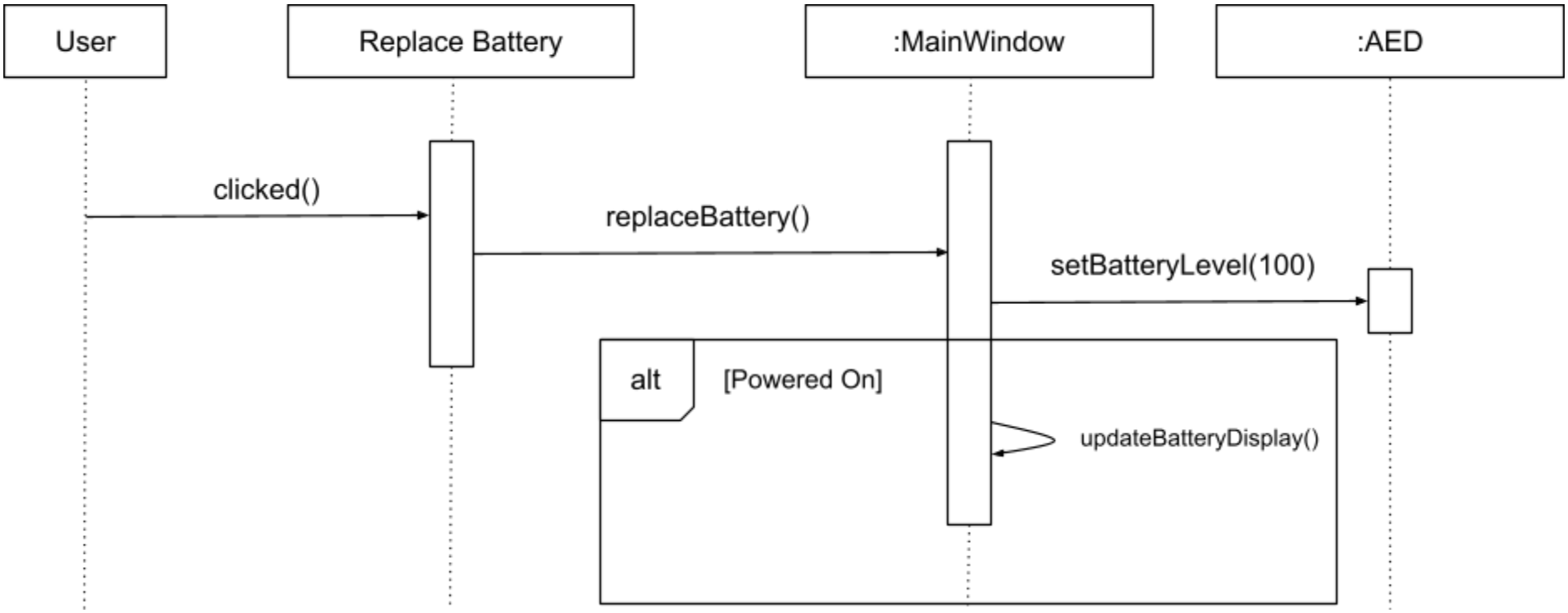
Battery Drain / Battery Dead Scenario

The battery will drain only if the unit is Powered On. The battery drains every 5 seconds as well as when shocks are performed and every time the battery drains the battery display value on the UI will update. When the battery drains to 10%, a change battery message will show on the display. The following applies when the batteries die. The UI displays a power off message, the UI updates the compression meter to show no compressions are happening. The AED gets powered off: the ECG display and all UI radio button state indicators go blank, the text display shows that the unit has failed and shows a red square on the display to indicate failure, CPR is stopped (there's a check to see if its happening), the text display goes blank.

Vince Cardillo, Adam Luczaj, Zachary Tesolin

Replace Batteries Scenario

The user replaces the batteries when they die or whenever they feel the need to replace the battery (if not dead). Pressing the Replace Battery button will set the battery level of the AED to 100. If the unit is powered on, the battery display on the UI will update to the new full 100% battery.



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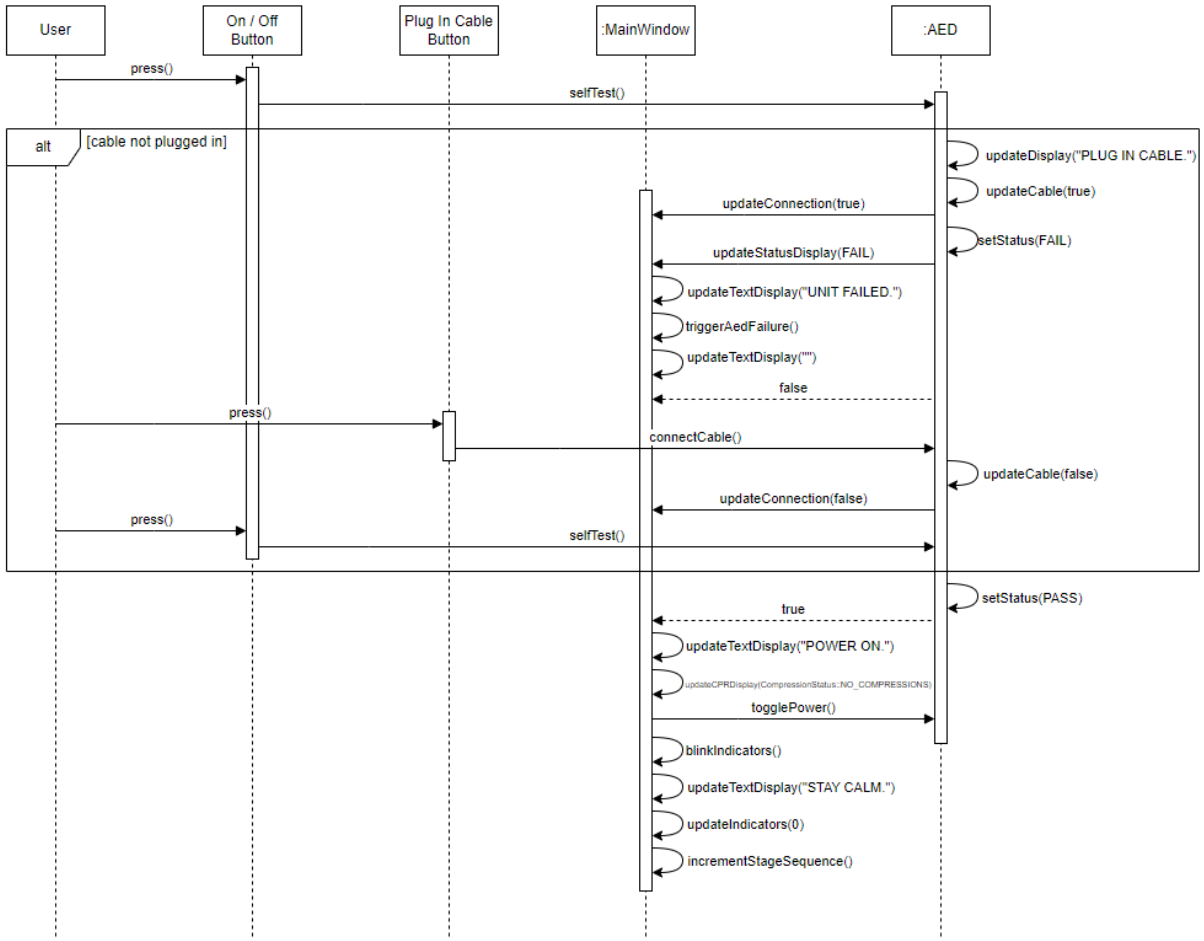
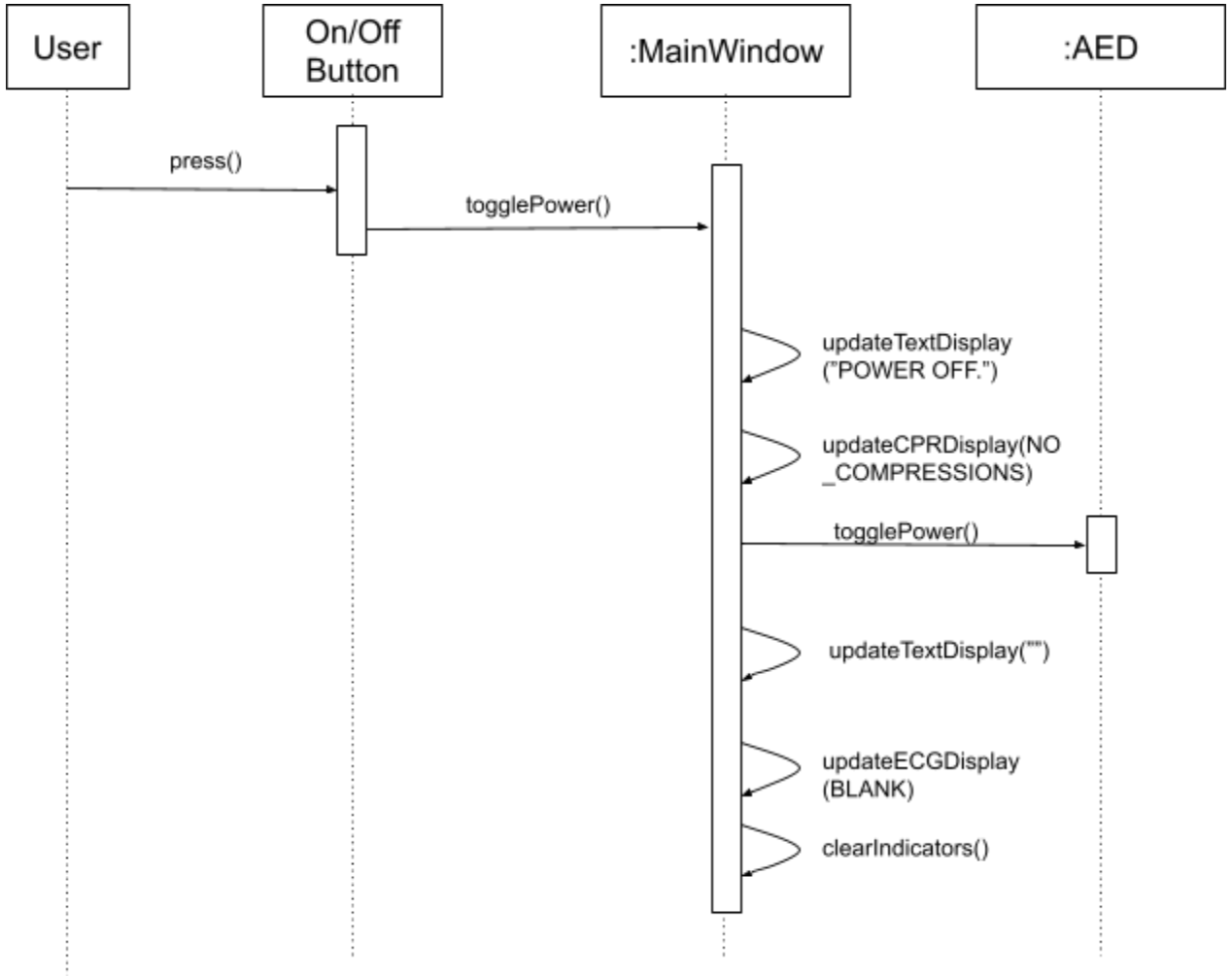
Power On / AED Self Test Scenario

Precondition: AED is powered off.
The user attempts to boot the AED. When powering on, the AED performs a self test. If the self test fails, the AED state is updated and the user is notified. To fix the AED, the user presses the “Fix Connection” button and attempts to boot the AED again (which performs another self test). Once the self test passes, the AED displays “POWER ON”, blinks all indicators, and notifies the user to “STAY CALM”.



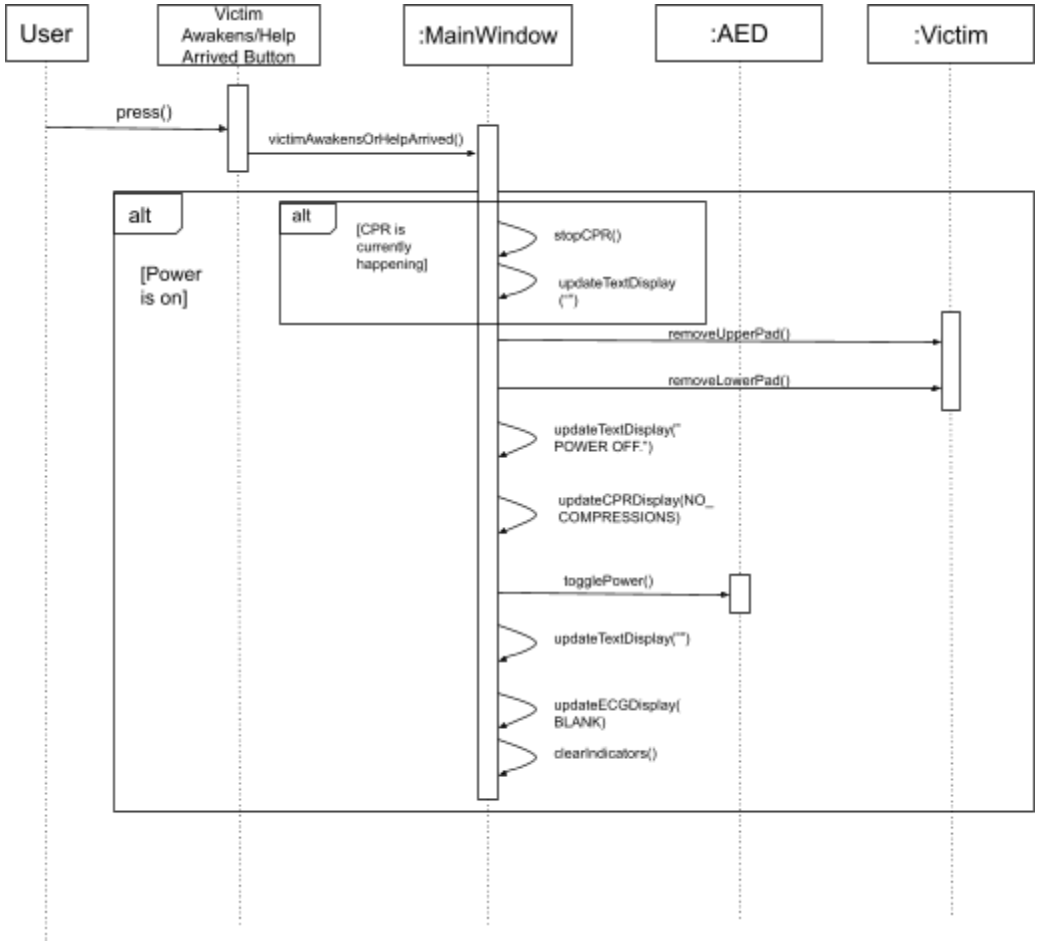
Power Off

The user presses the power off button on the UI. The UI displays a power off message, the UI updates the display to show no compressions are happening. The AED gets powered off: the text display goes blank, the ECG display and all UI radio button state indicators go blank.



Victim Woke Up or Help Arrived

The victim is awakened by pressing the victim/awakens help arrived button on the UI. The following instructions happen only if the power is currently on. If CPR is currently being done, CPR is stopped and the text display goes blank. Pads are removed from the victim. The UI displays a power off message, the UI updates the compression meter display to show no compressions are happening. The AED gets powered off: the text display goes blank, the ECG display and all UI radio button state indicators go blank.



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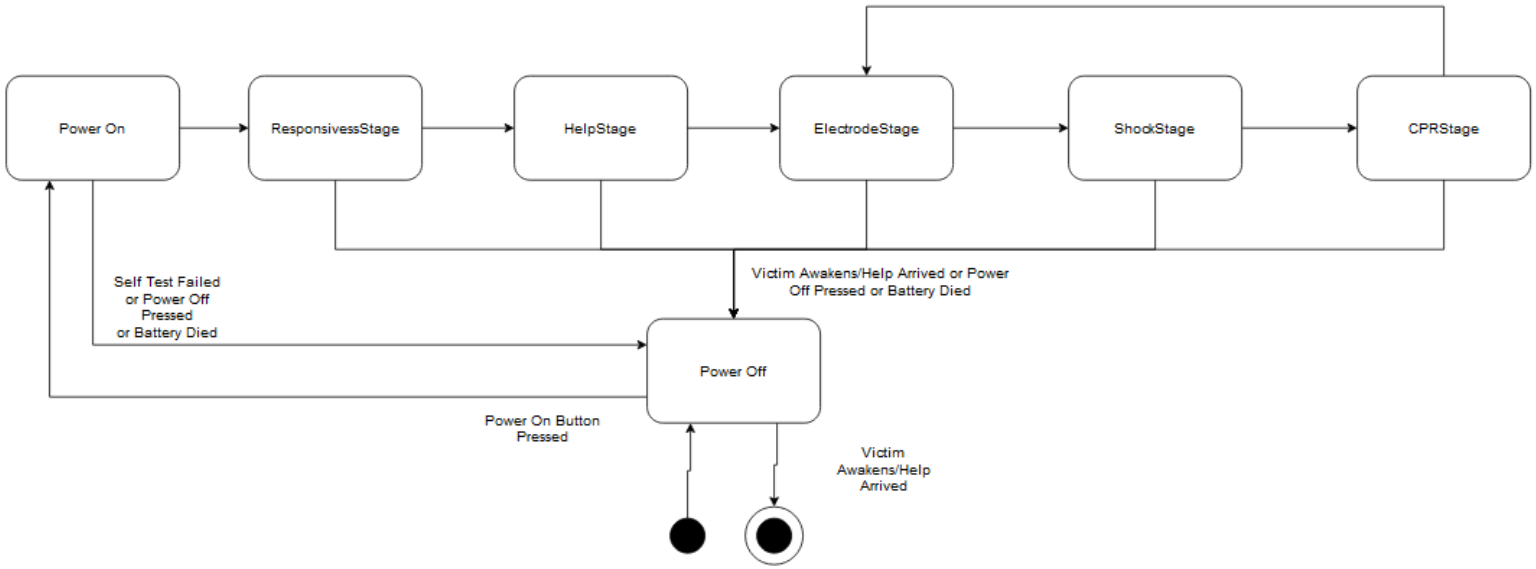
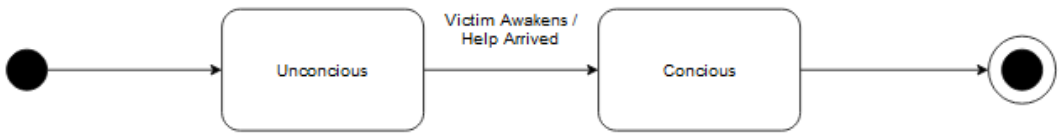
State Diagrams

AED



Victim



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Traceability Matrix

ID	Requirements	Use Case	Implemented By	Test	Description
1	Design the software for a graphical user interface (GUI) that resembles the AED Plus's display	N/A	MainWindow Aed	N/A	The MainWindow UI was designed to resemble the AED by replicating the images and indicator locations.
2	Develop visual elements to display essential information, including: Real-time CPR feedback.	Use Case 1	MainWindow Aed ElectrodeStage AnalysisStage CprStage Victim	After powering on the device and reaching the electroseStage, click “Apply CPR-D-padz” to confirm the victim is an adult. Afterwards, apply both the upper and lower pad. Once both pads are attached, the analysis will begin and update the first display. When CPR is reached, click “Start CPR”, this will begin compression and update the CPR labels.	The first text display is designed to show the different images for the ECG analysis. The second text display has several compression labels on the right-side to represent the different images for CPR feedback.
4	Device status indicators	Use Case 1	MainWindow Aed	When the device starts, the indicator has a 50% chance of updating to FAIL(Red) if the cable becomes unplugged. It will also FAIL if the battery dies.	The green/red box in the bottom left corner (changes during runtime) represents the status of the AED.
5	Simulated user interaction controls	Use Case 1 Use Case 4 Use Case 5	MainWindow Aed ElectrodeStage CprStage Victim	All the user interaction controls have been covered in different sections of this matrix.	User interaction functionality is simulated using buttons. With the various display buttons, users can: boot the AED, replace batteries, fix cable/electrodes connection,

					apply electrodes to victim, start CPR, and indicate whether the victim has awakened or help has arrived.
6	Include a display panel to show the simulated ECG (electrocardiogram) waveform and device status.	Use Case 1	MainWindow Aed ElectrodeStage AnalysisStage Victim	Click “ON/OFF” After the self-test has passed, and the Electrode Stage has been reached. Select which pad you would like to apply, then apply the upper and lower pads. The analysis process will begin and update the top display panel. Verify the ECG image in the first display.	After analysis, the AED will display the ECG wave on the first display. There are different types of ECG images that represent the shockable and non-shockable rhythms that can be detected. The device status is also represented at the bottom of the screen, and could become red if the AED detects an issue.
7	Develop a module to simulate the AED's capability to diagnose cardiac arrhythmias, specifically ventricular fibrillation and ventricular tachycardia. Simulate the analysis process where the AED Plus detects the heart.	Use Case 1	MainWindow Aed ElectrodeStage AnalysisStage Victim	Power on the device. After the self-test has passed, and the Electrode Stage has been reached. Select which pad you would like to apply, then apply the upper and lower pads. The analysis process will begin. Verify the "DON'T TOUCH PATIENT, ANALYZING." message in the second display. Verify the ECG image in the first display.	At the beginning of analysis, the victim’s heart rate is first determined. Depending on the victim’s heart rate, one of four diagnoses is prescribed: ventricular fibrillation, ventricular tachycardia, asystole, or normal. Given the diagnosis, the analysis concludes in making a determination as to whether or not a shock should be performed.
9	If a shockable rhythm is detected, display a message on the screen and provide	Use Case 1	MainWindow Aed AnalysisStage	After the upper and lower pads have been applied, the analysis Stage will determine	During analysis, if the AED finds a shockable rhythm, it will update the display and

	textual instructions on how to prepare and deliver a shock.		ShockStage Victim	if the rhythm is shockable, and will deliver the shock automatically.	automatically prepare to deliver a shock to the victim.
10	If a non-shockable rhythm is detected, provide appropriate textual guidance for CPR (Cardiopulmonary Resuscitation).	Use Case 1	MainWindow Aed AnalysisStage CprStage Victim	After the upper and lower pads have been applied, the analysis Stage will determine if the rhythm is unshockable, and then proceed to the CPR stage.	During analysis, if the AED finds a normal BPM, the AED will not perform a shock and instead, transition to the CPR stage.
11	Create a system that emulates the real-time CPR feedback feature of the AED Plus. Simulate the measurement and assessment of chest compressions, delivering visual and textual feedback to guide the user.	Use Case 5	MainWindow Aed CprStage	Click “ON/OFF” If the self-test fails, click “Fix Connection”. Verify "ATTACH DEFIB PADS TO PATIENT'S BARE CHEST." message in the second display. Click “Apply CPR-D-Padz '' for an adult or or “Apply PEDI-Padz II” for a child. The click Apply “Upper/Front Pad” and “Lower/Back Pad” Verify "START CPR." message in the second display. Click “Start CPR” Verify the different messages in the second display such as: "GOOD COMPRESSIONS.", "CONTINUE CPR.", And "PUSH HARDER."	During CPR, compressions go on for 30 seconds. We recognize compressions should go for 2 minutes but we shortened it so the TA doesn’t have to wait for a whole 2 minutes. What happens is every few seconds the UI will update the display message and compression meter based on a random chance (so if the same compression is done a few times the same compression meter will show). This will be good compressions or bad compressions based on the random chance result. There is also a very small chance (from the random chance that takes place) the UI will display a continue CPR message instead of a good/bad compression message and display. Regardless of what compression is happening, a QDebug message will play to say what type of compression

					is taking place.
12	Visual Prompts: Specify scenarios of a simulated cardiac emergency with visual prompts and their timing to guide the user through a rescue situation.			Click “ON/OFF” If the self-test fails, click “Fix Connection”. Click “Apply CPR-D-Padz '' for an adult or or “Apply PEDI-Padz II” for a child. The click Apply “Upper/Front Pad” and “Lower/Back Pad” Click “Start CPR” All of these user actions will provide visual prompts to the user as it guides them through the rescue.	Throughout the entire rescue, the AED will automatically provide the necessary visual prompts in the second display to guide the user through the stages.
13	Power On	Use Case 1	MainWindow Aed	Click “ON/OFF” If the self-test fails, click “Fix Connection”. Verify the “POWER ON.” is shown on the second display and the radio buttons perform a full cycle of the stages.	The ON/OFF button at the bottom corner will power on the AED.
14	Self-Test	Use Case 3	MainWindow Aed	Click “ON/OFF” If the self-test fails, click “Fix Connection”. Verify the color under the Status label is green and the “UNIT OK.” message is displayed in the second display.	After the AED has been powered on, the AED will automatically perform its self-test. In the event that it fails, the user must coorent the issue.

15	Check Reponsivness Stage	Use Case 1	MainWindow Aed CheckResponsivenessStage	Click “ON/OFF” If the self-test fails, click “Fix Connection” After booting the AED, Observe UI display message "CHECK RESPONSIVENESS.". Verify the user has checked the victim in the console.	After the AED has been powered on, and the self test passed. The AED will automatically prompt the user to check the victim's responsiveness.
16	Call for Help Stage	Use Case 1	MainWindow Aed HelpStage	Click “ON/OFF” If the self-test fails, click “Fix Connection” After booting the AED, observe the stage transition from Responsiveness stage to Help stage. Observe UI display message "CALL FOR HELP.". Verify the user has called for help in the console.	After some time has passed the AED will automatically transition from the responsiveness stage to the call for help stage.
17	Provide input mechanisms for Electrode Placement	Use Case 4	MainWindow Aed ElectrodeStage	Click “ON/OFF” If the self-test fails, click “Fix Connection”. Verify "ATTACH DEFIB PADS TO PATIENT'S BARE CHEST." message in the second display. Click “Apply CPR-D-Padz '' for an adult or or “Apply PEDI-Padz II” for a child. Verify the application of the pads through the console messages.	There are 4 buttons that allow the user to place the electrode onto the victim once this stage is reached. They are: “Apply CPR-D-Padz ''and “Apply PEDI-Padz II”. As well as: “Upper/Front Pad” and “Lower/Back Pad”

				Then click Apply “Upper/Front Pad” and “Lower/Back Pad”. Verify the application of the upper and lower pads through the console messages.	
18	Battery Drain and Replace	Use Case 1	MainWindow Aed ShockStage	Click “ON/OFF” If the self-test fails, click “Fix Connection”. Wait 10 seconds. Check Battery %. Click “Replace Battery” Verify Battery% is now at 100%.	The battery drains every 5 seconds during program runtime only if the unit is turned on. The battery also drains when shocks are delivered. The “Replace Battery” button will set the battery level to 100%. If the battery drains to 0%, then the unit will turn off and you have to press the “Replace Battery” button in order to turn it on again.
19	Different Victim Conditions	Use Case 1	MainWindow Aed ElectrodeStage AnalysisStage ShockStage CprStage Victim	Click “ON/OFF” If the self-test fails, click “Fix Connection”. Click “Apply CPR-D-Padz '' for an adult or or “Apply PEDI-Padz II” for a child. Verify the "ADULT PADS." or "PEDIATRIC PADS." in the display. The click Apply “Upper/Front Pad” and “Lower/Back Pad” There is a 15% chance the	The different conditions of the victim are whether they are an Adult or Child, which is decided by which pads are selected to apply. They can also have a pacemaker or be large. These are decided at random when the Victim is initialized.

				victim has a pacemaker. If so, verify the message “User determines the victim has a pacemaker." in the console. There is a 35% chance the victim is large. If so, verify the message “User determines the victim is large." in the console.	
20	Electrode Disconnection	Use Case 6	MainWindow Aed CprStage	Click “ON/OFF” If the self-test fails, click “Fix Connection”. Click “Apply CPR-D-Padz '' for an adult or or “Apply PEDI-Padz II” for a child. The click Apply “Upper/Front Pad” and “Lower/Back Pad” There is a 5% chance that the electrode pads could disconnect during a stage if they have already been connected. There is a 3% chance that the electrode pads could disconnect during CPR. Continue the program until a disconnection occurs and verify the message displayed.	During the runtime of the application, there is a 5% the electrode pads could be disconnected once applied. During the CPR there is a 3% that the pads disconnected when performing a compression Once a disconnection occurs, a check electrode pad message is displayed and AED status fails, requiring the user to fix the connection.