Homeland Security
Science and Technology

Summary

U.S. Department of Homeland Security
SAVER
System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions.

Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective operational tests on commercial equipment and systems and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

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Mechanical Chest Compression Devices

(AEL reference number 09ME-03-MCCD)

In order to provide emergency responders with information on currently available mechanical chest compression device (MCCD) capabilities, limitations, and usability, the Center for Domestic Preparedness conducted a comparative assessment of MCCDs for the SAVER Program in February 2009. Detailed findings are provided in the complete Assessment Report on Mechanical Chest Compression Devices*, which is available by request at https://www.rkb.us/.*

Background

MCCDs are automated cardiopulmonary resuscitation (CPR) machines that use either a mechanical piston or load-distributing band (LDB) to apply compressions to a patient's chest. MCCDs are intended to be used as an adjunct to CPR as they take over the chest compressions for the emergency responder. CPR—manual and automated—is unlikely to restart the heart, but rather its purpose is to maintain a flow of oxygenated blood to vital organs, thereby extending the window of opportunity for successful resuscitation. Inconsistent compressions along with rescuer fatigue and interruptions for patient movement limit the effectiveness of manual CPR.

Assessment

A focus group of eight emergency response practitioners within the emergency medical services and firefighting communities met in December 2008 to identify equipment selection criteria, evaluation criteria, and assessment scenarios. Based on focus group recommendations and market survey research, three MCCDs were selected for assessment:

- ZOLL AutoPulse®
- Michigan Instruments Life-Stat™
- Brunswick Biomedical HEARTSAVER100.

Six emergency response practitioners served as assessment evaluators, and the evaluators were divided into three teams of two for the assessment. Each team moved a prone mannequin to a spine board and began operation of the assigned MCCD. The teams then transferred the mannequin to a gurney with the MCCD functioning. Once the mannequin was secured on the gurney, the team members loaded the mannequin into an ambulance and continued operation of the MCCD inside the ambulance.

Assessment Results

Evaluators rated the MCCD based on the evaluation criteria established by the MCCD focus group. Each original criterion was assigned to one of the five SAVER categories, and each SAVER category was assigned a weighting factor to indicate its impact on the total composite score. The SAVER category and composite scores are shown in table 1. Higher scores indicate better performance. To view how each MCCD scored against the individual

evaluation criteria assigned to the SAVER Program categories, see table 2 (on page 5).

The following paragraphs provide a brief summary of the evaluator comments and feedback on each MCCD and present the devices from the highest to lowest composite score. For the purposes of this SAVER Summary, the category scores are normalized and rounded to the nearest whole number. The complete assessment report includes a breakdown of evaluator comments by individual criterion.

AutoPulse

The AutoPulse received the highest composite score while receiving the highest scores in the usability and deployability categories. Evaluators reported that the AutoPulse is user-friendly and the evaluators step-by-step informational display screen makes the MCCD simple and intuitive to operate. They stated that the AutoPulse has no patient limitations that would significantly limit its use in local jurisdictions. The evaluators noted that the load distributing band (LDB) remains secure and the light weight of the AutoPulse allows the user to easily move the device without interrupting its operation. Evaluators commented that the AutoPulse battery is easy to change and it is mechanically keyed so that it can only be inserted in one orientation. The evaluators commented that the two-bay battery charger allows for convenient storage of an extra battery. They also stated that the battery can be quickly changed in approximately 10 seconds with minimal loss of compressions. The evaluators stated that the AutoPulse can be quickly set up and put into operation. They noted that the AutoPulse self-adjusts to the patient's chest size, requiring little or no

Pros

- User-friendly
- Audible alarms for manual ventilation and low battery
- Long battery life
- Large LCD screen
- Easy battery swap
- Requires minimal training
- Pressure distributed equally with LDB
- Rugged construction
- Thorough manual with illustrations
- Easy to adjust LDB
- Good patient accessibility

Cons

- Does not provide ventilation
- Expendable items
- Narrow temperature operating range
- Clothing can get caught in LDB

AutoPulse — **Composite Assessment Score: 83**

SAVER Program Category Definitions

Affordability: This category groups criteria related to life-cycle costs of a piece of equipment or system.

Capability: This category groups criteria related to the power, capacity, or features available for a piece of equipment or system to perform or assist the responder in performing one or more responder-relevant tasks.

Deployability: This category groups criteria related to the movement, installation, or implementation of a piece of equipment or system by responders at the site of its intended use.

Maintainability: This category groups criteria related to the maintenance and restoration of a piece of equipment or system to operational conditions by responders.

Usability: This category groups criteria related to the quality of the responders' experience with the operational employment of a piece of equipment or system. This includes the relative ease of use, efficiency, and overall satisfaction of the responders with the equipment or system.

Table 1. MCCDs Assessment Results[1]

MCCD System	Composite Score	Affordability (15% Weighting)	Capability (25% Weighting)	Deployability (15% Weighting)	Maintainability (10% Weighting)	Usability (35% Weighting)
AutoPulse	**83**	63	75	88	83	95
Life-Stat	**82**	75	77	83	83	87
HEARTSAVER100	**50**	25	40	65	52	60

Note:

[1] Scores contained in the assessment report may be displayed differently. For the purposes of the SAVER Summary, all SAVER category scores are normalized using a 100-point scale and rounded to the nearest whole number.

adjustments from the responder. The evaluators also agreed that the AutoPulse appears durable enough for repeated use by emergency responders.

Evaluators noted disadvantages to using the AutoPulse. For example, they stated that the patient's clothing can get caught in the LDB if it is not removed properly. They also reported that the operating temperature range for the AutoPulse is listed as 32° to 104°F. Although the evaluators agreed that the high temperature range would not limit its use in their jurisdictions, they noted that use of the device would be limited in colder climates.

Life-Stat

The Life-Stat received the second highest composite score while receiving the highest scores in the capability and affordability categories. The evaluators agreed that the Life-Stat is simple and intuitive to operate. They noted that the Life-Stat's controls are easy for the evaluators to see and access. The evaluators noted that the ability to move the Life-Stat's arm allows sufficient access to the patient for administering drugs or additional treatment. The evaluators commented that the MCCD has no patient limitations that would significantly limit its use in their jurisdictions. They stated that the Life-Stat requires a medical grade oxygen (O_2) source capable of delivering pressure from 50 to 90 pounds per square inch (psi), with a minimum flow rate of 45 liters per minute (LPM). The evaluators noted that the operating time of the Life-Stat is dependent upon the size of the O_2 bottle being used. They reported that the manufacturer recommends shift checks, functional checks, and factory service based on heavy, frequent, or infrequent use of the Life-Stat. Following the initial setup and orientation, the evaluators agreed that the Life-Stat can be quickly set up and ready for operation. The evaluators stated that the Life-Stat allows for quick transfer from manual CPR to mechanical CPR with minimal compression interruption.

Disadvantages to the Life-Stat included the provided BackBoard. The evaluators commented that the BackBoard might not provide enough stability for evacuating patients from a remote location where a wheeled gurney or other similar equipment cannot be used. The estimated operating time using the O_2 provided is approximately eight minutes. The evaluators agreed that the Life-Stat uses a considerable amount of O_2 and would require a considerable amount of onboard O_2 or additional O_2 cylinders to be stored on the response vehicle.

HEARTSAVER100

The HEARTSAVER100 received the lowest composite score. The evaluators commented that the HEARTSAVER100's controls are easy to access depending on the position of the operator and that the MCCD allows sufficient access for drug administration and patient treatment. The evaluators also noted that the HEARTSAVER100 can be easily moved without disrupting its operation. The evaluators estimated the operating time using the included O_2 pack is approximately 15 minutes. They noted that the HEARTSAVER100 is capable of being

Pros

- Durable, rugged construction
- Easy to adjust
- Quick transfer from manual CPR to mechanical CPR
- Accommodates a wide variety of patient sizes
- Provides ventilations
- Back-up battery
- Good warranty
- Easy to clean
- O_2 wall adapter
- Thorough manual

Cons

- Bulky
- Restraint straps do not secure patient well
- Stability of Life-Stat BackBoard
- Compression control depth must be returned to "off" position
- Difficult to store depending on response vehicle size

Life-Stat — **Composite Assessment Score: 82**

Pros

- Lightweight
- Easy-to-read controls
- Power supply hot swap without interruption
- No batteries required
- Provides ventilation
- Customizable, built-to-order hoses available

Cons

- Complicated initial setup
- No wall hookup
- Possible pinch points
- Slippage on patient
- Poorly constructed
- Little/no explanation of parts
- No attachment for spine board
- Illustrations blurry in manual
- Difficult to use in narrow spaces
- Limited compression pressure

HEARTSAVER100 — **Composite Assessment Score: 50**

connected to on-board O_2 sources, and that this would prevent the necessity for storing an unreasonable amount of extra supplies on the response vehicle. Evaluators stated that the HEARTSAVER100 can be compactly stored in the provided bag after removing the arch assembly from the backboard and the device, allowing quick and easy access when stored on a response vehicle.

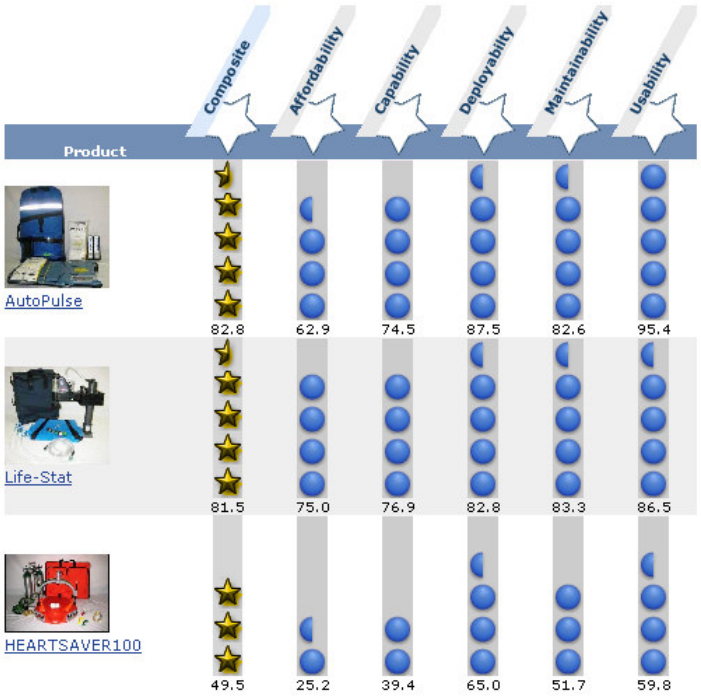
Evaluators noted several disadvantages to using the HEARTSAVER100. They stated that the device is difficult to assemble and apply to the patient initially, but it is easier to operate after repeated operation. The evaluators also noted that the included manual provides few instructions for operating the device. Evaluators explained that a patient's arms are required to be positioned outside of the HEARTSAVER100's arch assembly and that the design of the compressor arch will prevent some larger patients from being able to fit inside the unit. They agreed that this makes it difficult to maneuver the device and patient through narrow entrances or hallways. The evaluators stated that it appears that the HEARTSAVER100 could not withstand repeated use by emergency responders and that multiple pieces of the device could be broken off during use.

Conclusion

This assessment helped achieve the overall goal of evaluating the effectiveness of MCCDs used by emergency responders. The assessment goal was achieved by utilizing and evaluating the selected MCCDs in scenario-driven exercises. Overall, the ZOLL AutoPulse scored the highest, followed by the Michigan Instruments Life-Stat. The Brunswick Biomedical HEARTSAVER100 received the lowest overall product score. Analysis of the evaluators' scoring and comments revealed these common conclusions:

- The ability to rapidly transfer between manual and mechanical CPR is a key factor in overall user satisfaction. Evaluators expressed a strong preference for the MCCD models that allowed quick initiation of mechanical CPR but also allowed them to immediately return to manual CPR, if necessary.
- Prompt deployability and simple intuitive operation are crucial MCCD characteristics. Evaluators preferred MCCDs that required minimal additional training for qualified users to be familiar enough with the MCCDs to quickly deploy, set up, and operate each unit.
- Rugged construction and durability are essential for any MCCD to be used by emergency responders. MCCDs that demonstrated these characteristics during the assessment consistently received high ratings from the evaluators.

QuickLook Snapshot[2]



Notes:

[2] The SAVER QuickLook, available on the SAVER website, allows users to select the SAVER categories that are most important to their department and view results according to their specific needs.

[3] Scores contained in the assessment report may be displayed differently. For purposes of the QuickLook, all SAVER category scores are normalized using a 100-point scale.

All reports in this series as well as reports on other technologies are available by request at https://www.rkb.us/.

Table 2. SAVER Category and Criteria Scores

KEY Least Favorable → Most Favorable			
○ ◔ ◑ ◕ ●	AutoPulse	Life-Stat	HEARTSAVER100
Assessment Criteria			
Affordability			
Useful service life	●	●	○
Maintenance/calibration cost	◕	●	○
Expendable cost	◑	◕	○
Complete package cost	◕	●	◕
Capability			
Patient limitations	●	●	◑
Self-test feature	●	◕	○
Resource consumption	●	◕	◑
Ability to upgrade	◔	◔	○
Power source indicators	●	◕	◑
Deployability			
Quick implementation	●	●	◕
Vehicle storage requirements	●	◕	●
Easy to carry	●	●	◕
Operating conditions	◕	◕	◑
Remote operations	●	◑	◕
Maintainability			
Durability	●	●	◑
Warranty	●	●	●
Cleaning/decontamination requirements	●	●	◑
Calibration requirements	◑	◑	◔
Scheduled maintenance	◑	●	◔
Usability			
Simple to operate	●	●	◕
Patient accessibility	●	●	◑
Unit stability	●	●	◕
Pre-vehicle transport	●	●	●
Manageable size	●	◑	◑
Quick power source change	●	●	◕
Compatible with other devices	●	●	◔