REFERENCE MATERIAL

EFFECTS OF PEEP VALVE ATTACHMENT ON RESUSCITATOR TRAINING DEVICE EOLIFE® X: INVESTIGATING FALSE LEAK DETECTION AND FLOWRATE REDUCTION

AirLife™ received a customer concern regarding a claim that a resuscitator training device, the EOLife® X, indicated a leak was present in an AirLife manual resuscitator. An investigation was launched by the AirLife engineering team to determine why the training device reported a leak in the resuscitator circuit. The engineering team found that the EOLife X uses a flow sensor to calculate the flowrate of air entering and exiting simulated lungs when using a manual resuscitator for training purposes. The addition of a PEEP valve to a manual resuscitator reduces flow rate of air exiting the lungs on exhalation when intrapulmonary pressure is below the PEEP level and internal pressure does not overcome the valve mechanism. It was hypothesized that when used in conjunction with the EOLife X, the reduction in flowrate due to the use of a PEEP valve can result in the EOLife X falsely detecting leaks on exhalation when simulated lungs are at a low intrapulmonary pressure.

Test Methodology: Testing was conducted on several manual resuscitator models from AirLife, Ambu®, and Mercury Medical® on two test lungs. When no PEEP valve attachments were used, the EOLife X did not report any leaks for the AirLife, Ambu, or Mercury Medical manual resuscitators. When PEEP valves were used at 20 cmH_2O of PEEP and intrapulmonary pressure of the test lungs started at approximately 0 cmH_2O, the EOLife X falsely identified leaks for the manual resuscitators. The EOLife X did not report leaks for any other level of PEEP or for the 20 cmH_2O level of PEEP after the first compression of the manual resuscitator. No changes were made to the circuits during testing besides the addition of PEEP valves. Table 1 shows a summary of test results using a Michigan Test Lung.

TABLE 1.

Number of compressions (out of 10) without a reported leak for manual resuscitator trials at varying levels of PEEP on a Michigan Test Lung.

MANUAL RESUSCITATOR	SMALL PATIENT SETTING				MEDIUM PATIENT SETTING				TALL PATIENT SETTING			
PEEP Level (cmH_2O)	5	10	15	20	5	10	15	20	5	10	15	20
Airflow, Diaphragm Valve, Manometer (AirLife)	10	10	10	9	10	10	10	9	10	10	10	9
Airflow, Duckbill Valve, Manometer (AirLife)	10	10	10	9	10	10	10	9	10	10	10	9
Airflow Duckbill Valve, no Manometer (AirLife)	10	10	10	9	10	10	10	9	10	10	10	9
Spur II (Ambu)	10	10	10	10	10	10	10	10	10	10	10	10
Adult CPR-2 Bag (Mercury Medical)	10	10	10	9	10	10	10	9	10	10	10	9

Conclusion: Based on the results of the tests conducted, it was concluded that false reports of leaks by the EOLife X are due to increased differences between inhalation and exhalation volumes when high levels of PEEP are used with low intrapulmonary pressure. The frequency of false reports of leaks using the EOLife X vary between the simulated lung used and results with one testing device may not be representative of use in all situations. The EOLife X was found to be an unreliable method of detecting leaks in a circuit, and it is recommended that the EOLife X not be used as a substitute for leak testing.

False reports of leaks were observed at the 20 cmH_2O level of PEEP for all resuscitators tested except for Ambu's Spur II when using the EOLife X on a simulated lung. Further testing of additional Ambu PEEP valves found that a leak was present which allowed for continuous exhalation as shown in test report TR-0324. This continuous leakage is believed to be the reason the EOLife X did not report a leak for the Spur II at high levels of PEEP as there was little difference between the volume of air inhaled and exhaled by the simulated lung. Figure 1 shows average observed leak rates for various PEEP valves tested.

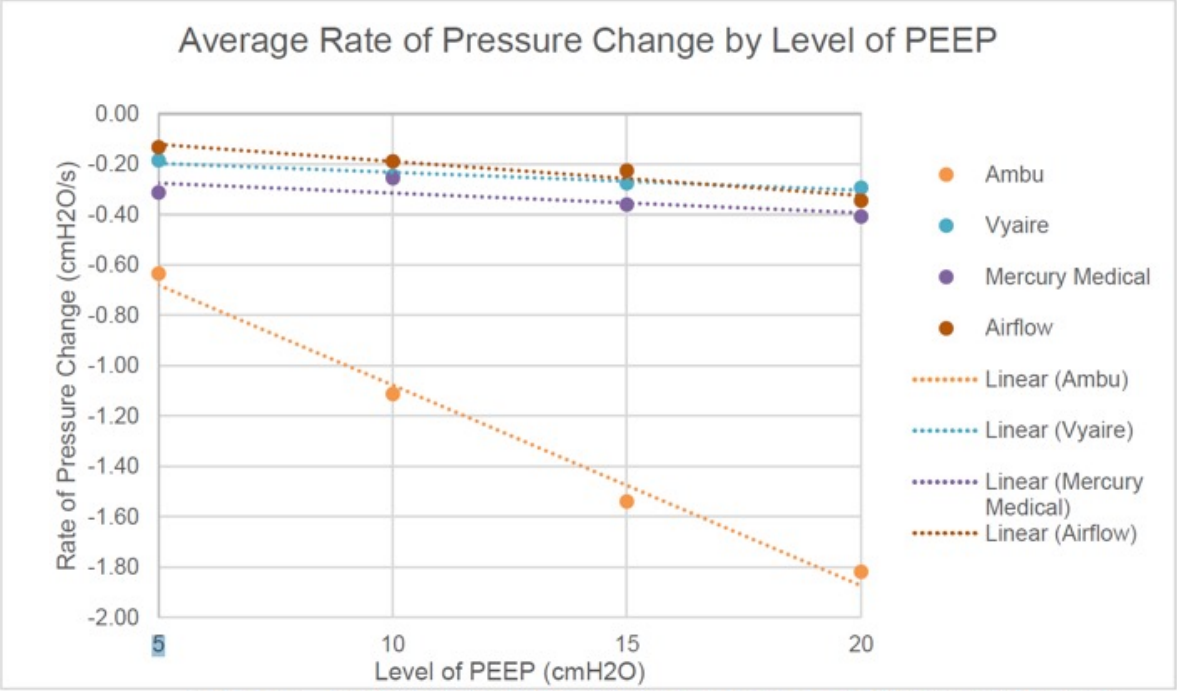

Figure 1. Average rate of pressure change per second for varying levels of PEEP, brand of PEEP valve.