Web-enabled, Transparent Reality Simulation Training Improves Anesthesia Machine Pre-use Check Fault Detection Rate

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http://vam.anest.ufl.edu/simulations/preusecheck.php

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ABSTRACT

Web-enabled, transparent reality simulation training improves anesthesia machine pre-use check fault detection rate.

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Failure to detect faults during the anesthesia machine pre-use check is well documented (1). The anesthesia machine is a very important and complex piece of equipment and undetected faults in it may have catastrophic consequences (2). We evaluated whether a free transparent reality simulation of the 1993 FDA anesthesia machine pre-use check (3) can alter performance.

We planted fault sets A and B (5 faults each, total of 10 unique faults) on an Aestiva anesthesia machine (GE Healthcare). With IRB approval and informed consent, incoming anesthesia residents were randomly divided into two groups. For the pre-intervention assessment, Group 1 (n = 8) conducted the pre-use check with fault set A. Group 1 then used the pre-use check simulation at http://vam.anest.ufl.edu/simulations/preusecheck.php as an on-line self-study tool. At least 24 hours after completing the simulation (to avoid evaluating short-term memory), Group 1 repeated the checkout on the same machine but with fault set B. Group 2 (n = 9) followed the same protocol as Group 1 except that fault set B was used for the pre- and fault set A for the post-intervention in case the fault sets were unbalanced in difficulty of detection. Participants were asked to indicate clearly when they thought a given step had failed. They were not required to identify or fix the faults. To minimize inter-observer variability, all participants were observed by the same researcher.

Results are reported as mean ± standard deviation. It took 78 ± 39 minutes to complete the simulation.

	Faults detected		False positives	
	Pre	Post	Pre	Post
Group 1 (AB)	3.13 ± 0.83	4.63 ± 0.52	1.13 ± 1.13	1.00 ± 0.76
Group 2 (BA)	3.33 ± 1.22	4.11 ± 0.78	0.67 ± 1.00	0.44 ± 0.53
All (1+2)	3.24 ± 1.03	4.35 ± 0.70	0.88 ± 1.05	0.71 ± 0.69

Differences between fault sets were not significant suggesting that the fault sets were balanced (Wilcoxon-Mann-Whitney exact test). The overall fault detection rate was 3.24 out of 5 prior to the simulation. After self-study with the simulation, 4.35 out of 5 faults were detected. Participants also performed the pre-use check in less time (p=.02). Preliminary analysis indicates that the simulation improved fault detection rate in new anesthesia residents (Wilcoxon Signed Rank test, p = 0.01). It seems wise at this time that anesthesia programs should have teaching modules available to help new residents understand the anesthesia machine, or use ours, which is available free at http://vam.anest.ufl.edu. New 2008 ASA recommendations may be considered (4).

1. Anesthesia & Analgesia, 104:154-6, 2007
2. Anesthesiology; 102:257-68, 2005.
3. Anesthesiology; 105:A934, 2006.
4. APSF Newsletter; 23: 6-7, 2008.

BACKGROUND

We conducted a study to evaluate whether a free anesthesia machine pre-use check simulation from the Virtual Anesthesia Machine web site at the University of Florida, when used as a self-study tool, is able to enhance anesthesia machine fault detection rate.

METHODS

We planted two unique fault sets, A and B, with five faults each on an anesthesia machine (Aestiva, GE Healthcare, Madison, WI, USA). With IRB approval and informed consent, incoming anesthesia residents were randomly divided into two groups. For the pre-intervention assessment, Group 1 (n = 8) conducted the pre-use check with fault set A. Group 1 then used the pre-use check simulation as an on-line self-study tool. At least 24 hours after completing the simulation (to avoid evaluating short-term memory), Group 1 repeated the checkout on the same machine, but loaded with fault set B. Group 2 (n = 9) followed the same protocol as Group 1, except that fault set B was used for the pre-intervention, and fault set A was used for the post-intervention in case the fault sets were unbalanced in difficulty. Participants were asked to indicate clearly when they thought a given step had failed; they were not required to identify or fix the faults. To minimize inter-observer variability, all participants were observed by the same researcher.

RESULTS

Differences between fault sets were not significant, suggesting that the fault sets were balanced with respect to difficulty (Wilcoxon-Mann-Whitney exact test). We therefore aggregated data from all participants and found that training for the pre-use check with a web-enabled transparent reality simulation improved the number of faults detected in new anesthesia residents (Wilcoxon Signed Rank test, p = .01). The overall fault detection rate was 3.24 out of 5 prior to the simulation. After self-study with the simulation, 4.35 out of 5 faults were detected. Participants also performed the pre-use check in less time on the post-test (p = .02) and there was a significant improvement in the time per fault ratio, 3.85 vs. 6.38 minutes/true fault detected.

Table 1. True Faults and False Positive Faults Detected by Group

	Faults Detected					False Positives				
	Group 1 (AB)		Group 2 (BA)			Group 1 (AB)		Group 2 (BA)		
	Mean (SD)	Median	Mean (SD)	Median	*p*	Mean (SD)	Median	Mean (SD)	Median	*p*
Pre-web simulation training	3.13 (.83)	3.00	3.33 (1.22)	3.00	0.82	1.13 (1.13)	1.00	.67 (1.00)	0.00	0.39
Post-web simulation training	4.63 (.52)	5.00	411 (.78)	4.00	0.22	1.00 (0.76)	1.00	.44 (0.53)	0.00	0.16

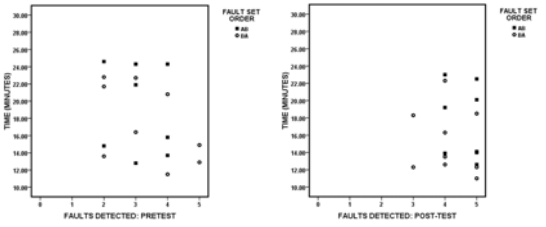
p-values are Wilcoxon exact tests for Group differences

Table 2. True Fault Detection Rate

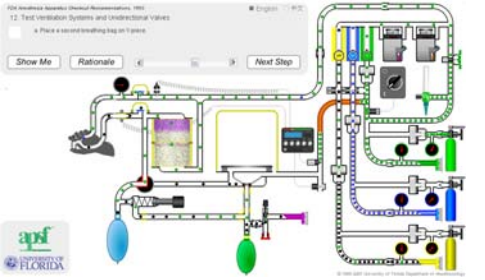
Fault Set	Overall	As Pre-test	As Post-test
A			
1. Faulty SIMR (Exhalation port leak)	0.24	0.00	0.24
2. Loose vaporizer filler cap	0.82	0.62	1.00
3. CO_2 absorbent wrappers left on	0.89	0.88	1.00
4. Cut on breathing circuit hose	0.82	0.75	0.89
5. Scavenging manifold red cap missing	0.72	0.75	0.78
B			
1. Missing inspiratory valve leaflet	1.00	1.00	1.00
2. Vaporizer O-ring missing (Iso)	0.71	0.56	0.88
3. CO_2 absorbent missing (only the top one)	0.71	0.56	0.88
4. Low oxygen cylinder pressure (600-700 psi)	1.00	1.00	1.00
5. Occluded scav pos press relief valve	0.53	0.22	0.88

SIMR = Self inflating manual resuscitator; Scav pos press = scavenger positive pressure

Figure 1. True faults detected by time for pre-intervention and post-intervention by group (fault set order).



A screenshot for of the pre-use check simulation for step 12a of the 1993 FDA pre-use check



CONCLUSIONS

Our data indicate that, when used as a self-study tool, the online simulation improved both fault detection rate (3.24 vs 4.35 faults detected) and the time per fault ratio in new anesthesia residents

REFERENCES

1. Anesthesia & Analgesia, 104:154-6, 2007
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