Can J Anesth/J Can Anesth (2012) 59:280–287
DOI 10.1007/s12630-011-9649-5

REPORTS OF ORIGINAL INVESTIGATIONS

An experiential teaching session on the anesthesia machine check improves resident performance

Une session expérientielle d'enseignement sur la vérification d'une machine d'anesthésie améliore les performances des résidents

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Received: 7 February 2011 / Accepted: 30 November 2011 / Published online: 23 December 2011

Abstract

Purpose *A preoperative machine check is imperative, yet machine faults are missed despite experience. We hypothesized that a simulation training session would improve junior residents' ability to perform a machine check beyond the level of final year residents who received only didactic training.*

Methods *In 2005, an experiential machine check training session was introduced into residency training at the postgraduate year 1 (PGY-1) level. Three weeks later, the simulation residents were asked to perform a machine check and detect ten preset faults. The control group consisted of PGY-5 residents who had received a didactic anesthesia machine lecture during their residency; these control residents were asked to perform the same machine check as the simulation residents. Data were collected from 2005 to 2008 with each cohort of incoming PGY-1 residents and graduating PGY-5 residents. When the first group of PGY-1 residents became PGY-5 residents in 2009, they were invited to return for a retention test. In all tests, the number of faults detected was recorded, and the machine check was evaluated using a checklist.*

Results *Thirty-seven simulation residents and 27 control residents participated in the study. Simulation residents had significantly higher checklist scores than the control residents, and they identified more machine faults (both $P < 0.001$). Twenty-one simulation residents repeated the study in their senior year, and they continued to achieve higher checklist scores and identify more machine faults than the control residents (both $P < 0.001$).*

Conclusion *Our results suggest that an experiential training session allowed junior residents to achieve skills superior to those of senior colleagues after a five-year residency. This training was retained for two to four years as they continued to outperform their comparative controls.*

Résumé

Objectif *La vérification préopératoire d'une machine est impératif, toutefois des pannes de l'appareil ne sont pas détectées en dépit de l'expérience. Nous avons émis l'hypothèse qu'une session de formation sous forme de simulation pouvait améliorer la capacité des résidents juniors à effectuer une vérification de la machine avec un meilleur résultat qu'un résident de dernière année n'ayant reçu qu'une formation didactique.*

Méthodes *En 2005, une session de formation expérientielle de vérification de machines a été introduite dans le programme de la première année de résidence (PGY-1). Trois semaines plus tard, il a été demandé aux résidents ayant suivi la simulation d'effectuer une vérification de la machine et détecter dix pannes préétablies. Le groupe témoin comportait des résidents PGY-5 qui avaient suivi un cours didactique sur la machine d'anesthésie pendant leur résidence; ces résidents « témoins » ont été invités à faire la même vérification de la machine que les résidents ayant suivi la simulation. Les données ont été collectées de 2005 à 2008 auprès de chaque cohorte de nouveaux résidents PGY-1 et de résidents PGY-5 finissants. Quand le premier groupe de résidents PGY-1 est devenu PGY-5 en 2009, ceux-ci ont été invités à revenir pour un test de rétention. Le nombre de pannes détectées au cours de chaque test a*

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été consigné et la vérification de la machine a été évaluée en s'aidant d'une liste de contrôle.

Résultats *Trente-sept résidents ont participé à la simulation et 27 résidents ont participé au groupe témoin de cette étude. Les résidents du groupe simulation ont eu des résultats significativement meilleurs d'après la liste de contrôle que les résidents témoins et ont identifié davantage de pannes de la machine (dans les deux cas, P < 0,001). Vingt et un résidents du groupe simulation ont répété l'étude au cours de leur dernière année et ils ont continué à obtenir de meilleurs résultats sur la liste de contrôle et à identifier davantage de pannes de la machine que les résidents témoins (dans les deux cas P < 0,001).*

Conclusion *Nos résultats suggèrent qu'une session expérientielle de formation a permis à de jeunes résidents d'acquérir des compétences supérieures à celles de leurs collègues séniors au terme d'une résidence de cinq ans. L'effet de cette formation s'est maintenu de deux à quatre ans puisqu'ils ont continué à avoir de meilleurs résultats que les membres du groupe de comparaison.*

In the event of an anesthesia machine malfunction, anesthesiologists must troubleshoot and, ideally, rectify the problem. Catchpole *et al.*[1] reviewed 12,606 reported incidents from the United Kingdom National Reporting and Learning Service and found a 13% incidence of problems involving medical devices associated with anesthesia patient care. Webb *et al.*[2] reported a 9% incidence of "pure equipment failure" in their review of 2,000 incidents reported to the Australian Incident Monitoring Study. Sixty percent of these 177 cases were related directly to anesthetic equipment failure, and 55% were deemed to have "potentially life-threatening consequences".[2]

As equipment faults and failures can occur, it is intuitively important to perform a preoperative anesthesia machine check, yet machine faults are still missed regardless of anesthesia experience. Buffington *et al.*[3] asked 179 volunteers to check an anesthesia machine preset with five faults; only 3.4% found all five errors, and an astounding 7.3% detected no faults at all. Larson *et al.*[4] found an inverse relationship between the number of years of anesthesia experience and the number of preset anesthesia machine faults detected by those providers.

The introduction of anesthesia machine checklists by the United States Food and Drug Administration (FDA) and the Association of Anaesthetists of Great Britain and Ireland over the last two decades has not enhanced anesthesiologists' recognition of anesthesia equipment faults.[5,6] In addition, few studies have been conducted to evaluate how best to teach trainees to perform a proper anesthesia machine check.[7,8]

The purpose of this study was to determine if 1) an experiential training session would improve junior (postgraduate year 1 or PGY-1) anesthesiology residents' ability to perform a thorough machine check and correctly identify preset faults beyond the level of final year (PGY-5) residents who had received only a didactic training session; and 2) to determine if the junior residents' ability would be retained over time until their senior (PGY-3 to PGY-5) year.

Methods

This study was approved by The Ottawa Hospital Research Ethics Board. Written informed consent was obtained from all participants prior to their participation in the study. In 2005, an experiential training session was designed to teach residents how to perform an anesthesia machine check and detect anesthesia machine faults. This experiential training session was introduced into the residency training program at the PGY-1 level (the residents received the training at the beginning of their two-month anesthesia rotation, which occurs at the end of their first year of residency). The control group included PGY-5 residents who received a traditional didactic lecture on the anesthesia machine as part of the Anesthesia Equipment core program series, which is delivered on a three-year cycle (thus, the control residents would have received this lecture as a PGY-2, 3, or 4). Data were collected prospectively from 2005 to 2008 with each incoming group of PGY-1 residents and graduating PGY-5 residents. When the original group of PGY-1 residents became PGY-5 residents in 2009, they were invited to return for a retention test.

At the end of their first year of training, all simulation residents were also given a didactic lecture on the anesthesia machine; the lecture was identical to the lecture given to control residents, and it was delivered by the same faculty as part of the Anesthesia Equipment core program. This lecture was followed by an experiential hands-on training session on the anesthesia machine, which consisted of a brief presentation on the anesthesia machine followed by a demonstration of a full machine check using a 45-item modified FDA checklist[9] (Appendix 1). The FDA checklist was customized to fit the GE Datex-Ohmeda Aestiva 5 gas machine (GE Healthcare, Madison, WI, USA) using the checkout procedures recommended in the GE Datex-Ohmeda manuals.[A] This modified checklist was comparable with the GE Datex-Ohmeda Aestiva checklist on the University of Florida's Virtual Anesthesia Machine website[9] (http://vam.anest.ufl.edu/). The 120-min experiential

[A] Datex-Ohmeda. Preoperative Checklist and Appendix – Preoperative Tests. *In*: Datex-Ohmeda Aestiva Operation Manual Part 1. 2000: 4-1 – 4-4, A-1 – A-22.

training session started with a 30-min overview on the operation of the gas machine with diagrams and demonstrations on an actual gas machine. The next 60 min were spent reviewing each step of the checkout procedure. During this time, the specific faults were not shown, but problems that could be encountered at each step of the checkout were discussed. The residents were encouraged to ask questions and interact. In the final 30 min, the checkout was repeated in an orderly fashion to show how the machine flowed and came together logically. There was no debriefing or evaluation at this initial session; however, the residents were given the opportunity to perform a machine check under direct supervision with feedback.

Three weeks later (post-test), the simulation residents returned for assessment. The residents were asked to detect as many machine faults as possible (the number of preset faults was not mentioned), and the number of faults detected was recorded. The ten preset faults are listed in Appendix 2. All machine faults were corrected, and the residents were then asked to perform a complete anesthesia machine check. Each resident's score on the 45-item checklist was recorded, as was the time each resident took to perform a complete machine check. The missed faults were revealed to the resident after the test session, and the importance of detecting the faults was emphasized. The resident was also shown the steps that were missed in the checklist and how to perform them. The resident's scores for both the machine faults and the machine check were evaluated in real time by a single attending anesthesiologist. Residents were invited to repeat both tests in their senior year (PGY-3 or higher) of residency (retention test).

The control residents were asked to find the same ten preset faults and complete a machine check at the end of their training (control test). The number of faults detected, the time taken for the machine check, and the score on the 45-item modified checklist were scored in real time by a single attending anesthesiologist.

Statistics

Simulation post-test, simulation retention test, and control tests were compared using an analysis of variance (ANOVA) for parametric data with a Tukey *post hoc* analysis for significant findings. Non-parametric data were compared using the Kruskal-Wallis test. Differences were considered significant at $P < 0.05$.

Results

Forty-two PGY-1 residents were approached and 37 participated in the study. Forty-three PGY-5 residents were approached and 27 participated in the study. Twenty-one residents of the original 37 PGY-1 residents who participated returned for the retention test. Table 1 describes the groups, the time of training during their residency, and the type of training they received.

Junior simulation residents identified more preset machine faults than senior control residents ($P < 0.001$) in their post-test (Table 2). Junior simulation residents also achieved significantly higher checklist scores than senior control residents with no experiential training ($P < 0.001$). Twenty-one of the simulation residents repeated the study in their senior year, and they continued to achieve higher checklist scores and identify more machine faults than senior control residents who did not receive experiential training ($P < 0.001$) (Figure; Table 3). The senior control residents took less time to check the machine than either the junior simulation or senior simulation residents ($P < 0.001$).

Table 1 Description of study groups and training received

Group	PGY level	Timing of Training	Type of Training
Simulation	One	End of PGY-1 year	• Traditional didactic lecture • New Experiential teaching session
Control	Five	Didactic lecture given on a 3-yr cycle. Individual residents received lecture as a PGY-2, 3, or 4.	• Traditional didactic lecture • Informal operating room teaching

PGY = postgraduate year of training

Table 2 Summary of results for senior control, junior simulation, and senior simulation residents

Group	Machine faults detected (maximum score = 10)	Checklist score (maximum score = 45)	Time taken to check machine (sec)
Senior control	6.4 (1.6)	24.4 (6.8)	366 (105)
Junior simulation	8.0 (1.5)*	37.7 (5.9)*	554 (97)*
Senior simulation	8.8 (0.9)*	32.8 (4.8)*	490 (120)*

Data are expressed as mean (standard deviation). *$P < 0.001$ compared with senior controls

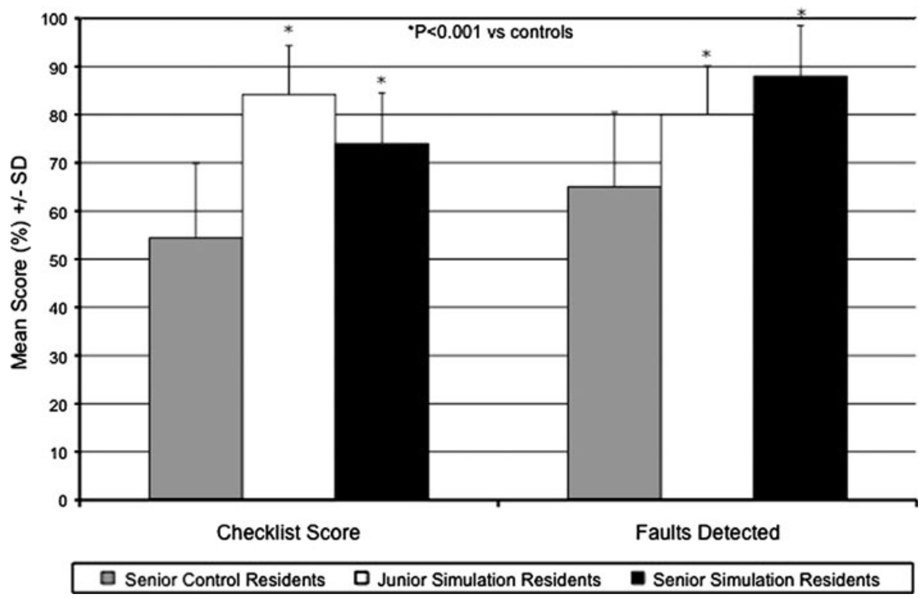

Figure Mean checklist score and number of machine faults detected expressed as a percentage (standard deviation) for senior control and junior and senior simulation residents

Discussion

This study showed that junior anesthesiology residents who received a focused experiential training session on the pre-use check of the anesthesia machine were significantly better able than senior anesthesiology residents without experiential training to detect preset machine faults and perform a thorough machine check.

Olympio *et al*. have studied the effect of a teaching intervention on the performance of residents managing checkout procedures on the anesthesia machine.[8] Residents in the control group were videotaped performing an anesthesia machine check twice before their videos were reviewed with them. Residents in the test group were also videotaped twice, but they received an instructional review of their videotaped performance between assessments. The performances of both groups were evaluated using an institutional anesthesia machine checklist. The test residents (81% criteria checked) significantly outperformed the control residents (63% criteria checked). Similarly, in our study, the junior simulation residents checked 84% of the checklist items while the senior control residents checked only 54% of the items. Clearly, intensive training correlates with improved performance.

Of greater interest is our finding that simulation residents continued to outperform control residents when retested in their senior year of training (two to four years after receiving the teaching session). Initially, their performance may have been due to the proximity of their training session to their assessment session. However, simulation residents who repeated the study in their senior year continued to outperform the control residents on the checklist. The attrition in their repeated scores likely attests to the need for a review partway through resident training. The optimal interval between initial and refresher training is uncertain and cannot be determined from this study.

In keeping with the trends seen in the checklist scores, the junior simulation residents detected more preset machine faults (80% detected) than the control residents (64% detected). In most cases, machine faults were not detected because that specific step of the checkout procedure was not performed (i.e., forgotten by the resident). Unlike the decline in checklist scores, the number of machine faults detected by the simulation residents increased by 8% in their senior year when they repeated the study. We would have expected their performance to show attrition due to need for refresher training. One explanation for this increase is that the simulation residents may have remembered the preset machine faults, although this is unlikely given the prolonged interval between testing. Another explanation is that detecting machine faults is a practical skill that may be better performed than recalling the fine points of a detailed checklist. The fact that the simulation residents were tested on the machine faults three weeks after receiving the teaching session and tested again in their senior year could also have contributed to their superior performance. This viewpoint is supported by the work of Karpicke and Roediger,[10] who showed that students' retrieval of knowledge under repeated test conditions significantly improved their knowledge retention compared with knowledge retrieval that involved studying without testing. In our study, it is possible that retrieval contributed towards the simulation residents' learning and boosted their performance in their senior year.

A potential criticism of our study is that we did not test the junior residents on their knowledge of the anesthesia

Table 3 Summary of checklist items performed correctly and machine faults detected correctly in each group

Assessment Tool	Item Number	% Correct Senior Control	% Correct Junior Simulation	% Correct Senior Simulation
Machine Checklist	1	60	92	62
	2	16	86	24
	3	20	80	76
	4	72	97	90
	5	92	97	95
	6	84	97	95
	7	28	64	14
	8	20	78	62
	9	76	94	86
	10	96	97	100
	11	40	94	90
	12	60	94	90
	13	44	94	90
	14	80	97	100
	15	80	97	100
	16	64	89	90
	17	88	97	100
	18	60	94	81
	19	56	92	100
	20	80	86	86
	21	44	83	90
	22	36	67	9
	23	76	83	90
	24	44	89	76
	25	32	81	57
	26	40	92	86
	27	36	86	45
	28	92	97	95
	29	56	67	52
	30	68	89	95
	31	88	86	95
	32	72	86	81
	33	20	64	33
	34	52	67	52
	35	8	50	19
	36	8	47	24
	37	48	92	95
	38	8	53	29
	39	6	81	81
	40	24	64	33
	41	56	94	76
	42	96	94	100
	43	88	92	90
	44	52	78	87
	45	24	67	52
Machine Faults	1	96	100	100
	2	89	97	100
	3	30	62	62
	4	30	81	57
	5	96	95	100
	6	67	70	95
	7	41	59	95
	8	59	68	86
	9	48	81	86
	10	85	89	95

The machine checklist items are described in Appendix 1 and the machine faults are listed in Appendix 2

machine check before they received their experiential teaching session. Thus, one could speculate that the junior residents may have possessed a superior level of knowledge of the anesthesia machine before receiving the teaching intervention. However, this was an unlikely possibility given that these residents were at the beginning of their anesthesia training.

Others[11] have specified that it is essential to clinician use and acceptance to have a concise anesthesia machine checklist which can be completed easily and in a short time period. Time, however, is not an accurate assessment of the completeness of a machine check. In our study, although the simulation residents took more time to check the machine, the machine check was more thorough than that of the control residents.

We used a checklist tailored to the specific anesthesia machine used in our institution. There is no universally accepted definition of an ideal anesthesia machine checklist. The Canadian Anesthesiologists' Society *Guidelines to the Practice of Anesthesia - Pre-anesthetic Checklist* consists of 46 items, 34 of which are specific to the anesthesia machine. Several of the 34 items have two steps combined into one (e.g., "Check unidirectional valves and soda lime").[12] The difference in the length of various checklists is due to the inclusion of "extra" items, for instance, our checklist includes a low pressure system check. Further support for the use of a tailored machine-specific checklist comes from the American Society of Anesthesiologists who recently condensed the 54-step *1993 FDA Anesthesia Machine Pre-Use Check* into a 14-item guideline that serves as a template for the development of an institution-specific anesthesia machine checklist.[9]

There are several limitations to our study. Resident assessment was not blinded. We considered videotaping the residents, but we ultimately considered that a static camera angle would not capture the nuances of their check given our clinical observations of how frequently residents would circle a machine during their checkout procedure. Also, with a well-designed checklist, there should be no ambiguity as to whether a task was performed. Just over half of the residents repeated the study in their senior year, and perhaps these residents self-selected themselves into a group that was particularly knowledgeable about the anesthesia machine. It could be argued that simulation residents did better because they received additional teaching; however, during their residency training, the control residents undoubtedly would have received additional informal teaching in the operating room on the anesthesia machine.

Proponents of simulation-centre education cite the many advantages of learning in a simulated environment,[13–15] including 1) repetitive and deliberate practice of skills with opportunities for learner feedback; 2) opportunity to learn on an individualized basis with individualized feedback (learner centred); 3) opportunity to learn in the clinical context (contextual learning); 4) learning that is no longer restricted to “chance” clinical encounters; and 5) opportunity to learn skills in a controlled environment without harm to patients. Simulation residents in our study likely benefited from many of the above advantages. The focus of many studies in the simulator has been on the improved acquisition of skills, and studies examining skill retention have followed learners for only one[16] to 14[17] months after the educational intervention. In our view, the retention of knowledge and skills shown by the simulation residents in this study (up to four years) is beyond that reported previously in the literature.

Despite studies showing poor performance on the anesthesia machine check both in clinical practice[4,18] and in a simulation environment,[7,19] few studies have assessed the effectiveness of teaching the anesthesia machine check to residents. Our results suggest that a brief experiential training session associated with a boost from repeated testing made even the most junior residents achieve results superior to senior colleagues after a five-year residency. Although there was some attrition in their performance, the residents retained most of their skills for up to four years as they continued to outperform compared with controls.

Acknowledgements The authors acknowledge the support of the Department of Anesthesiology, University of Ottawa. We also thank Ms. Emily Hladkowicz BA for her assistance in data management (summer research student, University of Ottawa, Ottawa, ON, Canada).

This study was supported by internal funding from the Department of Anesthesiology at the University of Ottawa. We have no commercial or non-commercial affiliations to disclose.

Competing interests None declared.

Appendix 1 Modified Food and Drug Administration (FDA) Checklist customized for the GE Datex-Ohmeda Aestiva 5 Gas Machine

Initial Steps

Quick visual check for:

1. Obvious damage / Missing components / BioMed notice of Return-to-Service / System master switch OFF
2. Electrical power cord plugged into receptacle with generator backup

Back-up ventilation equipment

3. Self-inflating resuscitation bag and O_2 source checked

High-Pressure System

Check central pipeline supplies

4. Hoses are connected correctly / Pipeline gauges read 50-55 pounds per square inch (psi)
5. Disconnect O_2 pipeline

Check O_2 reserve cylinder supply

6. Bleed O_2 cylinder pressure to zero with O_2 flush (O_2 pipeline disconnected) / Open O_2 cylinder and verify at least half full (approx. 1,000 psi) / Listen - no audible leak
7. Open and close O_2 flowmeter - no flow seen
8. Close cylinder - pressure gauge drops less than 100 psi over next five minutes

Low-pressure System

Check vapourizer installation

9. Tops of vapourizers are parallel to manifold - cannot be lifted from manifold / Vapourizers are full and fill ports are closed / Verify all vapourizers OFF

Perform low-pressure leak test

10. Do leak test with “suction bulb” device on auxiliary (fresh) gas outlet - Verify bulb stays collapsed for > 10 sec

11.–13. Repeat leak test for each flowmeter

14.–15. Repeat leak test for each vapourizer, one at a time - setting dial to 1%

16. Check vapourizer interlock mechanism – other vapourizers cannot be turned ON
17. Verify all vapourizers OFF, auxiliary gas outlet closed

Verify Electrical Power and Oxygen Supply Failure Alarm

18. Unplug machine power from electrical receptacle - Turn ON master switch / Verify "Backup Battery Power" message, plug in power cord and message disappears
19. Turn ON vital signs monitor to "warm up" gas analyzer
20. Verify O_2 supply failure alarm functions - Note distinctive auditory pattern of alarm and visual message on ventilator / Turn ON O_2 cylinder to silence alarm
21. Remove O_2 sensor (fuel cell) from circuit

Test flowmeters

22. Minimum O_2 flows are 25 $mL \cdot min^{-1}$ and 0 $mL \cdot min^{-1}$ for other gases
23. Flow tubes are undamaged; floats move smoothly throughout their full range
24. Check N_2O:O_2 proportioner - O_2 and N_2O flow controls cannot supply hypoxic flow rates / Turning vapourizer ON does not lower gas flow (Then verify vapourizer OFF)
25. Check O_2 "Fail-Safe" - Set all three floats to mid-range - close O_2 cylinder - push O_2 flush / As O_2 supply failure alarm sounds, N_2O float drops slightly before O_2 while Air continues / Close all three gas flow controls and reconnect O_2 pipeline - verify pipeline pressure

Breathing System

Calibrate O_2 monitor

26. Ensure monitor reads 21% with sensor in room air
27. Verify low O_2 alarm enabled by breathing on sensor through your surgical mask / Reinstall sensor in circuit - flush breathing system with O_2 until monitor reads $> 95\%$

Check initial status of breathing system

28. Set selector switch to "Bag/APL" / Set all flows to zero (or minimum) / Check circuit complete, undamaged, unobstructed - Attach gas sampling line to circuit
29. Verify CO_2 absorbent is adequate – colour, quantity

Check function of unidirectional valves

30. Attach a spare breathing bag to the inspiratory outlet of the absorber and close APL valve completely / Fill bag with O_2 flush until pressure gauge reads 35 cmH_2O / pressure should hold in both test bag and reservoir bag (both valves competent; - if reservoir bag slowly deflates – expiratory valve leaks; verify leak in expiratory valve with low-pressure "suction bulb" device) / Open APL valve – pressure holds (inspiratory valve OK) - only reservoir bag deflates

Perform leak test - Bag / APL valve circuit

31. Set selector switch to Bag/APL - close APL valve and attach spare breathing bag to Y-piece / Inflate bag with O_2 flush to just under 40 cmH_2O / Circuit pressure holds steady for > 10 sec / Sustained pressure alarm sounds / Ventilator bellows does not move during O_2 flush

Check APL valve and scavenging system

32. Check high pressure alarm and release - with APL valve still closed and circuit occluded, squeeze inflated bag until pressure reaches approximately 70 cmH_2O / High pressure alarm sounds when limit exceeded (e.g., 40 cmH2O) / At 70 cmH_2O, APL valve partially releases and reservoir bag on scavenger fills
33. Check sustained pressure alarm threshold - Open APL valve slowly until pressure drops below 20 cmH_2O, then stop / Pressure should stabilize and hold / Sustained pressure alarm stops
34. Check that APL valve opens fully and check scavenger relief valve - Open APL valve fully (to MIN), flush occluded circuit with O_2 / Circuit pressure does not exceed 10 cmH_2O / Scavenging reservoir bag fills - then positive pressure relief valve releases
35. Check that APL valve prevents negative pressure (vacuum) - APL valve fully open, flows set at minimum and circuit still occluded / Circuit breathing bag does not deflate / Scavenging reservoir bag does deflate

Ventilation Systems

Test automatic ventilation system

36. Check ventilator positive pressure relief valve - Selector switch set to Ventilator - all flows set to minimum, spare bag on Y-piece / Fill bellows with O_2 flush between ventilator breaths / Circuit pressure does not exceed 15 cmH_2O - release flush

37. Set appropriate ventilator parameters for next patient - Inspiration - bellows delivers correct tidal volume / Expiration - bellows fills completely / Volume monitor is consistent with ventilator / Proper action of unidirectional valves
38. Check low pressure and disconnect alarm - Remove spare breathing bag from Y-piece while ventilator is still working / Low pressure alarm sounds ("Cannot drive bellows") until spare bag is replaced
39. Check for ventilator leak - Set selector switch back to Bag/APL (turns off ventilator) when bellows fully inflated / Ventilator bellows does not drift downward over next few minutes

Test manual ventilation system

40. Ventilate manually and assure inflation and deflation of artificial lungs and appropriate feel of system resistance and compliance

Final Status Checks

Gas machine and breathing system

41. Final check of circuit - Attach face mask to Y-piece and breathe in and out through a surgical mask as final test
42. Patient suction adequate ("thumb test")

Monitors

43. Check gas analyzer and apnea alarm - Capnometer registers CO_2 from your breath / Ventilator apnea alarm sounds after appropriate interval / Check alarm settings
44. Check oximeter on your own finger for function / Check alarm settings
45. Make sure manual blood pressure cuff is available

Appendix 2

List of Machine Faults

1. Empty backup oxygen cylinder
2. Unlocked sevoflurane vaporizer
3. Missing O-ring on desflurane vaporizer
4. Faulty expiratory uni-directional valve
5. Open drain plug in the CO2 absorber
6. Granule crushed between the CO2 absorbent canisters
7. Closed scavenger valve
8. Mis-attached gas sampling line
9. Leaking ventilator bellows
10. Incorrectly assembled suction assembly

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