The Effect of Critical Task Auto-failure Criteria on Medical Evaluation Methods in the Pararescue Schoolhouse

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ABSTRACT

Background: Medical training and evaluation are important for mission readiness in the pararescue career field. Because evaluation methods are not standardized, evaluation methods must align with training objectives. We propose an alternative evaluation method and discuss relevant factors when designing military medical evaluation metrics. **Methods:** We compared two evaluation methods, the traditional checklist (TC) method used in the pararescue apprentice course and an alternative weighted checklist (AWC) method like that used at the U.S. Army static line jumpmaster course. The AWC allows up to two minor errors, while critical task errors result in auto-failure. We recorded 168 medical scenarios during two Apprentice course classes and retroactively compared the two evaluation methods. **Results:** Despite the possibility of auto-failure with the AWC, there was no significant difference between the two evaluation methods, and both showed similar overall pass rates (TC=50% pass, AWC=48.8% pass, p=.41). The two evaluation methods yielded the same result for 147 out of 168 scenarios (87.5%). **Conclusions:** The AWC method strongly emphasizes critical tasks without significantly increasing failures. It may provide additional benefits by being more closely aligned with our training objectives while providing quantifiable data for a longitudinal review of student performance.

Keywords: *evaluation metrics; military medicine; training techniques; trauma care; education; pararescue*

Introduction

Training via medical simulation is crucial to readiness. There are ethical and logistical constraints to teaching novice learners using live human patients, and it is difficult to integrate military medics into civilian hospitals. Thus, medical simulation provides an important training substitute.[1] There is strong evidence that medical simulation training is broadly effective in both civilian and military environments.[2] In a review of 44 studies, Lynagh et al. found that 70% of studies reported skill laboratories or simulator training significantly improved procedural skills in medical students when compared with standard or no training.[3]

Given the importance of medical simulation, how we evaluate medical simulation is critical. One of the primary challenges is the lack of standardized training evaluation metrics for tactical medicine, even though medical evaluations are ubiquitous and requisite for pararescue combat mission readiness.[4] The inherent complexity of combat medicine scenarios provides additional complexity when designing evaluation metrics.[5]

The traditional checklist (TC) evaluation counts a single instructor assist as an error, with the second error resulting in failure. All errors carry the same weight within the current evaluation criteria, and any two errors result in failure. This evaluation format is common within Air Education and Training Command (AETC) and U.S. Air Force Special Warfare training.[6,7] This evaluation method presents two problems. First, equal weight for all errors may result in unintended and inappropriate student focus. For instance, critical actions such as correct tourniquet application carry the same weight as less critical errors such as gross manipulation of fractures or documentation errors. This weighting may result in students focusing too much on some aspects of care and too little on others. Second, this method provides little quantifiable information to enable trending student performance over time.

This investigation aimed to address these problems by modifying the TC evaluation method to emphasize critical tasks while maintaining a similar level of difficulty for the evaluation. We propose an alternative weighted checklist (AWC) evaluation method, using a numeric score out of 100 possible points, with 70 points required to pass (Figure 1). This evaluation method is based on the major error/minor error system sometimes used in military training environments such as static line jumpmaster school.[8] We hypothesize that the AWC will more appropriately emphasize critical tasks but that the possibility of auto-failure using the AWC will increase failure rates.

Methods

The Pararescue Apprentice tactical medicine course is located at Kirtland Air Force Base, New Mexico, and trains students in

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FIGURE 1 *A typical scenario during the tactical medicine block of training at the Pararescue apprentice course.*

Students role-play as patients. They wear coveralls that require cutting to practice exposure and use simple moulage to indicate injuries (in this case, burns). Instructor injects are added to clarify patient presentation.

single medic polytrauma scenarios. These scenarios occur outdoors during daylight. The students have a standard loadout of a medical ruck, kit, plates, helmet, and rubber rifle (Figure 1). The scenarios occur with one student, one instructor, and an additional student with basic moulage acting as the patient. Scenarios are approximately 30–40 minutes.

Instructor baselining and standardization are critical to medical training evaluation. Before evaluating students independently, instructors must complete AETC's task qualification (TQ) process. The TQ process requires candidate instructors to shadow qualified instructors for three different medical scenario types, averaging 10–15 individual shadowed scenarios. Additionally, the instructor cadre is baselined on the expectations for individual skills or tasks within a medical training scenario.

As a general rule, student verbalization of patient care is minimized as much as possible, and students are held to standards of care found in the *Pararescue Medical Operations Handbook*.[9] For commercially produced devices (e.g., tourniquets, junctional tourniquets, Kendrick traction devices, SAM splints), the students must adhere to the manufacturer's instructions for application. Failure to do so would result in losing points for the task associated with that device. Performance expectations of other skills are established early in the course so students and instructors know the standard prior to evaluations. For instance, hypothermia treatment using a wool blanket requires the student to fully wrap the patient within the blanket anteriorly and posteriorly, exposing the patient only as required for assessments and treatments. Failure to perform this skill to this standard would result in failing the scenario for 2f, "Treat Hypothermia" (Figure 2).

To further emphasize instructor standardization, instructors meet to conduct an internal debrief for ~5 minutes following a scenario to maintain clear and uniform standards. Following the instructor debrief, we debrief students for approximately 5–10 minutes. To ensure all students get at least one practice round daily, we repeat this process 5–7 times during each day of medical scenarios.

FIGURE 2 *A comparison of two evaluation criteria.* **LEFT:** *TC evaluation method in which all errors have equal weight, with any two errors resulting in failure.* **RIGHT:** *The AWC method is based on a 100-point grading system, with 70 points required to pass.*

1. Perform scene evaluation (1 Min)	IA	Fail	**1. Perform scene evaluation (1 Min)**	Pts	X
a. Take universal precautions (BSI/PPE) *as appropriate*			**a.** Take universal precautions (BSI/PPE) *as appropriate*	-11	
b. Determine scene safety; unsafe issues			**b.** Determine scene safety; unsafe issues	-11	
c. Determine mechanism of injury			**c.** Determine mechanism of injury	-11	
2. Perform initial assessment (3 Min)			**2. Perform initial assessment (3 Min)**		
a. Assess / Treat Massive Hemorrhage			**a.** Assess / Treat Massive Hemorrhage	-31	
b. Assess / Treat Airway			**b.** Assess / Treat Airway	-31	
c. Assess / Treat Respirations			**c.** Assess / Treat Respirations	-31	
d. Assess / Treat Circulation			**d.** Assess / Treat Circulation	-31	
e. Assess / Treat Head (Mental Status and Pupils)			**e.** Assess / Treat Head (Mental Status and Pupils)	-31	
f. Treat Hypothermia			**f.** Treat Hypothermia	-31	
g. Treat Initial Life Threats			**g.** Treat Initial Life Threats	-31	
h. Initiate and prioritize appropriate transport			**h.** Initiate and prioritize appropriate transport	-31	
3. Perform Complete Secondary Assessment when Appropriate (10 Min)			**3. Perform Complete Secondary Assessment when Appropriate (10 Min)**		
a. Reassess previous treatments as necessary			**a.** Reassess previous treatments as necessary	-11	
b. Assess / treat head to include EENT			**b.** Assess / treat head to include EENT	-11	
c. Assess / treat neck, trachea / C-spine			**c.** Assess / treat neck, trachea / C-spine	-11	
d. Assess / treat chest			**d.** Assess / treat chest	-11	
e. Assess / treat the abdomen and pelvis			**e.** Assess / treat the abdomen and pelvis	-11	
f. Assess / treat all extremities and PMS			**f.** Assess / treat all extremities and PMS	-11	
g. Assess / treat backside of patient			**g.** Assess / treat backside of patient	-11	
h. Limit patient environmental exposure			**h.** Limit patient environmental exposure	-11	
i. Obtain pt history			**i.** Obtain pt history	-11	
4. Monitor Patient			**4. Monitor Patient**		
a. Reassess and document vitals (q 10 min)			**a.** Reassess and document vitals (q 10 min)	-11	
5. Administer Appropriate Medications			**5. Administer Appropriate Medications**		
a. Right medication, dose, time, route, patient			**a.** Right medication, dose, time, route, patient	-11	
6. Obtain appropriate access (IV/IO)			**6. Obtain appropriate access (IV/IO)**		
a. Within 6 min secured on live pt, max 3 attempts			**a.** Within 6 min secured on live pt, max 3 attempts	-31	
b. Initiate appropriate fluid therapy			**b.** Initiate appropriate fluid therapy	-11	
7. Document Treatment			**7. Document Treatment**		
a. Complete JTS Patient Treatment Card Completely			**a.** Complete JTS Patient Treatment Card Completely	-11	
8. Adhere to safety requirements			**8. Adhere to safety requirements**		
a. Do no harm to your patient			**a.** Do no harm to your patient	-11	
b. Do not ignore a condition which will harm the patient			**b.** Do not ignore a condition which will harm the patient	-11	
c. Do no grossly manipulate a fracture			**c.** Do no grossly manipulate a fracture	-11	
d. Properly dispose of sharps in appropriate container			**d.** Properly dispose of sharps in appropriate container	-11	
e. Do not delay transport for non-critical treatment			**e.** Do not delay transport for non-critical treatment	-11	
f. Do not use contaminated vials, tubing or needles			**f.** Do not use contaminated vials, tubing or needles	-11	
9. Handoff Patient			**9. Handoff Patient**		
a. Correct AT-MIST Format			**a.** Correct AT-MIST Format	-11	

Line items highlighted in yellow represent critical errors and result in the subtraction of 31 points. All other errors are considered minor and result in the subtraction of 11 points.

Following the crawl, walk, run adage, practice scenarios follow a progression in complexity—single injury, double injury, triple injury. Evaluation scenarios are medium complexity and devoid of ambiguity. We only evaluate students on injuries/skills that they were exposed to during practice scenarios.

For this study, we sampled 8–12 students for two classes during each training day. The number of students sampled per day varied based on the number of instructors available for scenario rotations. Students rotated through evaluators during practice scenarios, and data were collected from the same two instructors daily. In order to comply with AETC training requirements, we used a post-test-only, no-control-group design, which has shown to be adequate for certifying a level of performance.[10]

Evaluation Methods

A variety of methods have been proposed to evaluate complex psychomotor skills such as combat medicine delivery. Two commonly used rating methods for medical evaluations are checklist-based methods and global (or holistic) scoring.[2] Checklist-based methods reduce variability among evaluators and scenarios, while global scoring is more individualized, variable, and nuanced.

A comparison of these methods can be found in Table 1. Evaluation metrics may exist on a continuum between the checklist and global assessment methods, with varying methods of weighting and scoring. For instance, some Fire Department emergency medical services evaluations rely on a checklist with tasks scored from 1 to 5, while Joint Trauma System Tactical Combat Casualty Care assessments use checklists in which critical tasks are "must-do" items and others are "should-do" items.[11,12]

We blended the checklist and global assessment methods, then incorporated principles from the well-established U.S. Army

TABLE 1 *A comparison of commonly used evaluation methods in the context of medical simulation evaluation*

	Gold Standard	Complexity	Sensitivity	Objectivity
Checklist	Process-based evaluation. Protocol-based, sequential list of actions, assessments, and treatments.	Low; allows for rapid evaluation. Binary evaluation: was the task completed correctly or not?	Low; provides an accurate measure of competence but may be incapable of distinguishing between qualified and highly qualified examinees.[1]	High; checklist framework provides easily recorded and consistent evaluation.[2] Trained raters can be highly consistent.[3]
Global/Holistic Assessment	Outcome-based evaluation. Was the patient cared for appropriately?	Medium; each task is rated on a scale. Was the task incorrect, partially correct, or fully correct?	High; partial credit for tasks allows for more detailed delineation of examinee performance.	Low; less structured examination criteria introduces the possibility for inconsistency. Can be overcome with rater training.[4]

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jumpmaster training program to align our training objectives with training measurements. The U.S. Army Jumpmaster School defines *major deficiencies* as "any deficiency that could cause loss of life or serious injury."[8] Errors involving MARCH (massive hemorrhage, airway, respirations, circulation, head/hypothermia) assessments and treatments, meeting transport timelines, and successful intravenous/intraosseous access within 6 minutes are all considered major errors, are worth 31 points, and result in failure. Similarly, failure of any of the major tasks in a medical scenario would result in increased real-world morbidity and mortality and be considered critical tasks similar to those found in TCCC evaluation checklists.[12]

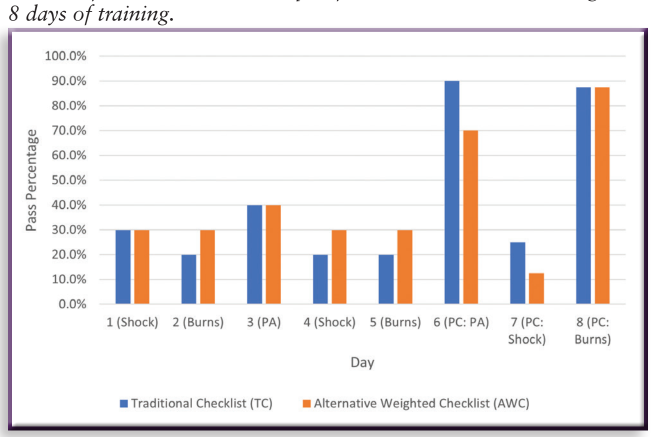
The U.S. Army Jumpmaster School defines *minor deficiencies* as "any discrepancy in the rigging or donning of the jumper's equipment that could cause injury . . . or a violation of standard rigging procedures."[8] Minor errors in our context are therefore defined as errors that reduce the quality of patient care but are not immediately life-threatening, including errors during secondary/PAWS (pain management, antibiotics, wound management, splinting) assessments and treatments. These tasks are worth 11 points, with three minor errors constituting failure (Figure 1).

Paired *t* tests were used to statistically compare pass rates for the TC and AWC on each day of practice and evaluation, and the level of significance was $p \leq .05$.

Results

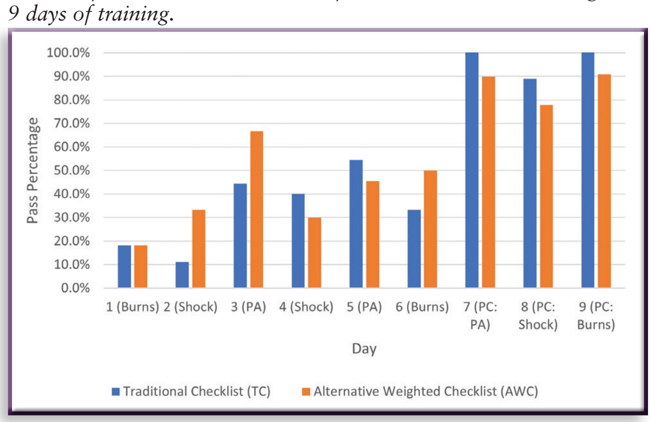
During practice scenarios, there was no significant difference between the TC (mean 30% [SD 13%] pass) and AWC (mean 37% [SD 13%] pass) (p=.084). During progress check (PC) scenarios, there was a significant difference between the TC (mean 82% [SD 28%] pass) and the AWC (mean 71% [SD 30%] pass) (p=.011). The two evaluation methods generated the same result for 147 out of 168 scenarios (87.5%), and the TC and AWC evaluation methods were not significantly different across the 168 medical scenarios analyzed (TC=50% pass, AWC=48.8% pass, p=.41). Figures 3 and 4 show two classes of by-day comparison of TC and AWC evaluation methods.

FIGURE 3 *A by-day comparison of TC and AWC evaluation methods for Pararescue class Alpha for 76 total scenarios during 8 days of training.*



PA = patient assessment; PC = progress check.

FIGURE 4 *A by-day comparison of TC and AWC evaluation methods for Pararescue class Bravo for 92 total scenarios during 9 days of training.*



PA = patient assessment; PC = progress check.

Discussion

Medical Simulation Evaluation Metrics

Although there is strong evidence supporting medical simulation as effective training, the ideal method with which to evaluate medical simulation remains unclear.[13] Cotin et al. stated that "the current method of defining metrics for medical simulation remains more art than a science."[13] This may be especially true for our purposes, given the highly dynamic and variable nature of tactical medicine, and the evolution towards standardization across military services.[14] Thus, reliability and validity, the two basic concepts of evaluation quality, are important to implement when creating evaluation standards.

Reliability indicates the consistency of measurement. Validity refers to the ability to make accurate and reproducible measurements using an evaluation metric based on the desired learning objective.[15,16] In the context of military medical simulation evaluation, a highly reliable evaluation method would produce the same results at different times and with different evaluators or simulation scenarios. Validity correlates with the inferences of a student's performance in an evaluation. For example, if a student is successful in medical simulation, we infer they will succeed in real-world scenarios.

The TC method's validity may be suboptimal due to its equal focus across all aspects of care. Bewley and O'Neil summarized how to develop an effective evaluation for military medicine. They recommended defining the desired training objectives and aligning the measures and scoring with them.[15] In this framework, our training objective can be defined as the acquisition of durable life-saving tactical medicine skills that can be transferred to novel environments. By making critical tasks auto-failure criteria, the AWC is more effective at emphasizing the critical assessments and treatments that align with our training objectives and increases the validity of our medical evaluations.

The difference in the TC and AWC for practice and progress check scenarios was likely driven by the high quantity of errors students made during practice scenarios (2.7 errors per scenario) compared with progress check scenarios (0.9 errors per scenario). For scenarios in which students make three or more errors (as they do during many practice scenarios), they would fail using either the TC or AWC. As student performance improves and the quantity of errors is reduced, the effect of auto-failure for single critical errors using the AWC becomes more evident.

We believe the AWC evaluation method more closely aligns with our training objectives than the TC evaluation method because it strongly emphasizes life-saving care, de-emphasizes less critical care, and maintains similar overall evaluation rigor as the TC. Because it is a checklist-based evaluation, the AWC maintains objectivity and is simple to use while providing numeric scores to allow for longitudinal data analysis and progress tracking. Future work should examine the inter-rater reliability of the AWC, and longitudinal studies should examine the validity of the evaluation metric.

Limitations

This is a retrospective study with inherent weaknesses. Evaluation data was only collected from two instructors to provide consistency but could also amplify their individual biases. Due to the limitations of our training requirements, we could not analyze inter-rater reliability for the AWC.

Conclusion

To improve our medical simulation evaluation metric, we used the following framework. First, we identified and stated our organization's training objectives. Then, we reviewed evaluation methods used in medical simulations and military training organizations and found evaluation methods that aligned with our stated training objectives. We then retrospectively compared evaluation methods to analyze their effectiveness prior to full implementation and ensure similarity in rigor. By drawing from established criteria, we tailored our evaluation method to evaluate student competencies more appropriately.

Author Contributions

IPR conceived of this study and wrote the protocol. IPR and JMS orchestrated all approvals for field observations. IPR and JMS collected data. IPR wrote the first draft of this paper. IPR and BLG analyzed data and performed statistical analysis. BLG performed the literature review. MJL and SCR provided overall guidance and revised each draft. All authors read and approved the final manuscript.

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