Examining the Learning Practice of Emergency Airway Management Within an Academic Medical Center: Implications for Training and Improving Outcomes

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ABSTRACT: Emergency airway management (EAM) is a "high stakes" clinical practice, associated with a significant risk of procedure-related complications and patient mortality. Learning within the EAM team practice is complex and challenging for trainees. Increasing concern for patient safety and changes in the structure of medical education have resulted in educational challenges and opportunities for improvement within the EAM team practice. This paper is divided into 3 sections that describe the past, present, and future of the EAM team learning practice within a large academic institution. Section 1 provides a brief overview of the evolution of the existing practice of EAM. Key features, goals, and challenges of the practice are outlined and a recently performed needs analysis to identify areas for improvement is described. Section 2 examines the underlying assumptions regarding learning within the existing practice and explores how these assumptions fit into major theories of learning. Section 3 proposes an idealized learning practice for the EAM team which includes the assumptions regarding learners, design of the learning environment, use of technology to enhance learning, and the means of assessment and measuring success. It is hoped that through this systematic exploration of the EAM team practice, learning efficacy and efficiency will be improved and remain adaptable for challenges in the future.

KEYWORDS: Emergency airway management, medical education, learning practice

Section 1: The Existing Emergency Airway Management Learning Practice

Overview of the clinical and learning practice

Emergency airway management (EAM) is required for patients on the verge of respiratory and/or hemodynamic collapse. EAM is a "high stakes" practice, associated with a significant risk of complications and mortality.[1-4] Historically, in many institutions, EAM has been performed by a single designated provider, often a trainee.[5-9] However, concerns for patient safety and quality have increasingly led to the development of multidisciplinary EAM teams.[10-12] In many academic institutions this EAM team consists of a respiratory therapist, residents and a senior leader, often an anesthesiologist or intensivist.[13,14] More specialized teams activated for difficult intubations may also include additional airway experts including a surgeon or otolaryngologist.[15] The EAM team is generally activated by pager and is available to respond 24 hours a day, 7 days a week.

EAM is a complex and challenging learning practice for trainees. The acquisition of a foundation of specialized knowledge together with the development of technical and clinical problem-solving skills is necessary for a trainee's success. The goal for the trainee is to become a skilled provider in the practice of emergent airway management who can ultimately lead the EAM team. Challenges in education include the vastly different clinical scenarios which can be encountered as well as a wide range in levels of training and experience. Fluctuations in the number of EAM team activations and reductions in duty hours permitted for trainees also contribute to the challenge of providing a consistent educational experience.[16] Furthermore formal training in emergency airway management is often limited.[17,18] The oftentimes chaotic and "stressful" environment in which EAM is performed can further serve as an impediment to learning and adversely impact patient outcomes.[19] Growing appreciation for the challenges in the practice of EAM and potential complications has resulted in calls to improve education in EAM for both physicians in training and practicing clinicians.[20,21]

In our institutions residents and critical care fellows are participants on the EAM team while rotating through the Intensive Care Unit, which occurs for a total of 12 or more weeks distributed throughout their training. The residents are in the anesthesiology training program while the fellows primary training is in anesthesiology, emergency medicine, or surgery. In preparation for their initial EAM team rotation these trainees receive a 1-hour orientation lecture that provides an overview of EAM team practice as well as member roles and responsibilities. Additional lectures covering advanced topics in airway management, crisis resource management and team training are provided during the course of their training. However, the primary pedagogical approach to learning in the EAM team practice is "learning by doing." Inexperienced trainees begin by observing the practice in action and

Table 1. Learning objectives for the trainees in emergency airway management.

A. Medical knowledge/patient care/technical skills
    1. Identify a patient with respiratory compromise
    2. Manage a patient with respiratory compromise
    3. Know the indications and equipment necessary for:
        a. Bag mask ventilation
        b. Endotracheal intubation
        c. Fiberoptic intubation
        d. Surgical airway
    4. Demonstrate appropriate use of this equipment
    5. Know the drugs commonly used for emergency airway management including dosages and contraindications
    6. Manage hemodynamic support for a patient with respiratory compromise
    7. Develop a comprehensive EAM plan.
    8. Modify the plan based on changing clinical circumstances
B. Communication/professionalism
    1. Communicate effectively with other providers in an emergency situation both "above" and "below" in the hierarchy and across services
    2. Share information and give guidance without engendering conflict, compromising professionalism or patient care
    3. Demonstrate the ability to function as both a team member and team leader in emergency airway management
    4. Conduct effective debriefing after emergency airway management
C. Teaching
    1. Demonstrate the ability to teach emergency airway management to residents and other health care providers including:
        a. Technical skills
        b. Core knowledge
        c. Communication/professionalism
        d. Debriefing

performing simple tasks (eg, data collection). When simple tasks are mastered the trainee progresses to more advanced tasks. The overarching goal for the trainee is to perform as a member of the EAM team without the need for intervention by the attending physician.

Key features of the practice

When the EAM team is activated a number of tasks must be rapidly performed and coordinated which include:

- Data collection (relevant patient history, allergies, code status)
- Patient assessment (airway evaluation, presence of vascular access)
- Preparation of tools and equipment (availability of airway equipment, patient positioning, drug selection)
- Hemodynamic stabilization (fluid resuscitation, vasopressor administration)
- Drug administration (anesthetic agent and muscle relaxant)
- Airway management (bag mask ventilation, intubation, surgical airway)
- Post-intubation stabilization (vasopressor support, mechanical ventilation, sedation)

The trainee is expected to perform the individual tasks based on his/her level of training and experience. A senior resident or fellow often takes the role of the EAM leader. The EAM team leader is expected to oversee the more inexperienced trainee's completion of the individual tasks and assume task roles as needed. In addition, the EAM team leader is expected to formulate the overall EAM plan, communicate with other care providers and troubleshoot problems as needed.

An attending physician is present and serves as backup and educational leader.

Learning interactions occur primarily through faculty instruction and facilitation that occur during the practice of EAM. Early in the course of EAM training, the attending assumes an active role in overseeing task completion but over time the attending serves more of a resource role as the trainees are able to assume more responsibility. Learning is also enhanced by interactions that occur between the junior trainees and EAM team leader. Ideally after completion of the EAM activity a feedback session is performed.

Learning goals

The learning goals for the existing EAM practice focus on acquisition of the specialized knowledge, development of technical skills, problem solving and communication skills, and finally developing a comprehensive plan necessary for successful EAM performance. In addition, it is expected that all residents and fellows will become proficient EAM teachers/facilitators over the course of their training. Finally, it is anticipated that the problem solving, communication and team training skills acquired during the EAM team experience will "carry over" to other areas of critical care practice. Specific learning objectives for each of the trainees are provided in Table 1.

Challenges and opportunities for learning

EAM is a difficult skillset to master, requiring extensive hands-on training with human patients and extensive clinical experience.[22,23] Airway management experiences in the elective setting certainly enhance a trainee's ability to perform in the emergency setting, especially regarding technical knowledge and skill. However, it is important to recognize that a

Table 2. Educational challenges and potential solutions.

Educational problem/challenge	Potential solutions
Inadequate preparation prior to EAM practice	Boot camp for trainees during orientation
Lack of role clarity on team	Provide trainees with rotation goals and expectations
	Clarify trainee role with faculty
Stressful experience for trainees	Embed EAM simulation in larger hospital wide code simulations
	Provide early training based on trainee specific needs
	Clarify roles and expectations
Inconsistent feedback	Implement "brief" structured debriefing after EAM events
Lack of role clarity regarding teaching	Assign the fellows to be instructors/facilitators during the simulation sessions and debriefing
Lack of autonomy/independence for senior fellows	Develop "milestones" which outline the expectations regarding developing proficiency and associated progressive independence
	Discuss milestones with both faculty and fellows
Lack of "buy in" from faculty and administration to change existing practice	Take advantage of the priority placed on "safety culture" to sell the innovation and secure necessary resources

number of factors are different in the emergency airway setting. These factors include time pressure, the limited physiologic reserve of a critically ill patient, unfamiliarity with the physical environment where EAM is to be performed and lack of immediate availability of backup equipment and personnel.[24] Human factors skills are vital for the successful EAM and include the ability for quick and independent judgment, situational awareness, clear and disciplined communication and as well as proficiency in managing contingencies, unfamiliar team dynamic and psychological pressure all of which are skills less commonly encountered in elective situations.[25] Literature suggests that even graduating residents in anesthesiology and related acute care fields have low levels of exposure to hands-on management of airway emergencies.[18,26,27] Poor judgment in conjunction with lack of education and training may be the leading preventable causes of adverse outcomes related to airway management.[28]

In our institutions we performed a survey and informal interviews of trainees and faculty to better understand the learning experience. Feedback from the junior trainees regarding the EAM experience focused on the inadequacy of formal training early in the rotation, lack of role clarity on the team and a deficiency of regular feedback regarding the trainee's performance. These factors were reported to result in "an unnecessarily stressful experience" and "ambiguous role" for the trainees. Evaluations by the senior trainees on the other hand reflected "lack of autonomy" as the major factor leading to dissatisfaction with the experience. Compared with prior cohorts, the faculty reported that recent trainees "assume a more passive role," "require more directed instruction," "are less engaged in teaching," and "are less well prepared for independent practice."

Potential solutions

Based on the survey and interviews of trainees and faculty, EAM training will benefit by innovative educational approaches that account for the unique learning needs of the trainees. These educational approaches must provide a fundamental "grounding" in technical skills, clarify the trainee's role in the team and set clear expectations. Additionally, constructive, formative feedback to allow for reflection must be provided. Educational technology that facilitates implementation of the educational approaches should be utilized. Development and implementation of the educational approaches should not substantially increase the demands on faculty. Finally, evaluation of the efficacy and efficiency of the educational intervention should be performed. Based on the survey results, feedback from interviews and discussions with faculty, a number of potential solutions have been proposed and are summarized in Table 2.

Section 2: Learning Theories and Change within the Practice of Emergency Airway Management

Emergency airway management as a sociocultural learning practice

Learning within the EAM practice is not viewed as an individual pursuit but rather results from engagement with others in shared activities. When the EAM team members participate in patient management they are engaged in both working and learning activities. There is no distinction made between learning and working in this practice. Engaging in the EAM practice is the condition for learning. For these reasons the practice of EAM falls within the sociocultural theory of learning.

Sociocultural learning theory proposes that social conditions and cultural context are essential elements to include in

the learning experience.[29,30] Learning is embedded in the social interactions within the practice and knowledge is socially, rather than individually, constructed. In complex settings such as the practice of the EAM team, individuals are unable to achieve the goals of the practice on their own as they depend on the knowledge of other people. Appropriate clinical management in critical situations results not from individual decisions but from the collective team actions.

The EAM team can be viewed as a "community of practice" identified by common goals and shared expertise.[29] To achieve successful outcomes, all members of the community must be engaged in supporting learning. At the beginning of their rotation trainees identify more experienced team members who help them "fit in" to the practice and who provide guidance in their learning. Given the opportunity to observe and practice in the actual practice setting, new trainees acquire the relevant jargon, imitate team member behavior, and gradually integrate into full participation as a member of the team.

In the sociocultural view of learning, the educational goal of the EAM practice is enculturation of the trainees as legitimate members of the team.[31] Enculturation results from participation in work activities that give rise to learning. These activities involve interactions among people, tools and culture in the collective effort to provide patient care, solve problems and create new tools to enhance the learning practice. This emphasis on immediate participation within the actual clinical setting helps develop adaptable knowledge structures that facilitate "real world" problem solving and transfer of this learning to new situations.

As the trainee develops new knowledge and skills, his or her contributions to EAM practice increase—the trainee progresses from performing single tasks such as intubation to managing the entire team. By making contributions to the team of increasing "challenge and value" the trainee develops a heightened sense of professional identity. Increasing participation in the practice of EAM results not just in the acquisition of knowledge but also in the production of new knowledge that shapes the future activities and success of the EAM team.

Conflicting assumptions and tensions within the practice

According to sociocultural theory, learning is most effective when individuals are given opportunities to engage in actual workplace activities. However, such opportunities for contextualized learning within the EAM practice are limited due to the time available for participation, the competence and confidence of trainees and the potential risks involved in the context of a safety culture with no allowance for errors. Sociocultural learning experiences in medical education are increasingly being replaced by competency-based frameworks and externally imposed topic-based curricula driven by the demand for increased public accountability.[32] These competency-based curricula often assume a behavioristic approach to learning.[33]

Specific behavioral objectives provide the trainee with information regarding exactly what behavior will be learned, the conditions under which it will be performed, and the criteria by which the behavior will be evaluated. By delineating learning objectives in this fashion, the level of competency that is expected for each objective within the curriculum can be explicitly stated. However, with this behaviorist approach there is a danger of fragmented learning, a reduction in practical experience and separation from the social practice. This restructuring of medical education according to behavioral principles of learning does not enhance the sociocultural progression of the individual from novice to expert and impairs the development of identity based on practice participation and skill mastery.

Design framework for the learning practice

Tasks. As a member of the EAM team the trainee is responsible for mastering a broad range of activities that are the basis for the learning practice (A detailed description of these tasks is provided in Table 1). In the EAM practice the trainee must communicate effectively with other providers, share information, provide guidance, and demonstrate the ability to function as both a team member and team leader. The primary goal of learning is full participation in a community of practice. While certain tasks within the practice are pre-structured (eg, intubation) the overall learning goals are open ended (eg, teamwork). Learning is a continuous process that is mediated by the learner's prior knowledge, experience, and goals, and facilitated by interpersonal interactions and the learning environment.

Tools. Tools are used to participate in the EAM practice, to learn, and ultimately new tools are developed by members to improve the community. For example, a video-laryngoscope is used to allow multiple clinicians to visualize the airway on a monitor screen during intubation. Use of this tool allows the team members to receive real time instruction and feedback during the intubation process. Electronic informational resources are tools that facilitate the practice by providing information on patient's medical history and allowing research on unfamiliar medical conditions. The attending physician on the team also functions as a "learning tool" by serving as a resource for information and providing interactive feedback. The trainees have enhanced the EAM practice by the introduction of tools. For example, the "EAM pocket card," which serves as a quick reference for information on drugs and equipment, was created by the trainees and is distributed to team members during their rotation.

Teacher-learner interactions. Rather than viewing learning as resulting from management by tasks within a classroom environment, sociocultural theorists believe that learning results from participation in a community of practice. In the EAM practice the trainees are collaborators in the learning process and are responsible for determining their learning goals and

the methods to achieve those goals based on their own prior knowledge and learning experiences. The attending physician on the team guides each trainee's learning efforts in a personalized way toward his/her own goals. Members of the EAM also learn from each other (eg, "I find it helpful to hold the laryngoscope this way") and share experiences (eg, "We had an emergent surgical airway yesterday").

The attending physician on the EAM team guides the trainee as he/she begins to participate in the practice. This guidance allows the trainees to perform tasks that they would not be able to perform on their own. The trainee apprentices, at first observing others and performing minor parts of the task, then taking on increased responsibility. The role of the attending physcian in the practice becomes that of structuring experiences rather than just transmitting knowledge. It is essential that the attending physician makes this learning process explicit to trainees, to help them recognize that they are learning "how to do EAM" by "doing EAM." In this way the attending physician facilitates a process of acquisition of knowledge and skills rather than transmission. Central to this learning process is the need for feedback and support for the building and maintenance of trainee confidence.

Connections and conflicts with other learning theories

The EAM practice would change dramatically if behavioral or cognitive theories served as the theoretical basis for learning. Behavioral theory emphasizes the learning of a sequence of simpler observable behaviors through reinforcement that lead to the overall goal—the desired complex behavior.[34] To apply this theory, educators should define the target behavior, design a path from intermediate behaviors based on what trainees can already do, and then reinforce successive approximations of the behavior until they produce the target behavior. For example, a simulation "task trainer" might be used to teach intubation. A "green light" might be used to indicated when the airway is successfully intubated. When a predetermined percentage of successful intubations are attained the trainee receives a "pass" and moves on to a more complicated task in airway management.

Cognitive theorists emphasize the process of learning through the development of mental models and subsequently expansion of those mental models by experience, in order to make them more accurate.[34] By applying this theory educators should provide learning environments that challenge the trainees to broaden and deepen their own models, thus opening up areas of the practice that trainees have not previously thought about. After educators have set up learning environments that challenge their beliefs and provoke them to reflect, they must allow the trainees to explore. For example, the trainee needs to learn a framework for conducting debriefing after a crisis. The educator provides a series of case-based scenarios for the trainee to work through and reflect on to facilitate accommodation of the new material.

Using the behavioral or cognitive theories as a basis for instructional design rely on creating the proper environment and providing a precise arrangement of information, practice, and testing.[34] Learners must learn and practice "the basics" before they can participate in the actual community of practice. Interactions between learners and instructors are usually confined to questions and answers that transmit more information to the student. Since the learning occurs out of context of the actual practice, so does the evaluation. The evaluation typically focuses on smaller learning objectives rather than assessment of the whole performance. Both of these theoretical frameworks could be used to facilitate learning within the EAM practice. However, they would require initial learning to occur in a decontextualized setting before introduction into actual practice. This decontextualized approach would be more effort intensive and disruptive to the established clinical practice.

Implementation of "technology tools" into the EAM learning practice

A needs analysis for the EAM practice (Section 1. IV) revealed that inadequacy of formal training early in the rotation, lack of role clarity on the team and a deficiency of regular feedback resulted in "an unnecessarily stressful experience" for the trainees. To address these needs a series of community integration and simulation experiences are proposed. A "boot-camp" during orientation is suggested to introduce the EAM role to the trainees, discuss expectations, familiarize trainees with the community of practice and provide a "hands on" experience in a less stressful environment.[35] The hope is that trainees who are made to feel welcome within the community of practice will be more likely to actively engage in the full range of learning opportunities provided and to seek to play an active role in the team. A brief yet focused conversation and assessment, that is, an "individualized learning needs analysis," will be conducted with each trainee. This learning-needs analysis will consist of determining what the trainee knows, reviewing his/her prior experience and identifying any concerns or anxieties he/she has about participation in the practice. In addition, the trainee will be provided back-up support (a rescue strategy) to be used if needed.

Simulation will be embedded within the EAM learning practice to create a "safety net" for the trainee.[36,37] Based on the results of the learning need analysis, simulated EAM scenarios will be conducted in which attendings will delegate some tasks to trainees to complete individually whereas other tasks will involve the attendings working in parallel with trainees, in order to increase competence and confidence. Simulation-based assessments will provide a profile of trainee performance, enabling the educator to identify gaps in skills or experience. These gaps will serve as the focus of clinical teaching, with the trainee being guided to experiences that help to meet their learning needs. The cyclical process of "doing," followed by "reflection/feedback" will be the foundation of the education process using simulation.[38] Vygotsky's theoretical construct of

the "zone of proximal development" is the basis for the proposed approach to simulation-based learning.[39] The zone is the theoretical area where learning takes place, and where guidance by a facilitator is likely to have the greatest impact on learning. In this role the attending provides the necessary "scaffolding," to allow the trainee to complete the task and offers progressively less guidance as the fellow develops increasing mastery of the skill.

Section 3: An Ideal Learning Practice for the Emergency Airway Management Team

Description of the ideal learning practice

The ideal learning practice for the EAM team is an enhancement of the existing practice. The theoretical model for learning in the ideal practice remains sociocultural although behavioral and cognitive aspects are embedded to promote educational efficiency. In the ideal practice learning is a collective activity shared by all members of the team. Therefore, learning activities focus on the learning needs of the team as well as those of its individual members. The ideal practice provides a structured method for integrating new members into the community of practice. The development of technical and nontechnical skills occurs through the use of both contextualized and decontextualized activities to ensure patient safety and promote learning efficiency. Simulation serves as the major technology tool for the initial development of technical and nontechnical skills and for assessing problem solving in unique or uncommon situations. A structured process of ongoing assessment and performance improvement is integrated into the ideal learning practice. This assessment is multidimensional and focuses on learning and performance of both the individual and the team as a whole. Finally, performance improvement activities support ongoing learning not by focusing on deficiencies, but by emphasizing the EAM team's successes, encouraging innovation and identifying strategies for improvement. The comparison between the existing and ideal learning practices for EAM is summarized in Table 3.

Assumptions regarding the design of the ideal learning practice and their justification

Sociocultural learning theory as a basis for the ideal practice. The success of clinical care activities performed by the EAM team is not determined by the performance of any single member; rather it is dependent on the performance of the team. Therefore, learning in the practice must focus on the development of the individuals as well as the team. Sociocultural learning theory emphasizes social interaction as the means of learning.[34] Collaboration and discussion with other members of the EAM team play a critical role in learning and performance. A sociocultural approach provides a meaningful way to design learning for the EAM team since actual practice provides the basis for learning from the beginning.

To fully engage the trainees in the EAM learning practice they need to feel valued as members of the team where their prior knowledge and experience is appreciated and integrated into the learning process. The trainees want to be part of a "community of practice" that will support them in reaching their learning goals. Consequently, activities that invite, introduce and more rapidly integrate new members into the EAM practice are important for learning. In the ideal practice it is important to collectively define and share the learning goals and success criteria with new members at the onset of their learning. New members not only learn about the learning goals but they also learn about the "scaffolding" they will receive in order to achieve these goals.

Incorporation of decontextualized activities to enhance learning. There is an expectation that team participants will have been prepared, for EAM before practicing on patients. However, changes in the structure of medical education have resulted in fewer opportunities for trainees to learn from a breadth of real patients prior to their EAM experience. Consequently, the traditional apprenticeship model alone is no longer effective for EAM team training. Incorporating simulation and other decontextualized activities into the ideal learning practice provide a feasible adjunct for learning both technical and nontechnical skills as well as an opportunity to rehearse performance in a safe, learner-centered semi-contextualized clinical setting. The intent in using these decontextualized activities is not to replace the apprenticeship model for EAM practice but rather to enhance it.

Comprehensive assessment and ongoing practice improvement. Assessment of learning is an important element in the design of the ideal practice for facilitating learning and enculturation within the community. In the ideal learning practice assessment provides ongoing, detailed, constructive feedback about improving performance for both the individual learner and the team. In this learning practice individuals are not penalized for making mistakes; rather mistakes are viewed as opportunities to learn. Assessment of learning occurs through both decontextualized activities (eg, simulated practice) and "real world" practice. Assessment covers the continuum of technical and nontechnical skills necessary for full participation in EAM team practice. Regular "learning practice conferences" are used to reflect on the existing practice, to celebrate the successes and to develop strategies for improvement.

Use of technology to support the ideal learning practice

Simulation is used to prepare the new trainee for the actual EAM team practice and to provide ongoing opportunities for the EAM team to "experience" uncommon situations. Simulation also provides the opportunity to examine the level of expertise of team members and to assess knowledge,

Table 3. Comparison of the actual and ideal learning practices for EAM.

	ACTUAL	IDEAL
Learning theory employed	Sociocultural	Sociocultural with embedded behavioral and cognitive aspects
Method of incorporating new members into the practice	Unstructured	Structured orientation ("bootcamp") which:
		Welcomes members into the practice
		Emphasizes the critical role of all members of the community
		Identifies learning needs of individual members and the group
		Addresses learning needs through activities that develop technical skills, facilitate team building, leadership and provide feedback.
		Promotes safety by practice of skills in a safe, semi-contextualized environment before actual "high risk" practice
		Discusses roles, expectations and goals for members and the team
Focus of learning	Trainee learning	Both trainee and team learning
Assessment and practice improvement	Single summative evaluation	Assessment of both the trainee and the team
		Assessment from multiple individuals
		Use of simulation to assess performance prior to participation in the actual process
		Review of videotapes of the actual practice
		Learning Practice Conferences to discuss successes and strategies for improvement
Measures of success	Success is demonstrated by the trainee achieving behaviorally defined objectives	Success for the trainee is demonstrated by development of identity as a team member and full participation in the practice
		Success for the team is demonstrated by providing safe, efficient patient care, enculturation of new members and demonstration of ongoing practice improvement.

procedural skills, decision-making, teamwork, communication and professional behavior.[40,41] Simulation is not a tool to replace learning in the actual practice, but a powerful adjunct to enhance learning and safety. In this context simulation sits at the third level of Miller's pyramid of learning by providing an environment for assessing the "shows how" of clinical ability for the trainees and the team.[42] Ultimately trainees will still need to refine and consolidate their skills through application in the actual EAM practice.

Video recording is another technological tool used for assessment, reflection, and practice improvement.[43,44] The use of video enhances the quality of feedback because it allows the trainee to view him/herself "from the outside" thereby providing the trainee a realistic perspective of their performance in context and promoting reflection. Multiple aspects of performance can be assessed using video including task completion as well as verbal and nonverbal (body) language. Use of video as a feedback tool also eliminates potential disagreement between the trainee and the facilitator over whether a particular behavior did or did not occur. Video review linked with self-assessment alone is less

likely to be effective for learning because "trainees often do not know what they don't know." Consequently, in the ideal practice facilitated discussion is used in conjunction with videotaped practice to promote the "critical reflection" necessary for transformative learning.[45]

Defining and measuring success of the ideal learning practice

In the existing EAM practice evaluation is focused on the individual trainee and success is demonstrated by achieving behaviorally defined objectives. In the ideal learning practice success is defined and measured in terms of achieving goals both for the individual and for the EAM team. Success for the trainee is reflected by their development of identity as a team member and by full participation in the EAM team practice. This success is measured by the demonstration of proficiency with technical skills, communication, leadership, and the contribution of new knowledge to the team. For the EAM team, success is defined and measured in terms of providing safe, efficient patient care,

enculturation of new members into the practice and the demonstration of ongoing practice improvement. Measurement of performance for the individual trainee and the team results from assessments of multiple individuals involved in the practice community and includes the trainee's self-assessment. Rather than occurring at predefined times, assessment is an ongoing process that takes place throughout the period of participation in the EAM team. This ongoing assessment is based on real time observation during participation in EAM team activities and on review of videotapes of the actual practice. In the ideal practice there is ongoing collaboration among the team members to monitor their current level of achievement in relation to the learning goals.

Combining assumptions about learning in the design of the ideal learning environment

As described in prior sections of this paper, the use of sociocultural learning theory as a framework for the ideal practice has implications regarding the learners, the design of instruction, learning goals, and the methods of assessment. Assuming a sociocultural model does not however exclude the possibility of incorporating specific strategies that employ other learning theories into the larger practice. For example, within the sociocultural practice learners may employ the use of mnemonics for memorization (cognitive theory) or repetitive practice for reinforcement of skills (behavioral theory). However, with this approach the learners select which strategies are most applicable to their needs, thereby motivating learning. Embedding learning strategies that assume different theories may be a more efficient way to achieve learning of a specific task. For example, learning to perform an emergency surgical airway through participation in the EAM practice alone would be inefficient given the infrequency with which this procedure is actually performed. Consequently, use of a surgical airway "task trainer" which utilizes a behavioral learning model of repetition and reinforcement allows the team member to more efficiently acquire the desired skill.[46]

Conclusion

This paper has provided a description of the current EAM team learning practice including its evolution, current structure, goals, challenges, and opportunities for improvement. The underlying assumptions regarding learning within the practice are examined and placed within a theoretical learning paradigm. Based on this analysis an idealized learning practice is formulated. While it would be gratifying to have meaningful improvement in the learning practice result from a solution proposed in this manuscript it is more likely that improvement in EAM practice change will occur over time through the collective ideas and efforts of the individuals engaged in the practice. Understanding the assumptions regarding learning within the practice provides a foundation for evaluating potential interventions for efficiency and efficacy, and designing methods for implementation, assessment, and measuring success. It is hoped that the application of critical analysis to the EAM team learning practice will inform efforts in improving learning efficacy and efficiency within EAM team learning practice and that the lessons learned will be generalizable to other clinical learning environments.

Authors' Note

EAB and US have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

Authors' Contributions

EAB devised the project, collected the data and performed the analysis. EAB drafted the manuscript. US provided critical feedback and manuscript revisions.

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