# Skill learning and retention

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## THE PARAMEDIC VIEW

Maintenance training should:

- be easy to organize/facilitate.
- be conducted independently or in small groups.
- not require the presence of an instructor at all times.
- consist of training sessions with a wide variety of lengths to easily fit into any time schedule.

## Resource Limitations

No matter whether you are in the civilian, military or private sector, in most of these organizations human resources are scarce. With instructors having a busy schedule it is difficult for them to organize/facilitate all skill learning and maintenance training. They should focus their time where the cost-to-benefit ratio is the greatest and where they can evaluate the performance level of the medics and thereafter give guidance, directions, or provide mentorship. Realistic scenarios supply the medic and the instructor with an environment that will affect the decision making process and where skills and knowledge are tested.

Organizations often have goals focused toward directly measurable output (e.g., presence in a conflict zone, care supplied to the general public, profit) and not time spent in training. Busy individual schedules aimed at the previously mentioned output also make it difficult to organize maintenance training where everybody participates. Often, only a limited number of people can engage in each training session. Even with long-term planning, setting off a large amount of time and people only to conduct maintenance medical training is difficult.

The medics cannot always rely on instructors having the time to provide training at the same time as the medic is available for it, the medic should be able to conduct some training without instructor support. By training in the downtime without an instructor the medic can maintain or hone his practical skills and review his theoretical skills.

It takes a lot of resources to educate a good medic. In academia, there is limited time for multiple realistic scenarios and helpful individual feedback. Often, the theoretical education is excellent, but later real-life work fails to maintain this knowledge because of the lack of its application on everyday patients. The medic will still need regular training and theoretical refreshers to maintain and to increase the skill level needed to succeed in the harder cases.

In the military system, the challenge comes after graduating from medical training. Hopefully, the medic gets some clinical rotations but it is hard in peaceful countries to expose the military medic to the kind of trauma patients that resembles the ones on the battlefield where he or she is expected to excel. After the education, the medic goes back to their unit and regular routines, where the chances to practice medicine might be few and far between.

When medics from military (MIL) and law enforcement officers (LEO) and civilian medics are mixed in theoretical and practical training scenarios, it turns out that the MIL/LEO group has more training than the civilian medics, whereas the civilian have a lot more everyday exposure to the different cases.

It takes time to build a good medic. The knowledge and experience of a good medic must be transferred onto the other colleagues. The system must make it possible and attractive for a medic to stay in his or her position for as long as possible.

## Learning Skills

Prehospital providers need to master the basics. The skill sets must therefore be carefully selected. Skill learning should be performed on mannequins, mock ups, in live tissue training, cadaver labs and clinical placements. During these learning sessions, the medic needs to be closely monitored by skilled instructors to make sure that the procedures are performed correctly and as close to perfect as possible. Otherwise, we run the risk of giving the medic a false sense of success and might ingrain an incorrect procedure. It might be beneficial to have other medics watch each other with the instructor because they then can listen in on the feedback supplied from the instructor.

## Skill Retention

When the skill is automated correctly, the medic can start retention training. In this phase, the instructor does not always need to be present, but equipment and mannequins must be available to the medic at any time.

They should encourage each other to train and to monitor each other's training as to continuously get feedback on their performance. By making short instruction videos of all the "fingertip" skills, the medics can refresh the procedures before performing their individual training. The videos should be connected with multiple written training programs to guide the medics to exercise the right way. Video recording during training makes it possible

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to review, by yourself or by a colleague, at a later time. Specific training goals and phases covering warm-up, main part, and summary/debriefing should be a part of each training program.

## Scenario Training

Skill learning/training and scenario training differs in that a skill is simple by nature where all the steps are laid out and there are specific pass/fail criteria. Scenario training on the other hand needs to take into account that not only does the same pass/fail apply but the skilled instructor also needs to be able to know when to go from instructor to mentor to bystander depending on how well the medic reads and reacts to the situation.

Medical scenarios should not be limited to training for the medics, but also included in tactical scenarios with nonmedical personnel. Short medical scenarios should be incorporated in unexpected places during other training. For example, during a climbing exercise, you could put in a fall form height case, or during a diving exercise you could put in a drowning case. By doing this, the medic gets to apply his medical skills without mental or kit preparation, which is how it often plays out in real life. The medic might then realize that the way his kit is organized might not be optimal. For the civilian medic, one might argue that they always prepare during the drive to the scene but the information in the call to emergency services is not always entirely accurate. The medics will be expected to perform under stress/duress so it could be beneficial to progress training into low light conditions, uncomfortable settings, unexpected events, and perhaps sleep deprivation. The entire team should have awareness of how injury and illness will affect the operation and how they can assist to complete the demanded tasks as efficiently as possible.

It is important *not* to incorporate these scenarios in *one* single hectic medic-week, but instead spread out the scenarios to give continuity regarding exposure. The firing range is a good example of this. It is a place where accidents do happen so vigilance is in its place. With proper safety, a shooting drill can progress into a casualty training scenario that does not need to run very long or even interrupt the shooting for more than a few minutes. Micro scenarios can be run in the garage for the ambulances without informing the crew which will respond to the training call. An instructor should evaluate all scenarios and through debriefing guide the personnel to improve their craftsmanship.

## Experience

Medics need to understand when a patient is doing poorly/deteriorating (pale, clammy, cyanotic, shallow/deep breathing, and so on). Medics are expected by their instructors, superiors, and peers to use their "clinical view," something that can take intrahospital professionals many years to develop. Can years of experience be replaced by sophisticated monitors, electronic decision makers, or video consulting? It is beyond the scope of this article to address this dilemma.

Both civilian and military medics need to be cool headed enough to know when to not intervene or stop treating a casualty that is beyond saving. The treating medic will be the one who must live with the decision to stop treating, or not start treating the patient. In the military setting, the patient could even be your best friend. Even in the civilian setting it has occurred more than once that prehospital and intrahospital providers have been exposed to treating friends and family. A fair bit of ethics should therefore be involved throughout the training.

# THE SCIENTIFIC VIEW

## Introduction

Skills are not easily learned, and fast forgotten. Studies have showed that few months after a CPR course (cardiopulmonary resuscitation) less than one third of the students are able to perform adequate resuscitation (Fig. 1).[1–15]

Experience and research from music education and athlete training show that skills are learned and maintained in a different way than theoretical knowledge.[16,17] Repeating and exercising the skill plays a very important role both in learning and retention.[6,8] I will now discuss how to acquire/learn a skill, and then how to maintain this skill over time (skill retention).

## Learning Skills

Skills consist of several automated motor actions. Instructors must know how to teach motor actions and that motor learning differs fundamentally from theoretical learning. With theoretical learning, you can have a lot of misunderstandings. But after your teacher has corrected them, you will understand things mostly right for the rest of the future.[18,19] With motor learning, every repetition must be correct from the start. If you exercise a procedure wrong, your motor actions are automated and stored with error. It is much harder to correct them afterward, than to learn them and store them correct from the start.[20] This means that when learning a skill, instruction must be very tight right from the start.[20,21]

Motor learning is much better if the student can learn, practice, and master one skill at the time.[20] This is in sharp contrast to our present practice where all procedures are presented in an intensive course over some weeks.

It is suggested that humans are able to concentrate fully on one task for an average of 20 minutes. After that learning deteriorates rapidly. Learning is better in a positive atmosphere without stress. Studies have shown up to a threefold increase in achievement, with short learning sessions on different days instead of long sessions on the same day.[22,23]

To build motor memory, the student needs many repetitions. How many is not known. Violin teachers and shooting

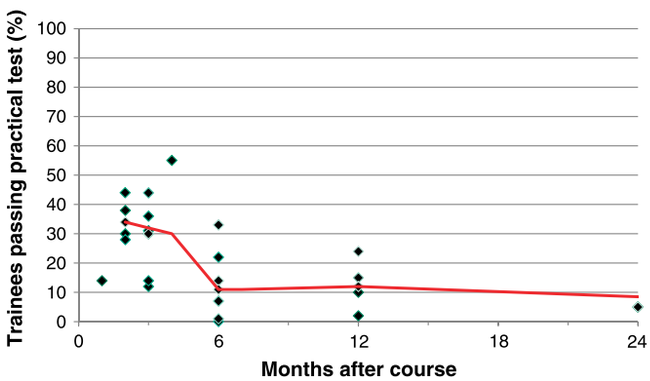


**Figure 1.** Results from 15 different studies showing the percentage of trainees passing a practical test of CPR skills, as a function of the time after the CPR course. *Black dots* are the individual studies. *Red line* is the median of the different studies.

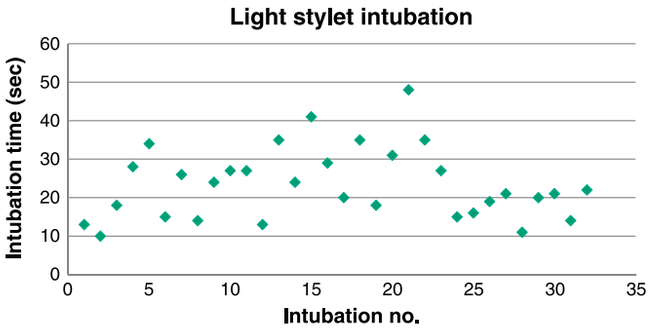


**Figure 2.** Intubation time as a function of the number of attempts. Intubation time was time from the bag/mask was removed from the patient, until the first ventilation on the cuffed endotracheal tube correctly placed in the trachea.

instructors often demand thousands, but that is not feasible in medical education.

When learning a new endotracheal intubation technique, we recorded the time from the start of the intubation attempt to the tube was in place in trachea.[24] In the beginning the time varied between 10 and 48 seconds. After approximately 25 repetitions, the intubation time stabilized between 11 and 22 seconds (Fig. 2). This could be taken as an indication that approximately 25 repetitions were needed to produce motor memory in this skill.

## Skill Retention

When a skill is learned, exercise is crucial to keep the skill.

The resuscitation skills of medical students were tested 13 months after a standard 10-hour emergency medicine course.[12] The control group had no repetition. The study group had an exercise every 3 to 4 months. In the study group, 66% of the defibrillations were within 60 seconds versus 15% in the control group. CPR was evaluated by the instructor on a scale from 1 to 5. 1 and 2 was harmful or inadequate CPR. In the study group, 83% of the students performed 3 or better versus 23% in the control group (Fig. 3).

If the skill has been automated correctly during the learning phase, the student can continue exercising the skill without

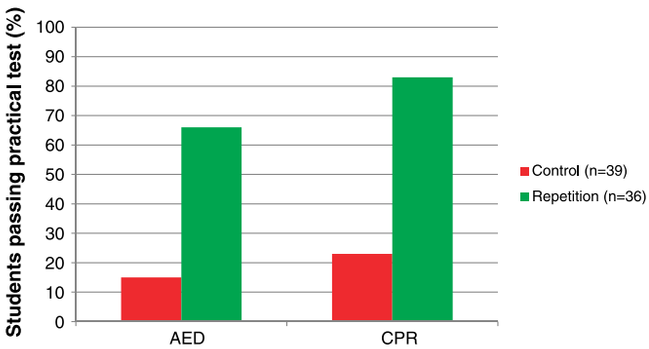


**Figure 3.** Performance of medical students 13 months after an emergency medicine course. The repetition group had three exercises at 3 to 4 months interval. The AED columns show percentage of students defibrillating within 60 seconds. The CPR columns show percentage of students giving adequate quality CPR. AED, automated external defibrillator.

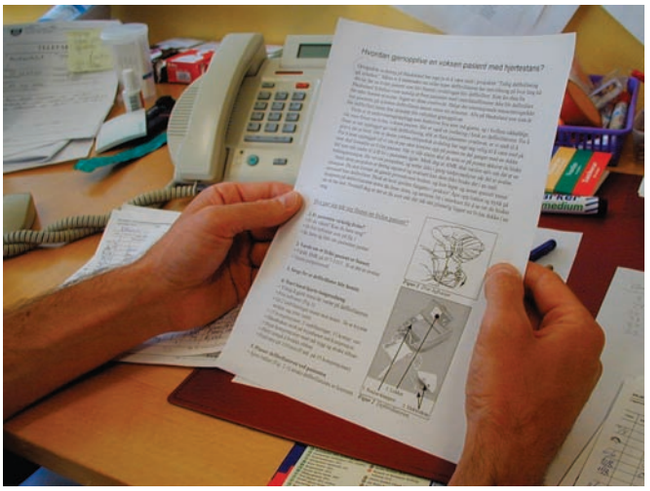

**Figure 4.** Information sheet replacing a standard 4-hour CPR course.

instructor in the retention phase. Stress can be added (sleep deprivation, multiple tasks, bad weather, enemy fire) to mimic realistic situations.

Training is more effective if you have a clearly defined goal to train for.[18] For example; more than 90% of the compressions must be correct, or intravenous access must be established within 3 minutes.

## Course Versus Exercise

A lot of our instructor recourses are used on designing and conducting courses. With limited resources, it is important to know whether instructors should concentrate on longer and more comprehensive courses or shorter repetitive training sessions. To study this, we replaced the standard 4-hour CPR course with an information sheet (Fig. 4) on an orthopedic ward.[25]

Then, we performed 40 unexpected tests on the ward, using the same amount of instructor time. Twenty tests were made during the first month, and 20 tests were made during the sixth month after handing out the information sheet. The results during the first month were not acceptable, but after 6 months, all parameters were much better (Table 1). Numbers were too small to test

**TABLE 1.** CPR/AED Performance Improves With Unexpected Testing Even Without a Formal Course

| | 1 mo | 6 mo |
|---|---|---|
| Time to obtain a free airway, min:s | 1:28 | 0:51 |
| Acceptable ventilations | 28% | 63% |
| Acceptable compressions | 74% | 93% |
| Longest hands-off time, min:s | 2:13 | 1:23 |
| Compressions/min | 76 | 87 |
| Time to the first defibrillation, min:s | 2:44 | 2:34 |

This table shows median performance during 20 tests made during the first month, and 20 tests made during the sixth month after handing out a CPR/AED information sheet. Hands-off time is time without chest compressions.

AED, automated external defibrillator.

for significance, but the trend was in sharp contrast to the decay of skills that is expected after a course. More research should be made on the effect of short repetitive training sessions versus traditional coursing for skill acquisition.

## Future Directions

This is what we know about motor learning. What we don't know is how many instructor guided repetitions are necessary, and how much and how frequent exercise is needed. These numbers are very important as they will have major implications on our education system. Are 15 to 25 repetitions enough, or are 10 000 repetitions necessary, as violin teachers and shooting instructors insist on? Are four exercises a year enough, or should we tell our medics to train three times weekly as their physical exercise instructors demand? And perhaps the most frustrating question: Why are we using most of our resources on making longer and more comprehensive courses, when we know that what we need is multiple short learning sessions to build motor memory, followed by frequent exercises to retain the skills?

### AUTHORSHIP

I.A. presented the work at the THOR/RDCR symposium, and has written the article. K.L.A. and H.P.K. have contributed to the section "The Paramedic View."

### DISCLOSURE

The authors declare no conflicts of interest.

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