Interhospital transport of the critically ill patient
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Chapter 5

Simulator-Based Crew Resource Management 
Training for Interhospital Transfer of Critically Ill Patients by a Mobile ICU

Joep M. Droogh, Hanneke L. Kruger, Jack J. M. Ligtenberg, Jan G. Zijlstra

Abstract

Background
Transporting critically ill ICU patients by standard ambulances, with or without an accompanying physician, imposes safety risks. In 2007 the Dutch Ministry of Public Health required that all critically ill patients transferred between ICUs in different hospitals be transported by a mobile ICU (MICU). Since March 2009 a specially designed MICU and a retrieval team have served the region near University Medical Center Groningen, in the northeastern region of the Netherlands. The MICU transport program includes simulator-based crew resource management (CRM) training for the intensivists and ICU nurses, who, with the drivers, constitute the MICU crews.

Methods
Training entails five pivotal aspects: (1) preparation, (2) teamwork, (3) new equipment, (4) mobility, and (5) safety. For example, the training accustoms participants to working in the narrow, moving ambulance and without benefit of additional manpower. The scenario-based team training, which takes about four hours, occurs in a training facility, with its reconstructed ICU, and then in the MICU itself. A “wireless” patient simulator that is able to mimic hemodynamic and respiratory patterns and to simulate lung and heart sounds is used. All scenarios can be adjusted to simulate medical, logistic, or technical problems.

Results
Since the start of MICU training in 2009, more than 70 training sessions, involving 100 team members, have been conducted. Quality issues identified include failure to anticipate possible problems (such as failing to ask for intubation of a respiratory-compromised patient at intake); late responses to alarms of the ventilator, perfusor pump, or monitor; and not anticipating a possible shortage of medication.

Conclusions
Setting up and implementing simulator based CRM training provides feasible and helpful preparation for an MICU team.
Introduction

Transporting critically ill ICU patients by standard ambulances, with or without an accompanying physician, imposes safety risks.[1–3] Although specialized “retrieval” teams have reported transport-related problems,[4–8] such transports seem to be safer.[6,8–11] In 2007 the Dutch Ministry of Public Health developed guidelines that stipulated that all critically ill patients transferred between ICUs in different hospitals be transported by a mobile ICU (MICU),[12] which led to the deployment of a nationwide system of seven MICU centers in the Netherlands.

Since March 2009 a specially designed MICU and a retrieval team have served the region near University Medical Center Groningen, in the northeastern region of the Netherlands, the MICU crew consists of intensivists, ICU nurses, and ambulance drivers recruited from the hospital’s ICU and ambulance service. The team from which the MICU crews are drawn has consisted of 15 to 20 intensivists and ICU nurses. We believe that a pool of 10 intensivists and 10 ICU nurses provides sufficient MICU staffing and transport experience. Because the MICU is neither an ICU nor an ambulance, we wanted to provide MICU–specific training for the intensivists and ICU nurses.

Intensive care medical societies have provided guidelines regarding patient transport,[13–16] which primarily address the required competencies of the patient transport (or “retrieval”) teams, yet safe patient transport also requires accessible standard operating procedures, addressing, for example, the equipment in the ambulance, protocols for personal safety, vehicle preparation, patient preparation for transport, communication within the team and with the referral and receiving teams, medical items, documentation, and incident monitoring.[5–7,13–25] There is scant literature on training for interhospital transport of critically ill patients.

In a study of 74 interhospital transfers of ICU patients who were conducted by our transport team in a 10- month period in 2009, we found that MICU transport was associated with a lower incident rate than for 100 standard ambulance transfers conducted in 2005, before our MICU service started (12.5% versus 34%).[1,2,8] We could not determine whether these results reflected the use of more sophisticated equipment and/or the use of the specialized retrieval team or the specifically designed training. However, we believe that performing complex procedures in a nonstandard setting, such as in the transport of critically ill patients, should not be done without special training to help the team members anticipate, prevent, and resolve technical problems.

In this article, we describe the training program for the possible benefit of other health care organizations considering establishing and refining their own interhospital patient transfer programs.
Methods

Setting up the training program
In setting up the MICU transport program in 2009, we identified five pivotal aspects of training: (1) preparation, (2) teamwork, (3) new equipment, (4) mobility, and (5) safety.

1. Preparation. Anticipating problems before they occur is a crucial aspect of interhospital transport, and therefore one of the main areas of training. Seventy percent of all complications during transport could have been avoided by good preparation.\[1\] On the basis of a literature review \[1,3,17,20,21,23,24\] and our own transport experiences, we created a list that served as a blueprint for transport preparation (Table 1) and can help prevent most medical problems.

2. Teamwork. The training addresses the lack of space in the ambulance and the absence of additional manpower. Good communication and teamwork is therefore of particularly vital importance. For example, communication with the driver regarding the possibility of speed adjustments or even making a complete stop is important.

3. New Equipment. Both the MICU and the “trolley” (transport stretcher) are custom made and, as a result, the training is held within the MICU and with a fully equipped trolley.

4. Mobility. Intensivists and ICU nurses are likely to have had experience with intrahospital but not interhospital transport and therefore need to be trained regarding interventions during transport. Some of this training occurs while the MICU is in motion.

5. Safety. Performing the training together with an MICU driver allows for practice in taking safety measures during transport, such as the use of safety belts in combination with adjustments in patient care. Because mobility itself can pose a safety risk, it is vital that all members of the team communicate well and recognize the risks. For example, changing infusions, preparing and supplying medication, and safely storing and using equipment are potentially more hazardous during transport than performing the same actions in the ICU.

Improvement and adjustments to the training along the way
Since the creation of the MICU transport program, we have continuously aimed to improve the training which now includes anticipation and treatment of technical problems that may arise during transport. The types of technical problems that we found in our preliminary experience with MICU transports, such as electric power (including batteries), gas supply, equipment, and mobility, had little impact on patient status, fortunately, but such problems are more threatening on the road, with little backup, than in an ICU.\[26\]

A few days before the training, participants thoroughly inspect the trolley and the MICU. In a session of approximately one hour, they are briefed about the different equipment used, the available supplies in the trolley and within the MICU, and the technical background of the equipment used (including the oxygen and compressed-air systems and the electric power system in the trolley and MICU). Critical procedures, such as switching from batteries to main
power supply and back, switching the oxygen/compressed-air supplies from tanks to wall outlets, and loading the trolley into the MICU, are further explained. Practical information about the training and transport protocols are sent to the trainees two weeks earlier.

Table 1. Important items for transport preparation

<table>
<thead>
<tr>
<th>Before Transport</th>
<th>Are all standard supplies complete (for example, medication, extra material, gas supply)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Is all equipment checked?</td>
</tr>
<tr>
<td>Patient Information</td>
<td>Medical history</td>
</tr>
<tr>
<td></td>
<td>Allergies</td>
</tr>
<tr>
<td></td>
<td>Reason for admission and medical course</td>
</tr>
<tr>
<td></td>
<td>Physical examination</td>
</tr>
<tr>
<td></td>
<td>Relevant lab results</td>
</tr>
<tr>
<td></td>
<td>Chest x-ray</td>
</tr>
<tr>
<td></td>
<td>Other potential important test (case specific)</td>
</tr>
<tr>
<td></td>
<td>Positions of tube, drains, iv access points</td>
</tr>
<tr>
<td></td>
<td>Present treatment</td>
</tr>
<tr>
<td>Evaluation before Transport</td>
<td>Is transport feasible?</td>
</tr>
<tr>
<td></td>
<td>Adjustment of treatment necessary?</td>
</tr>
<tr>
<td></td>
<td>Define possible problems and if possible take precautions</td>
</tr>
<tr>
<td></td>
<td>Additional monitoring necessary?</td>
</tr>
</tbody>
</table>

Simulator-based crew resource management training

The majority of training in medicine is based on training on the spot, but high-fidelity simulation-based training complements medical training in patient care settings.[27] Moreover, simulation-based training reduces medical error, enhances clinical outcomes, and reduces the cost of clinical care.[28–32] Health care providers are increasingly trained in specific medical skills and difficult team procedures, and crew resource management (CRM) is used to address aspects of human error, such as failures in interpersonal communication, decision making, and leadership. CRM provides a set of error countermeasures with three successive lines of defense: (1) avoidance of error, (2) trapping incipient errors before they are committed, and (3) mitigating the consequences of the errors that nonetheless occur.[33] Therefore, training focuses on communication, delegation, conflict management, leadership and followership, and calling for help early.[34] Given the risk of technical problems during MICU transport, the multiplicity of items needing to be addressed in training, and the large group of personnel to be trained, we decided to set up simulator-based CRM training.
**Scenario-Based Training**

The scenario-based team training takes about four hours. The training is led by an intensivist and two senior MICU nurses, who all participated in a simulator instructor course. An intensivist, an ICU nurse, and a driver are trained as a team. All aspects of a normal transport are simulated and are as realistic as possible. The training occurs in the university medical center’s training facility, with its reconstructed ICU, and, then, in the MICU itself. We use a patient simulator that is able to mimic hemodynamic and respiratory patterns and to simulate lung and heart sounds. The simulator is "wireless," so that transfers from the ICU bed to the MICU trolley and vice versa are as realistic as possible. Because the MICU intensivist and the MICU nurse are highly qualified and experienced ICU professionals, the focus is primarily on transport-related rather than medical-practice issues. Scenarios to simulate medical, logistic, or technical problems can be adjusted for the desired training in transport preparation, teamwork, equipment, mobility, and safety and may also be adjusted on the scene on the basis of how well the team is performing.

1. **Preparation**

We expect the team to perform a short physical examination of the patient and to check the latest laboratory results, electrocardiogram (EKG), and chest x-ray (Table 1). The team is also expected to ensure that the intravenous medication is prepared for the whole transport period and that all intravascular lines are secure. If items are overlooked during this phase, they will be addressed by modifying the scenario. For example, if a chest x-ray or tube position has not been checked on departure, we create a ventilator-tube dislocation after transfer to the MICU. Alternatively, if a patient with pneumonia and moderate respiratory distress has not been intubated before departure, it has to be done during transport.

2. **Equipment, Mobility, and Safety**

The simulation of minor medical problems is usually sufficient to help the team members learn to work in a narrow ambulance during transport with equipment that is often different from that used in the ICU. For example, mimicking sputum retention creates a need for checking on the patient while driving (and thus communicating with the driver), using the suction unit, or adjusting the ventilator settings. Initiating atrial fibrillation with a drop in blood pressure will most often result in administration of medication that has to be first collected and prepared. More severe medical procedures such as intubation or defibrillation are sometimes simulated, but it is not necessary to do so to reach our training goals.

3. **Technical Aspects of the Equipment**

A significant number of technical problems have occurred since we started our MICU service. [26] As stated, trainees receive information about the equipment before the simulation training.
For example, transport personnel have to be aware that the ICU ventilator consumes 3.5 liters of gas (compressed air or oxygen) in addition to the minute volume administered to the patient if they are to be able to calculate the right amount of gas supplies needed. In addition, simultaneous use of 2- and 10-liter tanks of gas, for example, sometimes drains the 2-liter tanks first.[26] If tanks are used incorrectly during the training, a shortage of gas would result. Leakage of gas can also be included in training scenarios, where trainees have to bypass the entire gas system and use a backup ventilator directly connected to an oxygen tank.

Problems with our electric power system, such as blown fuses or defective equipment, have also occurred, leading to the revision of our transport protocol (for example, the charging status of the transport trolley has to be checked before departure).[26] To simulate electric power system problems, we can switch off the 220-volt power supply to the MICU during training, even during transport.

A breakdown of the MICU itself is difficult to simulate. Yet there are procedures for such a breakdown, which would involve a second ambulance, and trainees are sometimes asked about them.

4. Teamwork
Transport; equipment, mobility, and safety; and technical aspects of the equipment all represent a team effort. During preparation and the transport itself, trainees are observed and judged on their communication skills, such as thinking aloud and closed-loop communication.

Conducting the Training
On the day of training, the MICU nurse to be trained checks all equipment according to the protocol (this standard procedure is performed on a daily basis). The training starts with a short introduction of trainers and trainees, description of training goals, and the scope of equipment training.

The scenario starts with a transport request by phone, a request that is handled by the MICU nurse, who completes an intake form. The nurse then discusses the case with the MICU intensivist. If necessary, additional information is obtained, and they decide whether or not to proceed with the request. If the request proceeds, the the MICU nurse and intensivist inform the driver, check the gas supply, and load the trolley in the MICU. They then travel in the MICU to the training facility ICU, where they are welcomed by an intensivist and ICU nurse for the medical transfer. Depending on how well they prepare themselves and the patient for transport, they will request additional information, such as laboratory results. Although they may be pressured for a rapid transport, there is time for the team to perform a thorough physical examination of the patient.
When the transport team agrees that the patient’s medical condition permits his or her transport, the patient is moved from the ICU bed to the trolley. The team then leaves the training facility and loads the trolley with the patient into the MICU. In the next 45 minutes, the MICU will have a quick drive to a nearby parking lot and back to the training facility, during which various medical and/or technical problems are simulated. The scenario concludes with the patient’s delivery to an ICU team at the training facility and transfer to an ICU bed. The training ends after a debriefing, in which feedback is given to all team members, different aspects of the scenario are discussed, and questions are asked about the reasons for certain decisions. In an open atmosphere, the team members discuss which aspects of the transport were handled correctly and which could have been done differently.

Results

Since the start of MICU training in 2009, more than 70 training sessions, involving 100 team members, have been conducted. We try to schedule training twice a month, both for new team members as well as current team members who may need a refresher session. Anecdotal information suggests that all team members, experienced ICU nurses, board-certified intensivists and ambulance drivers, have found the training to be useful. For example, they generally feel more confident about their skills after practicing the logistics of the transport process, with an increased awareness of medical, technical, or purely transport-related issues. The quality issues identified during the training sessions are listed in Table 2.

Conclusion

Setting up and implementing simulator-based CRM training provides feasible and helpful preparation for an MICU team. Our work since 2009 highlights the importance of continuously aiming to improve, with adjustment of training based on day-to-day experiences from the field. A major limitation of the training effort is that we have not investigated the effect of the training on complications during actual patient transfers and other patient outcomes. However, training in relatively simple procedures, such as basic life support and central venous catheter placement in training facilities, has proven to be effective.[32] So we suggest that using training facilities to provide training in the more complicated team procedure of transporting critically ill patients is also likely to be effective. This description of a training program is intended to advance the use of transport teams and help set new standards for training them.
### Table 2. Quality issues identified and improved through simulation

<table>
<thead>
<tr>
<th>Quality issues Identified</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Logistics</strong></td>
<td></td>
</tr>
<tr>
<td>- Incomplete intake forms</td>
<td>- Explain the relevance of procedures and protocols.</td>
</tr>
<tr>
<td>- Not following the procedures</td>
<td>- Extra attention during the training for procedures and anticipating possible problems</td>
</tr>
<tr>
<td>- Not anticipating possible problems, which could be anticipated at an early stage (at intake) so as not to delay transport (for example, failing to ask for intubation of a respiratory-compromised patient at intake).</td>
<td></td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
</tr>
<tr>
<td>- Traditional role model, in which the MICU nurse listens to the ICU nurse’s medical briefing, and the MICU intensivist listens to the physician’s medical briefing. Instead of the entire MICU team hearing both briefings</td>
<td>- Standardized procedure: The whole MICU team listens together to both briefings</td>
</tr>
<tr>
<td>- Not thinking out loud</td>
<td>- Emphasizes the importance of good communication: thinking out loud and closed loop communication</td>
</tr>
<tr>
<td>- Lack of closed loop communication</td>
<td>- While debriefing the training, point out situations where communication was lacking</td>
</tr>
<tr>
<td>- Inconsistent knowledge of how to use the intercom to communicate with the driver.</td>
<td></td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>- Unfamiliarity with the MICU trolley: what is the best way to get the patient on the trolley, taking into account the location and accessibility of the different equipment of the trolley</td>
<td>- Create training settings where different aspects of positioning the trolley play a role</td>
</tr>
<tr>
<td>- Unfamiliarity with the location of supplies within the MICU / forgetting the existence of plastic index lists within the MICU</td>
<td>- In debriefing, point out the issues to be considered while positioning the trolley</td>
</tr>
<tr>
<td>- Late responses to alarms of the ventilator, perfusor pump, or monitor, particularly when the team is distracted, for example, while loading the trolley into the MICU.</td>
<td>- Create training settings where different equipment or stocks have to be looked up</td>
</tr>
<tr>
<td>- Inconsistent knowledge of oxygen and compressed air tanks: How to connect them and when and how to use the main hospital/MICU supplies.</td>
<td>- Emphasize the importance of the alarms, especially in a transport setting</td>
</tr>
<tr>
<td>- Inconsistent knowledge of the electric system: Late responses to blown fuses or other electric power failure.</td>
<td>- Supply participants with background information about the use of tanks and how they are used by the ventilator</td>
</tr>
<tr>
<td><strong>Medication</strong></td>
<td></td>
</tr>
<tr>
<td>- Not anticipating a possible shortage of medication during transport and therefore not preparing additional medication before transport.</td>
<td>- Supply participants with background information about the electric system</td>
</tr>
<tr>
<td>- Difficulties in preparing medication while driving</td>
<td></td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td></td>
</tr>
<tr>
<td>- Failing to meet the safety standards, for example, not wearing seat belts when possible, not warning the driver while planning to perform interventions (when seat belts would need to be removed)</td>
<td>- Emphasize importance of anticipating possible problems, such as empty syringes</td>
</tr>
<tr>
<td>- Failing to discuss before departure how urgent the transport is. Should the driver use the siren, is police assistance necessary?</td>
<td>- Create training settings where medication has to be prepared during transportation</td>
</tr>
<tr>
<td>- Standardized safety procedures</td>
<td>- Continuously confront participants when infringing these procedures</td>
</tr>
</tbody>
</table>
References
