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Review

# High-fidelity simulation in Neonatology and the Italian experience of *Nina*

**Armando Cuttano[1], Rosa Teresa Scaramuzzo[1,2], Marzia Gentile[1], Francesca Moscuzza[1], Massimiliano Ciantelli[1], Emilio Sigali[1], Antonio Boldrini[1]**

[1]Neonatal Intensive Care Unit, Azienda Ospedaliera Universitaria, Pisa, Italy
[2]Life Science Institute, Scuola Superiore Sant'Anna, Pisa, Italy

## Abstract

The modern methodology of simulation was born in the aeronautical field. In medicine, anesthetists showed great attention for technological advances and simulation, closely followed by surgeons with minimally invasive surgery. In Neonatology training in simulation is actually useful in order to face unexpected dramatic events, to minimize clinical risk preventing errors and to optimize team work. Critical issues in simulation are: teachers-learners relationship, focus on technical and non-technical skills, training coordination, adequate scenarios, effective debriefing. Therefore, the quality of a simulation training center is multi-factorial and is not only related to the mannequin equipment. High-fidelity simulation is the most effective method in education. In Italy simulation for education in Medicine has been used for a few years only. In Pisa we founded *Nina* (that is the acronymous for the Italian name of the Center, *CeNtro di FormazIone e SimulazioNe NeonAtale*), the first neonatal simulation center dedicated but integrated within a Hospital Unit in Italy. This paper describes how we manage education in *Nina* Center, in order to offer a model for other similar experiences.

## Keywords

Simulation, Neonatology, team work, crisis management resource, error, debriefing.

## Corresponding author

Armando Cuttano, Neonatal Intensive Care Unit, Azienda Ospedaliera Universitaria, Pisa, Italy; email: acuttano@gmail.com.

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## Introduction: the history of simulation

Once upon a time a man observed that fire could be generated by a violent collision between two flints or by the friction of two dry woods on some straw or dry foliage. He strongly wanted to create that light again, so he tried and tried in order to make the method perfect. Simulation was performed to be prepared to generate the fire whenever he needed. Simulation was born.

The modern methodology of simulation was born in the aeronautical field. Critical moments during the flight, e.g., taking off, landing and many others, can be reproduced in simulators (which were simple tools at the beginning but nowadays are more and more complex) so that experience is amplified, capacity and security are reached on the landscape before going in the sky [1]. For a F-18 aircraft, landing on an aircraft-carrier during a storm should not be a unique event but a real possibility: it is difficult to perform but belongs to routine, it is complex but has large safety margins. The F-18 pilot is able to land in 300 meters on the track of that aircraft-carrier as well as the Airbus A-380 pilot, carrying 850 passengers, does in a three-kilometer-long airport track: both of them have to be trained to something unexpected. So, simulation training has been employed extensively among pilots for many years now.

In the modern medicine, anesthetists showed a major sensitivity for technological advances and simulation [2], closely followed by surgeons with minimally invasive surgery (i.e., laparoscopy). It has been developed the so-called computer-assisted surgery, allowing to perform complicated surgical interventions by sophisticate equipment such as the *Da Vinci* robot, Intuitive Surgical, Sunnyvale, CA [3, 4]. This methodology even allows the surgeon to be far from his patient, as occurred for professor Marescaux in Strasbourg moving satellite-linked up instruments (remote controlled *Zeus* Surgical System) on a 68-years-old female patient in the United States, to perform a gallbladder removal [5, 6]. Furthermore, even if a disadvantage of robotic surgery could be pointed out in its high costs related to purchase and maintenance of technology, operating room time decreases with experience using the robot and performance quality improves through simulations [7].

The *Da Vinci* user has to be prepared for anything unexpected as well as the F-18 pilot. This aim is likely reached not through improvisation, but through trials and errors in a never-ending simulation, until movements become smooth, knowledge becomes broad and instrument control become complete. Yet, it is not enough since possible adverse situations to simulate and experiment are endless. Therefore, the finishing work must be continuous and license maintenance should require a continuous simulation training for surgeons as well as for pilots.

## Simulation in Neonatology

An unexpected event (e.g., placental abruption, umbilical cord prolapse, a newborn with undiagnosed malformations, a NICU patient with cardiac arrest or shock) is not rare in Neonatology and can become dramatic. Operators are required to act with the right skills and abilities in the shortest time. Awareness and education are mandatory. Often it is a team work, in which each member must be trained specifically in what they are doing [8, 9].

According to the *Swiss cheese model* by J. Reason every incident is not due to a single error but it is the result of a series of misunderstandings, irregularities or negligence (cheese holes). Many lined holes make the incident occur [10].

The human factor is crucial in healthcare [11]. The clinical risk should always be taken into account: fear of ligation leads to defensive medicine, which is definitely not the best practice [12]. Instead, to raise the safety standards is necessary [13]. Errors should be imagined earlier than they could occur so that theorized management strategies can be correctly applied [14].

Moreover, hot issues in error management are the staff turnover, the continuous technological progress with ever new equipment and the advancement of knowledge, requiring continuous upgrade.

Neonatology is a multidisciplinary field since it includes pediatric knowledge (i.e., diagnosis and treatment of congenital, connatal and early childhood diseases), anesthesiological abilities (i.e., intubation, mechanical ventilation), mini-invasive surgical skills (e.g., ultrasound-guided effusions evacuation, pneumothorax drainage) and much more.

In addition, the neonatologist is used to work within a wider team in the delivery room, e.g., gynecologists, anesthesiologists, nurses, midwives.

For all these reasons Neonatology married simulation some years ago, especially high-fidelity simulation.

## Trainers and learners

A problem felt by those who approach this type of training, both those who deliver and those who receive it, is the trainers' license. Excellent qualified simulation centers have been established. Others only boast about this feature. Actually, the issue is that this kind of trainers must join a large knowledge and many skills.

Firstly, communication ability, between dialectics and counseling, is mandatory.

Secondly, trainers have to know all the simulation equipment and the skills.

Finally, they must be able to work in teams with other trainers.

A student to teacher ratio of 1:3-1:4 is optimal and complex simulations are supposed to involve 3-4 instructors simultaneously. Teachers must have a deep specific knowledge in order to enhance the learner, providing the tools for a proper critical evaluation of the facts. They have to maintain a peripheral position towards learners and always respect them. Even the most inexperienced student should not be put in the corner but still receive a chance of successful learning.

All learners in a high fidelity simulation training centre are supposed to receive respect and calm, basically because two opposite conditions may occur:

1. Learners may face a subordinate position, which is never good because it could make them close their communication channels. This subordinate position can arise in part from a bad-managed instructor's role, when he is the only ruler of a very specific knowledge.
2. Learners may be experienced in the specific medical field (e.g., anesthesiologists). If the instructor lose the contact with the audience, this kind of learner does not fully appreciate the methodology and re-evaluate the usefulness of their attendance at the training phase. This situation does not happen if the instructor stands at the side, emphasizes the presence of each participant and makes him feel a good actor and useful to the success of the course.

Briefly, every course should be not performed by teachers and learners, but by people who act as more or less experienced colleagues in the field. Of course, if learners are very young and completely inexperienced colleagues or students in training, the instructor's role is different since he is supposed to indicate a strong guide, the most simple yet clearly understood, in order to avoid confusion.

For the extreme cultural diversity of all potential learners, instructors have a virtually endless work in designing and playing courses according to different strategies.

To gain the skills is an aim of this type of formation. Skills that can be divided into technical and non-technical ones.

Technical skills can be simple (e.g., orotracheal intubation, artherial or venous catheterism, evacuation of effusions or pneumothorax, lumbar puncture) or complex (e.g., optimizing mechanical ventilation strategies, using medications such as inhaled nitric oxide by proper use of dedicated equipment, managing of asphyxiated neonate by therapeutic hypothermia).

Non-technical skills relate to relationships between people, as theorized in the Crisis Resource Management (CRM) model, encoded in 15 points: (**Tab. 1**) [15].

**Table 1.** Gaba's points.

| |
|---|
| 1. Know the environment |
| 2. Anticipate and plan |
| 3. Get early help |
| 4. Exercise leadership |
| 5. Distribute the workload |
| 6. Mobilize all available resources |
| 7. Communicate effectively |
| 8. Use all available information |
| 9. Prevent and manage fixation errors |
| 10. Cross (double) control |
| 11. Use cognitive aids |
| 12. Reassess again and again |
| 13. Use good teamwork |
| 14. Pay attention wisely |
| 15. Set priorities dynamically |

The staff involved in neonatal management includes physicians and nurses in the ward and in the emergency services too. They all are supposed to relate to patients' parents and relatives. Communication with them is a hot topic. The very final aim is to integrate all the professional staff in an effective team. To this aim, a collaboration with psychologists and linguists may be beneficial to decode behaviors that, even if private, tend to become nodes limiting the team functioning. Therefore, the CRM could become mandatory in Neonatology.

## Simulation steps

To analyze the simulation process step by step it is useful to organize a training course in the correct way (**Fig. 1**).

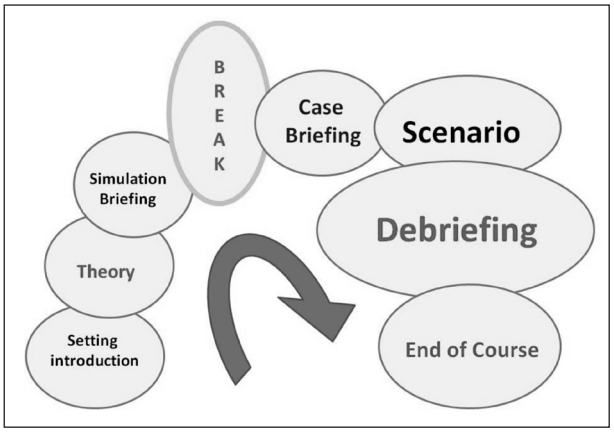


**Figure 1.** Simulation training programme can be ideally divided into different phases: setting introduction, theory, simulator briefing, case briefing, scenario, debriefing. Learners go through three different processes: preparation, action and reflexion. The different size of the rounds explain the different importance of the phases in the learning process in our opinion.

1. Introduction setting – During the introduction relationships between instructors and learners are established. They all begin to know the rules of simulation and explore the environment. All possible verbal and non-verbal techniques should be used by instructors to encourage a constructive approach to learning.
2. Theory – It is the opportunity for knowledge consolidation. It is the time for critical review of protocols and checklists, and critical analysis of the possible choices. All that should be done by choral participation.
3. Simulator Briefing – It is the deep explanation of the simulation rules. So, it is the nearest step to the simulation itself and it is mandatory to the success of the training phase.
4. Break – Pleasant pauses to join a cup of coffee are useful and friendly talks are a real part of this kind of education!
5. Case Briefing – It is the description of the case that is going to be simulated. It is a simple introduction to the action. Its importance to the simulation itself should not be underestimated.
6. Scenarios – Realism is the basis of a well-written scene. If it is possible, real material should be used. Every clinical event is suitable for simulation: perinatal asphyxia, neonatal shock, neonatal seizures, arrhythmias, sepsis. During simulation, everything is videotaped.
7. Debriefing – The discussion following the simulation, led by two instructors, is the debriefing. It tries to hoard all the good done. Of course, it should also point out anything that needs to be improved. Anyway, it must always be constructive and never destructive, otherwise it would ultimately turn into a negative experience learners want to go far away from. In our opinion, debriefing is the most important phase of this methodology but it is also the most difficult to realize for instructors themselves. Some Authors argue that simulation is an excuse to do the debriefing. To guide debriefing instructors may use the audio-videos recorded during simulation. This step is generally twice longer than simulation. It follows precise rules even if different instruments could be used [16].
8. Course conclusion – This final stage pull the threads of the discussion. Hot topics are finally pointed out and underlined again. Eventually, foundations for future simulations start from here. There is also an important feedback for instructors at the end of each course, so that they can collect ideas to optimize and improve the work at present and in the future.

## Aim of this paper

In Italy simulation for education in Medicine has been used for a few years only. In Pisa we founded *Nina* (that is the acronymous for the Italian name of the Center, *CeNtro di FormazIone e SimulazioNe NeonAtale*), the first neonatal simulation center dedicated but integrated within a Hospital Unit in Italy. This paper describes how we manage education in *Nina* Center, in order to offer a model for other similar experiences.

## Materials and methods

While speaking about simulation-based education, we have to focus on location, staff and instruments.

In our opinion, the strategic choice of *Nina* has been to create a training center with high technology just in a location within the NICU ward, so deeply linked to the real daily healthcare activities, but functionally separated from it.

All simulation training centers are divided mainly into two types:

1. *In situ* centers, where the simulators are housed in the ward but their use is allowed only during caregivers' work breaks.
2. Dedicated centers, often placed in structures faraway from hospitals and completely disconnected from real work environments.

Thanks to *Nina*, a third type can be described, i.e., a dedicated *in situ* center. The whole ward has been audio-video wired, so that the real and the simulated could be equally enjoyable in the courses rooms.

In an advanced center like *Nina*, learners can join several options of loyalty, from the static simulator or plastic anatomical piece, to simulators with an intermediate single utility (e.g., a plastic head and throw for intubation skills), to simulators with a few detectable functions (e.g., dummy sensor for effective CPR), to more complex simulators with multiple functions.

Actually, in our opinion the quality of a simulation training center is multi-factorial and is not only related to the mannequins equipment. It depends on the instructors' ability, on the whole working environment, on the simulations originality and appeal, and last on the used devices.

Instructors working at *Nina* Center are all certified by SIN (Società Italiana di Neonatologia: Italian Society of Neonatology) and some of them (i.e., group leaders) have international certifications.

Moreover, the fidelity of a simulator is not always strictly linked with its cost. For example, *Nina* instructors often use real umbilical cord pieces placed into a plastic bottle in order to teach umbilical vessels catheterism. In this case, the only cost is a paper sheet to get informed consent by parents plus a 0.50 cents cost of the bottle!

Anyway, a good center should use appropriate devices for teaching tools. For example it is particularly difficult to teach intubation without a video laryngoscope, which allows both the instructor and the learner to see larynx together and allows the teacher to give learners indications in real time. This methodology allows quickly and effective learning skills without any additional risk for the newborn.

## Results

Our activity in medical education started 3 years ago, in 2009.

Since there, we performed 9 classes per year, 2-day-lasting each one. In our opinion this time is the minimum to practice in technical skills for educated staff.

Generally, 15 learners attend to each class (ratio learners:teachers = 3:1). Therefore, about 900 learners attended to our activities so far.

Learners in each class are homogeneous, composed of physicians (pediatricians, neonatologists, anesthesiologists, gynecologists and emergency doctors) and nurses. They work in Pisa and in the nearest hospitals or in the first aid services in Tuscany. The courses were divided and organized for different levels of experience of the students, studying their approach to learning the skills with the use of new devices, such as video laryngoscope (C-Mac-Stortz) and the video spindle (Bambridge-Storz) for difficult intubation.

We primarly discuss topics about neonatal resuscitation. Starting from APP (American Academy of Pediatrics) guidelines, we propose algorithms from Advanced Neonatal Resuscitation and Stabilization Scenarios by Laerdal.

## Conclusions and future perspectives

In simulation involvement is unavoidable, even if at the beginning people can be sceptic.

At the end, partecipants cannot remove the memory of simulation as like as after an intense really lived experience. So, memory will remain in everyone's emotional baggage and experience, and will fall inevitably into the possible choices for a future real occurrence.

Our experience in Pisa with the Center for Neonatal training and simulation *Nina* is the first one in Italy, and it is still continuously growing.

We are including a dedicated Delivery Room within the block, with an advanced simulators (mother-infant). A larger group of instructors is still forming, and it is the true resource of the methodology.

We are going to study the learning curves focusing on attention (given by the pointing of the learners' eyes, which remain fixed in time, movements of fixation frequency of movement, level of concentration and other parameters).

We are also trying to study the leader's function, observing learners' behaviour with and without the teacher in the same room. Our center has been being transformed into a real laboratory, where also ideas for innovative devices can take shape.

In our opinion simulation should be the key for medical education and training. Improving it will have great consequences on real patients care.

## Declaration of interest

No conflicts of interest exist.

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