Teamwork and Communication

Eight Critical Factors in Creating and Implementing a Successful Simulation Program

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Training has been shown to have life-saving consequences."[1(p. 79)]

Clinicians, researchers, administrators, practitioners, and educators, given the need to reduce preventable adverse events caused by human error, have strived to enhance clinicians' knowledge, skills, and attitudes (KSAs). One potentially effective mechanism for achieving such gains is training. Training is designed to develop the requisite competencies for task completion by producing sustained cognitive and behavioral changes.[2] Because of the risks inherent in learning new skills or advancing underdeveloped skills on actual patients, simulation-based training (SBT) has become a staple across the medical education continuum.

The prevalence of SBT is abundantly clear, as indicated, for example, by a 2010 survey conducted by the Association of American Medical Colleges[3] that showed that more than 85% of the 90 participating medical schools and 64 teaching hospitals use simulation across the medical residency training continuum, approximately 60% use simulation for subspecialty clinical fellowships, and approximately 68% use simulation for practicing physicians. Responses from the 115 medical simulation centers (of 700 centers invited) in a 2010 survey indicated that medical schools had the highest annual operating costs for their simulation centers.[4] Because an extensive amount of time and money is dedicated to developing, implementing, and evaluating simulation, the simulation literature has also increased exponentially—as represented by meta-analyses,[5] qualitative reviews,[6] systematic reviews,[7] best practices,[8] frameworks,[9] and guidelines.[10] In a systematic review of 109 articles, Issenberg et al. found that high-fidelity medical simulations positively affect learning under the appropriate circumstances, such as providing feedback, individualizing learning and simulators, and repetitive practice.[11]

Although this literature has provided useful insights, the proliferation of information can be overwhelming, confusing, or even forgettable. Furthermore, practitioners are frequently faced

Article-at-a-Glance

Background: Recognizing the need to minimize human error and adverse events, clinicians, researchers, administrators, and educators have strived to enhance clinicians' knowledge, skills, and attitudes through training. Given the risks inherent in learning new skills or advancing underdeveloped skills on actual patients, simulation-based training (SBT) has become an invaluable tool across the medical education spectrum. The large simulation, training, and learning literature was used to provide a synthesized yet innovative and "memorable" heuristic of the important facets of simulation program creation and implementation, as represented by eight critical "S" factors—science, staff, supplies, space, support, systems, success, and sustainability. These critical factors advance earlier work that primarily focused on the science of SBT success, to also include more practical, perhaps even seemingly obvious but significantly challenging components of SBT, such as resources, space, and supplies.

Systems: One of the eight critical factors—systems—refers to the need to match fidelity requirements to training needs and ensure that technological infrastructure is in place. The type of learning objectives that the training is intended to address should determine these requirements. For example, some simulators emphasize physical fidelity to enable clinicians to practice technical and nontechnical skills in a safe environment that mirrors real-world conditions. Such simulators are most appropriate when trainees are learning how to use specific equipment or conduct specific procedures.

Conclusion: The eight factors—science, staff, supplies, space, support, systems, success, and sustainability—represent a synthesis of the most critical elements necessary for successful simulation programs. The order of the factors does not represent a deliberate prioritization or sequence, and the factors' relative importance may change as the program evolves.

Table 1. Success Factors and Tips for Incorporating Them into Simulation Programs

Success Factor	Tips for Incorporation
Science	• Utilize multidisciplinary collaborations of clinicians and training designers. • Leverage available checklists to ensure that all facets of training have been accounted for. • Use an in situ training location to foster attendance by having it conveniently located. • Create a bulletin board to publicly announce desired behaviors. • Provide impromptu drills to offer trainees more opportunities to practice.
Staff	• Recruit champions to promote the use of simulation for training. • Demonstrate simulation in all departments to encourage interest and active participation. • Capitalize on unique resources, such as college or high school volunteers, local theatrical students, and military medical personnel.
Supplies	• Procure supplies from surplus or expired equipment available in other units. • Look to outside funding when obtaining supplies from local facilities is not feasible.
Space	• Connect with the committee responsible for allocating facility space. • Suggest temporary locations like a "time share" for the simulation laboratory when a permanent location is not possible. • Seek off-site locations and consider community resources.
Support	• Offer simulation briefings and demonstrations to senior leadership to generate their interest and support. • Focus on the positives of simulation-based training and show its value. • Consider publishing facility employee newsletter articles on simulation training to keep interest and awareness alive.
Systems	• Match the fidelity of the training system with desired training objectives. • Ensure that the network infrastructure/capabilities are sufficient. • Consider upfront costs and recurring maintenance that is needed for simulation equipment.
Success	• Share success stories verbally and in newsletters or posters. • Encourage sharing success stories.
Sustainability	• Hold contests for naming mannequins. • Create simulation committees. • Build a cadre of staff with new simulation champions and instructors.

with a multitude of challenges in creating and championing simulation programs. Because creating a simulation program is still a daunting feat, there is a need for a streamlined synthesis of the critical factors of simulation. Accordingly, in this article we draw on the extensive body of research pertaining to simulation, training, and learning to delineate eight critical factors that can serve as a heuristic that clinicians, researchers, educators, and administrators can use to promote the creation and implementation of simulation programs. These critical factors advance earlier work that primarily focused on the science of SBT[12,13] success, to also include more practical, perhaps even seemingly obvious, but significantly challenging components of SBT, such as resources, space, and supplies. These eight factors do not represent another review or a new theory but rather depict a novel organizational structure, to provide practical guidance for those who would like to create and implement a successful simulation program.

The Eight Critical Factors for Simulation

In the attempt provide a heuristic of the important factors for successful simulation, we developed the eight "S's" of simulation—science, staff, supplies, space, support, systems, success, and sustainability. Leveraging eight "S" words for prosperous simulation may seem trivial; however, this heuristic is advantageous, considering the parameters inherent within human information processing and memory.[14] That is, organizing this heuristic by "S" words should foster memorability and, ultimately, use. It should also be noted that we are not organizing these factors based on importance or sequence, as they all have merit. In the following sections, we describe each of these factors in detail and provide an example to illustrate successful implementation. Table 1 (above) provides a list of the eight factors and tips on how to effectively incorporate them into the creation and implementation of simulation programs.

1. Science—Maximize Your Training Potential

Although evidence suggests that training, even SBT, is effective,[15,16] it is not a guarantee. Trainees can participate in training without acquiring knowledge and skills or changing attitudes. Simply adding the "bells and whistles" of simulation to training does not necessarily ensure its success.[12] SBT must adhere to the science of training (and learning) to truly maximize effectiveness. The science of training suggests that simulation scenarios should be linked to learning objectives, have multiple opportunities to perform, include diagnostic measurement tools, and be appropriately guided by timely and constructive feedback.[17] Rooting simulation in learning objectives ensures that scenarios are targeting the desired competencies, as opposed to simply leveraging previous, interesting cases. Ensuring that there are multiple opportunities to perform is beneficial for the trainee, as it offers more practice moments and is advantageous for the observer because multiple exposures afford more chances to measure behaviors,[18] which provides a more accurate assessment of the trainee's ability. Finally, diagnostic measurement, as well as timely and constructive feedback, produce meaningful guidance on how to improve specific behaviors in future performance.[19] Appropriate use of training will foster improvements in performance and learning, although it should be noted that learning occurs in and out of training.

Consequently, SBT should be thought of as a system and not a one-time event, so that the components preceding and following training are equally accounted for and considered as the training itself.[1] In particular, the trainee's characteristics (for example, cognitive ability) and states (self-efficacy), the training surroundings (location), the training requirements (voluntary or mandatory attendance), the organizational policies (rewards or support), and the transfer environment (opportunities to practice) should all be appropriately scrutinized and addressed. It is important to consider the facets of the trainees, training, and organization—all of which can influence training outcomes.[20]

As suspected, there are numerous ways to consider trainees, training, and organization, and every program needs to adapt accordingly. A few potential ideas to facilitate a more holistic approach include incorporating in situ training to facilitate attendance in a more convenient location, creating a bulletin board to promote trained skills by publicly recognizing desired behaviors, and performing impromptu drills to offer more opportunities to practice. For example, Jackson Memorial Hospital, in conjunction with the Army Trauma Training Center (ATTC) in Miami, provides in situ simulations in the emergency room. The instructors also leverage the audio and video recording capabilities to review the performance with the trainees to provide immediate feedback that can facilitate accurate, task-based discussion targeted at either individuals or the team collectively, a cornerstone for self-reflection and learning.[21] As another example, the Gjøvik University College (Norway), when conducting simulations, uses an interactive approach with learners. Interactivity fosters active learning, engagement, and motivation, all advantageous for advancing knowledge and skill acquisition. For additional ideas on how to practically incorporate the science into a simulation program, we encourage clinicians to collaborate with training designers. If such collaborations are not feasible, we recommend leveraging checklists that offer prescriptive guidance and structure on building and sustaining a scientifically sound simulation program.

2. Staff—Recruit Champions to Promote Simulation

An organization's workforce is its most valuable asset. Worldwide economic cycles and a global economy have leveled the financial and product market, making human capital the domain in which organizations have the best opportunity to gain an advantage over their competitors.[22] An organization's workforce is not only its most valuable asset, it is also its most expensive. The cost of human capital investments has been estimated to be as high as 70% of organizational costs.[23] To stay abreast of the competition, organizations spend more than $134 billion annually on training initiatives,[24] including SBT, to ensure that employees have the capability to correctly and effectively perform their jobs. Because of this expense, organizations often aim to cut costs by employing a leaner workforce.[25] As a result, many organizations are faced with staffing concerns and work overloads. This is particularly felt in the health care sector, where employees work long hours in fast-paced and high-stakes environments.

It is ideal for organizations that desire to establish a simulation program and those that already have a program in place to hire a simulation coordinator to orchestrate and lead SBT efforts. Unfortunately, the trend toward leaner workforces often makes it impossible to hire a dedicated coordinator. The simulation education mission is likely an added duty at most medical centers. In the absence of a dedicated coordinator, how does a medical facility create or expand a simulation program? Recruitment of health care champions is imperative for program growth. Champions promote the importance of simulation programs within medical facilities and educate organizational members about the varied purposes and functions of simulation and how simulation can directly impact both employees and the facility. Focusing SBT to include all facility academic partnerships and programs will aid organizationwide support of simulation efforts by engaging multiple disciplines (for example, operating room, anesthesia, labor and delivery) throughout the facility. Such a tactic has the advantage of quickly spreading the word about simulation and facilitates champion recruitment across all departments. In addition, creation of a simulation program may be made easier when support comes from persons of power within the medical center. For example, in 2002 Dean Thomas Nasca, MD, at Thomas Jefferson University in Philadelphia issued the command to develop simulation support of undergraduate medical education.[26] In response, the codirectors of the University Clinical Skills and Simulation Center (UCSSC) worked with the Jefferson Medical College Curriculum Committee and within two years put into place a 10-station Objective Structured Clinical Examination (OSCE), which every student was required to pass to enter into the fourth year (at Thomas Jefferson University).

Resistance from facility personnel is likely. The best way to overcome resistance is to communicate the importance and utility of SBT, educate people about the simulation department's mission, and encourage participation.[27] Education and recruitment can be accomplished through department simulation demonstrations and networking. Creativity and willingness to capitalize on access to unique resources can help. For example, college or high school volunteers and military medical personnel volunteering or on approved orders can be used for training scenarios. Local theatrical students can be solicited to serve as scenario actors.

3. Supplies—Obtain Resources from Local Facilities and External Organizations, Agencies, and Institutions

SBT is resource-intensive,[28] and it should come as no surprise that supplies are needed to support SBT.[29] "Supplies" encompass the broad spectrum of materials, resources, and equipment that are used during actual training scenarios (for example, examination tables, mannequins, monitors, telephones, or clinician tools). Although it may seem commonplace that supplies will need to be incorporated into SBT, determining how best to secure relevant training materials and resources is no trivial task. Supplies cost money, and securing adequate resources to support simulation with a limited budget is a manageable, yet challenging fiduciary task.[30] Identifying partnerships within local facilities or looking to outside funding sources provide fruitful opportunities to this end. Training program facilitators can make contact with their facility's Supply and Logistic staff to inquire whether—or when—equipment or supplies are turned in for disposal. Material turned in for disposal, in turn, can be leveraged to support training. However, we caution that leveraging such supplies has the potential for negative learning. To ensure that inappropriate behaviors (for example, using expired medications) are not adopted on-the-job, it should be explicitly stated to learners that such materials are being used. Accordingly, capitalizing on partnerships and disposed supplies may be the only feasible option. For example, the Institute for Simulation and Interprofessional Studies (ISIS; University of Washington, Seattle) formed a partnership with the pharmacy at its local institution.[31] This relationship enabled the ISIS to procure supplies for simulation at no additional cost. For example, the ISIS used expired medications and syringes filled with water. When appropriately framed, the use of expired medical supplies can be added to enhance the realism of the training scenarios. In addition, Biomedical Equipment and Facilities Engineering may also have excess equipment that can be used as actual or simulated equipment or props for simulation labs or centers. Leveraging such partnerships allows simulation centers to obtain additional medical equipment and supplies with no upfront or recurring costs.[31] Collaborative partnerships with other departments or institutions not only brings additional resources to the table but allows other groups to benefit from the simulation program.[32]

If obtaining supplies from local facilities is not feasible, training facilitators can look for funding opportunities to pay for aspects of their training program. Comprehensive Emergency Management Program funds, which are financial resources targeted at improving the planning and coordination efforts at responding to and addressing emergency and disaster-type situations, have been approved for simulation training, and annual calls for facility improvement fund requests occurs in the spring.[33] Joint Incentive Fund projects provide support when the US Department of Defense and the Department of Veterans Affairs (VA) work collaboratively to develop innovative research to improve facets of training.[34] Research grants from the Telemedicine & Advanced Technology Research Center (TATRC),[35] Agency for Healthcare Research and Quality (AHRQ) Research Grants,[36] and community or state grants should also be considered. For example, TATRC cites the US Department of Defense's requirement to train 100,000 military health care personnel annually and "increasing national interest in reducing medical errors." Alternatively, revenue may be generated from outside clinicians willing to pay for practice and training sessions,[37] thereby providing the simulation effort with its own internal funding source.

4. Space—Think Beyond Your Own Walls

Successful training requires a prepared learning climate and environment.[1] Environmental features, known as situational constraints (for example, a lack of materials and supplies needed to complete job tasks[38]) can inhibit individuals' work performance.[39] Similarly, situational constraints can undermine training attitudes[40] and subsequent use of trained KSAs on the job,[41] underscoring the importance of situational elements, such as dedicated training space, to training success.

Many medical facilities have some or significant space issues. Being a facility committee member or being networked with the facility committee responsible for allocating space, along with securing senior leadership buy-in, is helpful in prioritizing the need for a dedicated SBT home within the facility. When renovations and new construction are considered, suggest including a simulation training area in the construction plans.[29] Simulation facilities represent a combination of clinical, educational, and theatrical environments,[29] so it is important to proactively consider and plan for the logistical needs associated with a dedicated simulation area, the heat that simulation equipment generates, and technology needs when deciding on a permanent simulation site.[28] For example, limiting the physical distance between the simulation center and the facilities in which potential participants actually work will help with recruitment (especially if participants are frontline providers).[42] Failure to plan for these issues in advance may result in major problems later.

Realistically, without a simulation lab or center, a successful simulation program can exist via in situ training. When it is impossible to allocate permanent space to simulation training, identifying wards, clinics, operating rooms, ICUs, and conference rooms that can be used during dedicated time frames can provide individual or group training opportunities. For example, the University of New Mexico (UNM) Surgical Training Program established a small skills lab in its operating room. This worked well for UNM, as it afforded an easily accessible location to residents participating in these mandatory educational activities.[43] In fact, in situ training may have a variety of benefits, including training efficiency and providing concrete learning experiences within the actual clinical environment[44] that encourage lifelike participant behavior.[45]

The important point to remember is to work with available resources, including those in the broader community. VA facilities, for example, have entered into agreements to house VA–owned mannequin in an off-site simulation labs in return for staff's ability to receive free training at that location. Military simulation labs and centers are also a consideration for establishing joint simulation training between medical facilities and the US Department of Defense.

5. Support—Network

Training experts have acknowledged the critical role that organizational support and upper-level management buy-in play in the success of training program initiatives,[46] including SBT.[13] Organizational support facilitates training success in two major ways. First, organizations that support and articulate the value of training initiatives such as SBT assist the transition of learned KSAs to the work context.[47,48] Second, organizations dedicate more resources (for example, staff, supplies, time, funding) to simulation efforts when they accept simulation initiatives as a facility priority. This may enhance the effectiveness of simulation by providing more time to systematically design and implement a simulation program. This is critical in ensuring that the program meets organizational needs. Poorly designed programs are less effective than those created based on instructionally sound principles. Alternatively, even well-designed simulations will fail to effect meaningful changes on the job if organizations do not support the use of learned KSAs. To cultivate organizational support for simulation, the importance of networking cannot be overstated. Being proactive in contacting department heads and senior leadership to offer simulation briefings and demonstrations helps educate and orient future simulation supporters. During these meetings, the value of simulation initiatives should be "sold," starting with the project proposal and continuing through implementation. Every opportunity to explain the value of simulation efforts to organizational personnel should be capitalized on, with a focus on the positives even in the face of resistance.[49] A facility simulation committee should be created to identify, focus, and drive simulation training initiatives. The simulation committee's primary goals should be to champion simulation efforts and cultivate additional support from organizational management. A simulation database site, e-mail group address, and simulation calendar to communicate simulation training efforts to facility employees can all be created, along with the publication of facility employee newsletter articles on simulation training.

In networking, mutual partnerships should be sought with persons who can help plan and execute simulations. SBT design and delivery require cooperation between technical and audiovisual professionals, individuals with experience in creating learning contexts, and experts in the training topic area. For example, in addition to providing basic assistance, members of technical and audiovisual departments can provide advice on managing technical resources.[50] Furthermore, pairing clinical experts with learning experts will help facilitate the development of valid training scenarios that are practically relevant to clinicians.[40] Together, these experts support the SBT program by ensuring the training design is instructionally sound and that content is accurate and appropriate. For example, the faculty at the Penn State Hershey Clinical Simulation Center represents an interdisciplinary mix of departments and divisions, all sharing the goal of advancing medical education. This multidepartment collaboration was a major factor in the simulation center's recognition as an American College of Surgeons Accredited Comprehensive Education Institute, Level I.[51]

6. Systems—Match Fidelity Requirements to Training Needs and Ensure That Technological Infrastructure Is in Place

SBT covers an array of fidelity types that may be more—or less—appropriate, depending on the type of learning objectives that the training is intended to address.[52,53] For example, some simulators emphasize physical fidelity, in which the physical components of the task environment are replicated in the simulation.[53] Physical fidelity, which can include not only equipment but even simulated patients, enables clinicians to practice technical and nontechnical skills in a safe environment that mirrors real-world conditions.[53] Such simulators are most appropriate when trainees are learning how to use specific equipment or conduct specific procedures.[54,55] The Center for Medical Simulation (Boston), for example, enhanced the physical realism of a critical care setting by including actual medical equipment and integrating oxygen and nitrogen systems.[56] The center also uses a mannequin that has locking mechanisms to enable the instructor to control the positioning of the jaw and neck.

Other types of simulations, such as personal computer–based systems, emphasize cognitive fidelity—the extent to which the skill in the real task is duplicated in the simulated task[53]—over physical realism. High-cognitive-fidelity simulations are equally useful when the goal of training is to foster nontechnical skills such as problem solving and decision making[57] that are needed in the task environment. For example, in a low-fidelity simulation, in which researchers at the Keck School of Medicine at the University of Southern California (Los Angeles) used material purchased from a craft store to develop a Total Abdominal Hysterectomy (TAH) teaching model,[58] the simulation improved both knowledge and confidence among gynecology residents—illustrating that physical and cognitive fidelity are not necessarily mutually exclusive. Best practices for SBT in health care call for matching fidelity specifications to training requirements.[12] When determining the level of physical realism to incorporate in a simulation, system developers should partner with subject matter experts (for example, clinicians, nurses, administrators) and training experts to ensure that program objectives are realized.[12,59]

In addition to selecting the right type of simulator to employ during training, it is of paramount importance to ensure that the technological and organizational infrastructure is in place to support the training. For example, training systems that use laptops may require periodic software updates and are prone to all the familiar ills and frustrations of personal computers. Issues related to signal strength, server errors, and network security are also important considerations when using a local area network (LAN) or when using the Internet.[54] Accordingly, partnerships should be formed with the facility's biomedical engineers and information technology staff to support SBT. Finally, there are several upfront costs to consider to ensure that SBT systems are operational, including cameras and audiovisual equipment, security entry systems, and recurring maintenance that is required for software updates. The decision on how capital expenditures are allocated is locally determined; however, visiting and researching other simulation centers provides a valuable point of reference and background to help inform such decisions. Training experts should be consulted to help determine what features should be incorporated in the simulation.

7. Success—Evaluate and Share Success Stories Throughout the Organization

Effective training programs are associated with success stories, that is, evidence to indicate that the simulation program is efficacious. Such evidence is procured by measurement.[60] Measurement is not only the key to understanding the strengths in SBT but is also essential to accelerate the learning and performance targeted by the learning objectives.[61] Measurement also provides a means to track improvements in trainees' performance and the program collectively over time.[61]

Multilevel evaluations should be used for the greatest possible empirical support for the effectiveness of training programs. There are several training outcome typologies,[62,63] but Kirkpatrick's multilevel training evaluation framework—which addresses reactions, learning, behaviors, and results[64]—may provide a particularly useful mechanism for providing a comprehensive depiction of a simulation program's effectiveness.[65] However, Yardley and Dornan recently cautioned that no particular methodology or framework should be used globally.[66] We believe that, respective of the particular evaluation framework used, and given that training can have differential effects, assessing multiple levels is necessary for an accurate representation of the impact and efficacy of training.

It is advantageous to share success stories with staff throughout the organization, which can be a powerful technique of communicating ideas and has the advantage of being memorable and believable.[67] Stories enable employees to visualize potential future opportunities by providing meaning[68] and foster new ways of thinking and diverse perspectives by articulating ideas in a different manner.[69,70] As Simmons states, "when you want to influence others, there is no tool more powerful than story."[68(p. 29)]

Administrators, instructors, and trainees should all be encouraged to share success stories, and examples of success can be included in newsletters or on bulletin boards,[71] as represented, for example, by the VA's report of a simulation program targeting women's health training.[72] Disseminating success stories can foster fellow trainees' and other colleagues' own participation in simulation training and can help sustain senior leadership's buy-in and support.

8. Sustainability—Focus on Maintenance Not Just Development

Even with all of the fundamental simulation program components developed and implemented at the onset of simulation, the program will not prosper without a sustainability plan.[13] In fact, sustainability, a strategic imperative to maintain change and performance, can be considered the key to long-lasting impact and success.[73] Therefore, sustainability should not be an afterthought but rather a key component at the program's inception.[27] After all, continuing and maintaining initiatives has long been considered one of the most difficult challenges in quality improvement.[74] Simulation programs should aim for sustainability within the program's ongoing, daily activities.[75] A simulation committee—rather than, say, one or two simulation champions—can help to maintain a simulation program's projected path toward accomplishing its goals and objectives. For example, the Center for Immersive and Simulation-Based Learning (CISL) at Stanford's School of Medicine (Palo Alto, California) and affiliated hospitals have created a strong interdisciplinary team of clinical and simulation experts with extensive resources at their disposal.[76] At a more granular level, the center's two committees—an executive committee and an advisory committee—which are composed of key stakeholders, help ensure that it can and addressing the health care community's needs through the availability of a variety of simulation modalities at diverse clinical care providers at multiple locations.

Finally, constantly recruiting new simulation champions and instructors helps build a cadre of energized staff with a common goal of improving patient safety and team communications.[77] Ultimately, there is no one-size-fits-all formula for sustaining long-term success. Every program should revise and adapt strategies that are most appropriate for its specific context, but pressure to sustain should be maintained to avoid degradation.[78]

Summary

The eight factors—science, staff, supplies, space, support, systems, success, and sustainability—represent a synthesis of the most critical elements necessary for successful simulation programs. The order of these factors does not represent a deliberate prioritization or sequence, and the factors' relative importance may change as the program evolves. In addition, the factors do not operate in independent silos, but rather are interdependent. For example, as support increases, the program may acquire a dedicated simulation space or a simulation coordinator (staff), more success stories may be shared more frequently and on a larger scale (success), and efforts to maintain a long-term presence may become the norm (sustainability). Finally, insofar as all eight factors significantly contribute to a simulation program's effectiveness, we encourage attention to each factor. J

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