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Comparative Cost of Virtual Reality Training and Live Exercises for Training Hospital Workers for Evacuation

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Abstract

Adoption of virtual reality technology may be delayed due to high up-front costs with unknown returns on that investment. In this article, we present a cost analysis of using virtual reality as a training tool. Virtual reality was used to train neonatal intensive care workers in hospital evacuation. A live disaster exercise with mannequins was also conducted that approximated the virtual experience. Comparative costs are presented for the planning, development, and implementation of both interventions. Initially, virtual reality is more expensive, with a cost of $229.79 per participant (total cost $18 617.54 per exercise) for the live drill versus $327.78 (total cost $106 951.14) for virtual reality. When development costs are extrapolated to repeated training over 3 years, however, the virtual exercise becomes less expensive with a cost of $115.43 per participant, while the cost of live exercises remains fixed. The larger initial investment invirtual reality can be spread across a large number of trainees and a longer time period with little additional cost, while each live drill requires additional costs that scale with the number of participants.

Keywords

Cost analysis; Disaster training; Drills; Evacuation; Virtual simulation

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Virtual reality (VR) provides a productive medium for training, due to the ability to simulate, customize, and capture performance data for a wide variety of situations. In particular, VR excels at simulating dangerous or otherwise logistically difficult situations

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that are hard to recreate in real life. Disaster preparedness is one of these areas. Federal and regulatory agencies[1,2] have increased their focus on emergency preparedness over the past decade. Hurricanes Katrina, Rita, and Sandy, as well as tornadoes in Joplin, MO, and Tuscaloosa, AL, and numerous workplace violence issues have highlighted the need for hospitals in particular to take a proactive approach to all hazards emergency planning.[3,4] History has demonstrated the profound effects of poor disaster planning; during the aftermath of Hurricane Katrina, the evacuation failures at Memorial Medical Center in New Orleans resulted in massive loss of life despite current mandates requiring evacuation training.[1,2] Recent experiences during Hurricane Harvey show that continued gaps exist in current training and accrediting agencies require hospitals to conduct disaster preparedness training at least annually.[1,2] Given these requirements, it is helpful to consider whether VR can be a cost-effective method of training healthcare professionals to prepare for future disasters.

The authors recently conducted an institutional review board–approved study comparing VR training to traditional Web-based training methods, funded by the Agency for Healthcare Research and Quality. The mixed-methods study used a quasi-experimental design to examine differences in performance in a live disaster exercise of participants who were trained either with VR or with case study clinical updates. The live drill involved evacuating mannequin infants from a neonatal intensive care unit (NICU) at Cincinnati Children's Hospital Medical Center, a large regional facility with a 55-bed NICU staffed by more than 300 employees. In short, the study found significantly improved performance for VR participants during a live disaster exercise,[5] which is consistent with other results showing the effectiveness of VR as a training tool.[6–12] Additionally, the costs of the final live exercise were tracked and quantified along with the costs of the VR training simulations.

The purpose of this article is to provide a cost analysis of one live disaster exercise compared to development and implementation of the VR exercises. This is somewhat different from traditional cost-benefit analysis, in which both the costs of development and the resulting return-on-investment would be quantified to determine the financial value of a business decision. The original work described above did not compare the outcomes of training with VR and a live exercise, but used the live exercise to measure performance after VR, although the findings of the study suggest that VR is a valuable training instrument in preparing healthcare workers for evacuation.[5] Training should increase the number of saved lives and reduce legal liability/settlement costs, but it is not possible to estimate more or less of these benefits to one form of training or another.

HOSPITAL DISASTER EXERCISES

When developing exercises for hospital personnel, identification of hazard and vulnerability is the foundation for preparedness. The Federal Emergency Management Agency Web site describes hazard identification and risk assessment as the "factual basis" for planning activities. The hazard vulnerability analysis (HVA) is required by The Joint Commission.[2] All hospitals accredited through this agency must complete an annual HVA. Exercises should address those events that most likely occur including a focus on areas for improvement and corrective actions.[2] In some instances, the highest vulnerabilities may necessitate complex responses. To prepare for such events, the type of exercise needed for training and evaluation purposes must be determined. Disaster exercises can be designed in differing forms ranging from discussion-based, tabletop, drills, and functional to full-scale exercises.[13] Disaster exercises addressing complex events may initially be at the level of discussion-based or tabletop, but eventually functional or full-scale exercises may be needed. Unfortunately, most disaster formats allow for the participation of only a limited number of individuals. Typically, when an exercise is implemented in a healthcare facility, only a small percentage of staff are able to participate and learn from the experience. This is a potential strength of VR, given that many participants can use a training computer asynchronously over a long time period, instead of gathering a limited number of staff together for a limited number of training sessions.

In addition to the limited participation in exercises, functional and full-scale exercises consume a great deal of time, energy, and resources and are often conducted only in a specific area. There is also a possibility that a live exercise may interfere with patient care. Training for complex events only once a year is less than optimum. Recent literature indicates that decay of knowledge following training occurs beginning at approximately 3 months, and annual training may not be enough.[13]

Virtual Reality Studies

A systematic review of the use of VR and medical inpatient settings found that pain management, eating disorders, and cognitive and motor rehabilitation were the primary foci reported in studies.[14] The authors found that overall, research demonstrated positive results, but identified the need for larger, well-controlled studies. Moreover, the authors suggested that studies of cost-effectiveness be conducted. Several studies of VR have demonstrated positive outcomes in emergency/disaster training. Research has demonstrated that VR is associated with user satisfaction and improvements in knowledge and performance.[15–18] Over the years, simulation has played a valuable role in healthcare education. This is especially true in pediatrics, with this trend expected to increase dramatically in the next decade.[19] While simulation using live exercises has been used extensively as a training method, other forms of simulation may have advantages related to access and cost. Balancing the delivery of high-quality emergency training while minimizing cost is a constant challenge in healthcare. Zengin et al[20] suggest departments and hospitals need to conduct regular cost analyses of emergency training.

EXERCISES IMPLEMENTED

Two forms of disaster preparedness training were considered for this cost analysis. The *live exercise* was implemented using Department of Homeland Security[13] guidelines for operations-based exercises. Operations-based exercises include hands-on drills and exercises in which participants actually reacting to a scenario and are intended to validate a facility's disaster procedures. These exercises can identify shortcomings in the plan or missing resources and serve to clarify staff roles in a disaster.[21] In the present study, we analyzed the costs of a live vertical evacuation of neonatal mannequins from a NICU ward. Live training was provided for 57 employees, roughly 17% of the total NICU staff (N = 334).

The second method of disaster preparedness training involved the design, development, deployment, and use of a series of four evacuation exercises implemented in VR. According to the Society of Simulation in Healthcare, VR simulation as defined in the medical field refers to a variety of immersive, highly visual, three-dimensional (3D) features that present real-life situations and/or healthcare procedures. In the present case, the virtual drills included a wider variety of scenarios including the same vertical evacuation simulated in the live drill and were completed using Oculus Rift head-mounted displays (HMDs; Oculus VR, Menlo Park, CA). They could also be completed via a mouse-and-keyboard desktop-VR version if users encountered sim-sickness or preferred not to use an HMD. The VR training was provided for 34 employees. Detailed costs on the implementation of each training method are below.

Live Exercise Development/Implementation

Based upon the experience of the authors, the implementation of live disaster exercises consumed a great deal of resources. There were two main areas where staff costs were most evident: (1) planning and design of the exercise, and (2) participation in the implementation of the live exercise.

Planning Costs—Leading up to the exercise, several planning meetings were held to determine the size and scope. During these meetings, various stakeholder groups and participants were involved to assist in the development of goals, objectives, patient scenarios, and other aspects of the exercise. For this live exercise, 10 1-hour planning meetings were held with varying numbers of participants. The meetings included representation from several departments throughout the organization including NICU, Emergency Preparedness, Protective Services, Occupational Safety and Environmental Health, Accreditation, and the Center for Simulation and Research. Staff costs indicated in the analyses are based on the average hourly rate of representatives with a given title of those who participated. In total, staff costs for planning meetings totaled $7184.10 for a total of 160 staff hours in various roles. In other words, the cost was $44.90 per meeting hour. The amount of time and cost would necessarily fluctuate based on the size, scope, and number of departments participating in the exercise.

Implementation Costs—During the exercise, staff costs were divided between participants (trainees) and support staff (trainers). Participants for this particular exercise included a total of 57 clinical staff from the NICU including RNs, monitor technicians, and respiratory therapists. The exercise consumed a total of 85.5 participant hours at a total cost of $2726.42. This translated to a cost of $31.89 per participant hour. Numerous support staff were needed to conduct a successful live exercise. Support staff included staff from the NICU and Occupational Health and Safety. Staff maintained a safe staffing level in the unit, set up the exercise space with supplies, and generally coordinated all the activities throughout the exercise including debriefing. Hours worked over the course of the two exercise days resulted in a total cost of $5021.88. This translated to $41.68 per support staff hour.

Exercise evaluators from the organization had specialized training in disaster and emergency response and were given an hour-long training on participant performance evaluation. Evaluators came from various disciplines throughout the hospital including paramedics, physicians, nurses, and clinical directors. Evaluator costs reflected the average hourly rate for the specialty and were based on the time required for the scenarios, which averaged 1 to 1.5 hours. In total, this exercise had six evaluators who worked 87 hours at a total cost of $3685.14. This translated to $42.36 per evaluator hour. Table 1 provides the actual costs for the live exercise.

Scheduling Live Exercise—It took a great deal of planning to schedule the live drill. Dates for the exercise were set several months in advance with a backup plan in case of high unit census. The room in which the exercise was to take place had to be cleared of patients, cleaned, and set up prior to the drill dates. The team also reviewed unit staffing, as participants were encouraged to work on the day they signed up for the live exercise. Each exercise time slot was approximately 75 to 90 minutes in length, including prebrief, the exercise, and debriefing. Extra resources were available to cover assignments while staff participated in the exercise. Approximately half of the participants came in from home and clocked in and out for timekeeping purposes. A portion of those in the larger study could not participate in the live exercise due to leave of absence, planned vacation time off, or other schedule conflicts.

Consideration for hospital census did affect the selection of exercise dates and required use of backup dates. Hospital and NICU census was consistently elevated in the winter months and was not conducive to such a large-scale exercise in the NICU. Seasonal rates of infectious diseases such as influenza restricted the number of people that could be in the NICU at one time for the protection of the neonate and immunocompromised patients. In order to minimize the risk of infection, it was decided that late spring worked best. Note that these issues largely do not affect VR training, as it can be implemented in a room not normally used for patients and can be accessed intermittently as patient census and other work demands allow.

One other potential source of expense in live exercises was the cost of using an actual patient room for training. In the present case, training utilized a patient care space that was open and not expected to take patients at any time during the exercise. The opportunity cost of using the space was therefore zero. However, consideration must be given to the potential missed opportunity for revenue under different circumstances if a patient care space is taken out of commission for the duration of the exercise. This exercise required three NICU beds for 48 hours. If those beds had been utilized for patient care, the revenue on average would have been $8901 a day. Organizations should consider the costs (or lost revenue) of using a patient care area in the development and budgeting of emergency exercises. In summary, the total cost of training 57 staff was $18 617.54, which translated to $326.32 per staff member. If lost revenue from room costs had been realized, this would have risen to $27 518.54. To be conservative in our analyses, however, we relied on the lower figure.

Virtual Reality Simulation Development/Implementation

Screen shots from the virtual reality hospital are shown in Figure 1. The main cost of VR development no longer lies in the acquisition of hardware, which used to be prohibitively expensive, but instead in the personnel costs for content development and deployment. In the present case, the personnel cost was 87.7% of the overall budget. Costs are broken down as follows and are detailed in Table 2.

Planning—Storyboards were developed by disaster, simulation, and education experts from the hospital, regional universities, and external consultants. The cost of the storyboard has been approximated here, as an exact log of hours was not kept. Subject matter time was approximately 80 hours at a rate of $75.00 per hour totaling $6000.00.

Development—The simulations developed for this training involved digitally recreating a large portion of two different floors of the hospital along with connecting stairwells and exterior scenery. A branching storyline was implemented—dictated by the storyboard creation—that involved multiple evacuation scenarios and branching player roles. The simulation was implemented using the Unity 3D game engine (Unity Technologies, San Francisco, CA) and was built flexibly so that users could play through the simulations either in an Oculus HMD with an Xbox controller (Microsoft, Redmond, WA) or on a desktop computer screen with mouse-and-keyboard controls. Development included significant audio voice-over work and internal quality assurance testing. Hours were logged for undergraduate research assistants who helped in development. Faculty costs were on a fixed stipend. Content development man-hours made up the largest cost of the simulation, at $79 524.

External Review—A set of external consultants with either medical expertise or VR expertise was retained to review iterations of the simulations for content accuracy and usability issues. These consultants were paid an hourly fee for their input, with a total cost of $10 000.

Implementation and Participation—Unlike a live exercise, the VR simulation was available on the NICU for staff to participate in at their convenience, which required no disruptions of workflow, extra support staff, or payment for extra work hours. A total of 34 participants spent approximately 15 minutes each to complete the final VR. The exercise consumed a total of 8.5 participant hours at a total cost of $294.14. Additional costs accrued for implementation included travel for installation and maintenance, as well as the acquisition of hardware to run the VR, including two computers, peripherals, and multiple Oculus Rift HMDs (both DK2 and CV1 models were used at various points during the longitudinal study).

Other Costs—In other simulations, developers may run into costs not seen for the present project. For example, there may be legal or intellectual property issues that should be resolved, or specific software licenses that need to be acquired. Depending on the method of deployment, it may also be necessary to invest in internet servers or streaming bandwidth to transmit or store data in a distributed system.

In sum, the total cost of training 34 staff was $106 951.14, which translated to $3145.62 per staff member. As discussed further below, the costs for VR are largely fixed up-front development costs and not per-participant costs. The cost per staff member was high largely because of the small number of staff trained (about 10% of the workforce). The per-staff cost becomes increasingly favorable as more staff are provided training.

For this simulation, the development costs breakdown was as follows:

Cost Comparison: In order to have a meaningful comparison, we projected the cost of each alternative assuming that all 334 of the NICU staff were to undergo training once a year for 3 years. This necessarily glosses over some meaningful differences, but helps to compare them on equal footing. For instance, VR training was actually conducted with one of the four scenarios presented every 3 months and could theoretically be used beyond the third year at little additional cost (ie, gaming hardware has a 4-year life expectancy). Yet, we can assume for present purposes that the one VR simulation most closely matching the live drill is performed on an annual basis and that some unforeseen change in evacuation procedures or equipment or physical facilities necessitates the creation of a new simulation after 3 years. The important considerations here are (1) which costs are fixed, up-front expenditures versus recurring over time, and (2) which costs scale with the number of participants.

Live Exercise: The exercise planning cost of $7184.10 will not change with the number of participants, but does repeat over time as new annual drills are planned and scheduled. On the other hand, staff time for participation in the drill does scale linearly with the number of participants and will also be incurred with each drill. Increasing from 57 to 334 trainees will increase participant cost to $18 545.84. A proportional increase would be assumed in the number of support staff and evaluator hours. The cost of three annual live exercises would thus total $230 250 and cover 1002 staff members, resulting in a cost of $229.79 per participant. The costs per year for the live exercise are projected in Table 3. Total costs are plotted in Figure 2.

Virtual Reality Simulation Costs: The initial investment for VR at $106 387.00 was much higher than the similar up-front planning costs for live exercises. This is not a recurring cost and is independent of the number of trainees. Instead, this investment can be assumed to last for 3 years (and potentially longer) with only minimal additional costs related to trainee participation. This circumstance makes it much easier to extrapolate over time. Less than $300 of VR cost was attributable to staff time spent in training, or $8.65 per participant for their 15-minute sessions. Thus, training 334 participants once per year would result in 83.5 participant hours at a total annual cost of $3009.97, or a total of $9272.92 for 3 years. Adding that to the initial investment for VR, the 3-year cost of VR training would be $115 659.92 and cover 1002 staff members, resulting in a cost of $115.43 per participant. This cost was reduced significantly from the original $3145.62 per-staff investment to train 34 participants and would only further decrease in a larger facility with more staff, or if used more frequently (eg, quarterly), or if it continued to be used over a longer time period.

It is important to note that a VR need not be expensive as the one used here, or alternatively may cost more. Early design decisions can have a dramatic effect on the scope and cost of

VR development. Estimates of project time and cost are often off by up to a factor of four (in either direction), and it is recommended that key stakeholders be included early in the project and throughout development.[22] Iterative reviews help to define what will and will not be included, or what cuts should be made to maintain a target budget or deployment deadline. In the present case, an evacuation, it was deemed important to have trainees move virtually through multiple rooms, hallways, and different floors of the building. This greatly expanded the scale of the desired virtual environment and necessitated significant effort to accurately 3D model, texture, and light a digital recreation of the physical environment. It also required additional software development efforts and quality assurance testing to implement dynamic loading and to control performance and rendering frame rate. A different training scenario that was contained in a single room, for example, would see significantly lower cost to develop. Other design decisions could increase the cost.

DISCUSSION

One of the hardest selling points of VR is its inherently high up-front costs. However, this analysis shows that the only costs incurred beyond the initial period result from staff time for training participation. With each additional training, the fixed initial investment is spread over a higher number of trainees, resulting in lower average cost per trainee. Compared to VR, the initial costs of the live exercise are indeed lower, but those costs are repeated with each iteration; total costs accumulate, and the average cost per trainee will not change with the number of iterations.

Assuming all 334 staff are trained, the total cost of the live exercise for the first year would be $76 750.02 compared to $109 747.97 for VR. That translates to an average cost of $229.79 per trainee in the live exercise and $328.59 for VR. In the second year, the cost of the live exercise would stay constant at $76 750.02, while the cost for VR would be significantly lower at $3090.97. The marginal cost of additional training (ie, the incremental cost for one unit, in this case one trainee) during year 2 is $229.79 for live exercise versus only $9.25 for VR. Therefore, over a 2-year period, the average cost per trainee for live exercise is $229.79 versus $168.92 for VR. This trend continues in the third year as the cost of the live exercise would stay constant at $76 750.02, and the cost for VR again adds only $3090.97, yielding the same marginal costs as year 2. Therefore, over a 3-year period, the average cost per trainee for the live exercise is $229.79 versus $115.70 for VR. These results are summarized in Table 3 below and are illustrated in Figure 2.

CONCLUSIONS

While the outcomes of live exercise training and VR training were not directly compared in this study, there is sufficient evidence in general to show that VR can be an effective training medium. In the research study on which this cost analysis is based, for example, the VR group significantly outperformed their peers trained with Web-based clinical update modules, both in statistical terms ($t_{63} = 7.13$, $P < .0001$: effect size of 1.71) and in clinical terms (scored 13.6 percentage points higher in correct rubric items performed in the live drill).[6] Although many participants preferred live exercises to VR training, qualitative analyses demonstrated that participants found the VR experience realistic and engaging.

Yearly exercises and drills are required of healthcare agencies by several government and accrediting organizations. Beyond simply meeting these expectations, healthcare agencies should conduct exercises and drills because it puts their staff in the best possible position to maintain safe patient care and keep visitors and colleagues safe should an emergency arise. Unfortunately, live exercises usually involve only the staff who are present on the day of the exercise and can incur large costs each time they are conducted—costs that escalate with increasing numbers of participants. Even when exercises are undertaken, they touch only a small percentage of the staff. For example, an emergency department practice may have 41 physician partners, but during a staff exercise in the emergency room, only two or three are able to participate. Due to its ability to reach larger numbers of staff on a convenient schedule and its long-term cost savings, VR offers a potential solution to these problems. In conclusion, then, VR can be an effective training tool and has been shown here to be a cost-effective medium as well. The high up-front costs of VR can rapidly become long-term cost savings as the number of staff trained increases and as the training is repeated over time.

A few things are worth discussing here. First, early design decisions can have a profound impact on the scope of work and the resulting development cost of VR, as mentioned above. Cost savings can be realized sooner in a different scenario with lower development costs. Furthermore, the present analysis did not need to consider any financial benefits of VR (ie, revenue). In other domains, business decisions may need to factor in revenue streams and a measurable return on investment. If VR provides lower long-term costs than the alternative but does not produce enough revenue, then it may prove the lesser option.

In addition to actual financial costs, healthcare agencies should also consider the opportunity costs associated with using patient care space during emergency exercises. In this case, the hospital was able to absorb the patients in other parts of the hospital, but the potential opportunity cost for taking up patient care space is significant. Revenue for the use of those beds at $8901 per day and the potential opportunity costs of 2 days yield an additional potential cost of $17 802, which almost doubles the cost of the original exercise. A larger exercise with 334 staff may have required even more beds or occupied them for a longer time. A VR work-station, by contrast, can be installed in existing staff work-rooms and does not interrupt patient space.

Likewise, agencies must consider the logistical costs of pulling multiple staff members away from their duties simultaneously to serve as trainers, trainees, support staff, or evaluators. Difficulties with staffing and planning are incurred as large numbers of staff need to participate in the exercise at the same time, and these difficulties grow as larger numbers of staff are to be trained. Scheduling can be difficult and implementation can be burdensome to staff and patients. By contrast, VR can be completed asynchronously by a single staff member at his/her convenience. The software can serve as trainer and evaluator and log performance for later review. Theoretically, 334 staff members could train at a rate of one per day, and all would be able to complete the training annually with no interruptions to normal work.

Limitations

This study was limited to specific scenarios involving the evacuation of three simulated patients in a large single NICU setting in a single facility. In addition, there were persons involved in planning and implementation of the exercises, which may not have been captured in costs. In light of variety in salaries and costs, other facilities or scenarios may present different costs or savings beyond what is considered here. Virtual reality training in fields outside of the healthcare industry may also see different types of costs or constraints that need to be considered. The VR considered here was developed in an academic setting as part of a research study. A commercially developed VR may see a different cost structure and likely a faster time scale. Finally, because the research study was designed to address training effectiveness between VR and Web-based training with live drill performance as a dependent measure, we are not able to speculate as to whether VR training is better or worse than live drill training. This is a fertile area for future work.

RECOMMENDATIONS

As the cost of VR technology has fallen dramatically in recent years and continues to decline, it offers many opportunities for integration into education, healthcare, and corporate training. However, VR cannot be a mere gimmick. A sound business justification is required for the potentially high up-front costs of VR, particularly when considering custom content development. In this work, we have identified one use case where the high initial costs of VR can become notable long-term cost savings. Virtual reality excels at simulating things that are otherwise expensive, dangerous, or logistically complicated in the real world. Live disaster evacuations in a NICU and in other healthcare settings fit this category well, and VR offers a way to train more staff in a cost-effective manner and potentially do it faster and more often. Other scenarios in other industries that have similar constraints may find similar cost savings. Key items to look for here are (1) the longevity of the training across number of years that the training can be deployed with minimal ongoing expenses; (2) the reach of the training across number of staff members that costs can be distributed; (3) design choices, specifically ways to change the simulation to make it simpler to develop, such as limiting the size of the virtual environment; and (4) the degree to which the alternative costs scale over time and staff. If non-VR training is likely to consume additional resources for each trainee, or to incur extra costs and logistical/scheduling complications each time it is conducted, then VR may prove the better and more economical alternative.

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FIGURE 1.
Screenshots of the virtual hospital. Participants gathered equipment, answered questions, interacted with other staff, and ultimately pushed a crib or carried a baby to safety.

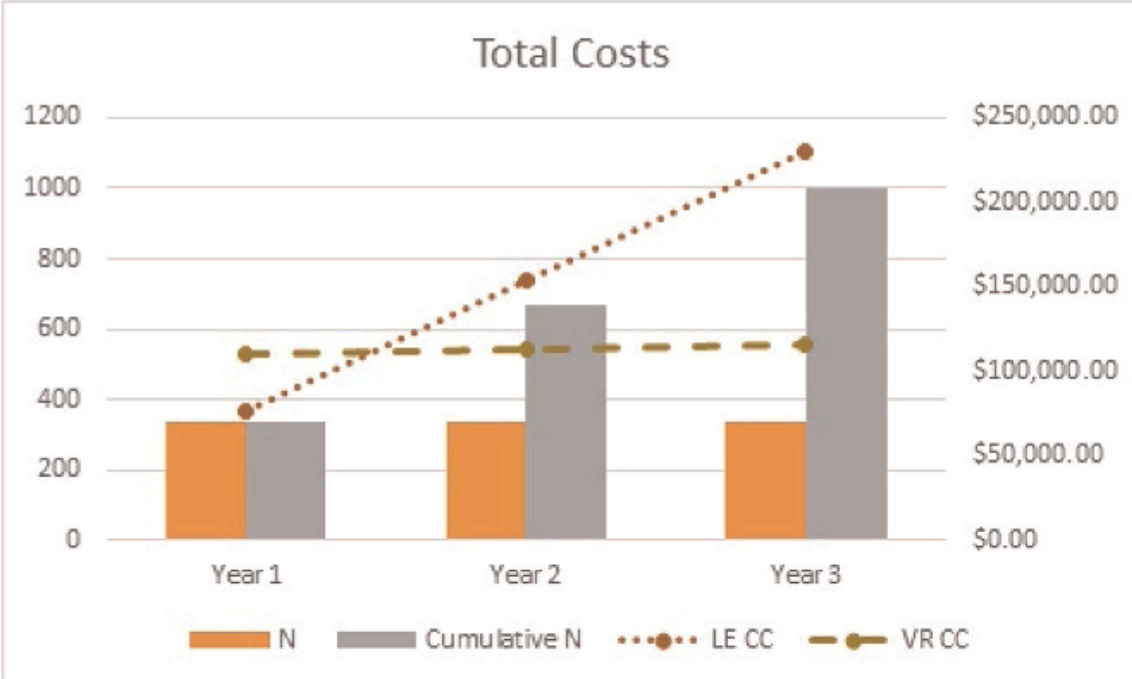

FIGURE 2.

Number of participants trained versus training costs. Live drills would be initially cheaper, but costs recur and accumulate over time. Costs for training additional staff in VR are nearly $0, yielding long-term savings.

Table 1.

Live Exercise Costs

Item	Personnel	Cost[a]	Total
Exercise planning	16 Staff	\$44.90 per meeting hour × 160 h	\$7184.10
Exercise participants	57 Staff	\$31.89 per participant hour × 85.5 h	\$2726.42
Exercise support	5 Staff	\$41.68 per support staff hour × 120.5 h	\$5021.88
Exercise evaluation	6 Evaluators	\$42.36 per evaluator hour × 87 h	\$3685.14
Room charge[b]			\$0.00
Total			\$18 617.54

[a]Salaries were direct costs (do not include fringe costs).

[b]No costs were incurred to host the mannequins in a patient room; this may not be true at other facilities or under different circumstances and should be considered.

Table 2.

Virtual Reality Costs

Item	Personnel	Purpose	Total[a]
Storyboard		Determine content	$6000.00
Consultants	4	Iterative review	$10 000.00
Simulation development	1× project lead, 2× 3D modelers, 4× developers, 1× audio engineer	Content creation, editing, testing, audio engineering, software development	$79 524.00
Travel	1× project lead, 1× 3D modeler, 1× developer	Site visits for 3D modeling research, deployment, and maintenance	$1200.00
Supplies	n/a	Software, VR hardware, computers, computer components	$9933.00
Staff time for training participation	34 NICU staff	15-min sessions, average cost $34.60/h	$294.14
Total			$106 951.14

[a]Salaries are direct costs (do not include fringe costs).

Table 3.

Annual Costs

	Year 1	Year 2	Year 3
No. of participants	334	334	334
Cumulative no.	334	668	1002
Live Exercise			
Cost	$76 750.02	$76 750.02	$76 750.02
Cumulative cost	$76 750.02	$153 500.04	$230 250.06
Marginal cost per new trainee	$229.79	$229.79	$229.79
Average cost per all trainees	$229.79	$229.79	$229.79
VR			
Cost	$109 747.97	$3090.97	$3090.97
Cumulative cost	$109 747.97	$112 838.94	$115 929.91
Marginal cost per new trainee	$328.59	$9.25	$9.25
Average cost per all trainees	$328.59	$168.92	$115.70