British Columbia Interprofessional Model for Simulation-Based Education in Health Care

A Network of Simulation Sites

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The rapid uptake of simulation-based education has led to the development of simulation programs and centers all around the world. Unfortunately, many of these centers are functioning as localized silos and not taking advantage of the potential for collaboration with other regional centers to promote interprofessional education. In the province of British Columbia (BC), Canada, 38 institutions, including health care authorities, universities, colleges, and other health-related organizations, have participated in assessing the use of simulation in BC and in developing a provincial model that enables collaboration and interprofessional learning at the provincial level.

This article describes methods and results of a needs assessment and discusses an interprofessional simulation in health care educational model that provides access for all health care professionals in BC regardless of their geographic location and/or institutional affiliation. We anticipate that this information will be useful to and supportive of others in developing simulation collaborations in their respective regions.

(*Sim Healthcare* 7:295Y307, 2012)

Key Words: Simulation, Model, Health education, Network

Simulation-based learning has become an integral part of health care education and practice over the past few decades.[1-6] This movement is based on scientific research and empirical evidence that simulation training is superior to that of traditional teaching that uses primarily didactic methods.[7-10] Health care organizations show a great deal of interest in simulation-based education (SBE) to address and advance patient safety initiatives and to support professional development in the health care sector.[11-13] Recently, a number of businesses [14-17] and governments [18-23] have expressed their interest in the promotion and implementation of simulation in health care education.

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The value of simulation is recognized by professional societies and regulatory bodies such as the Society for Simulation in Healthcare, the American College of Surgeons, the Royal College of Physicians and Surgeons of Canada (RCPSC), the Accreditation Council for Graduate Medical Education, and the United States Medical Licensing Examination. These organizations have recognized simulation by establishing credentialing and accreditation programs around simulation to help establish standards for the delivery of SBE.[5,24-29] Despite the efforts of these organizations, various factors such as the relative wealth of institutions, political will, and the rapid growth of simulation have created discrepancies in the delivery of educational services of many regions who have implemented SBE. Issues such as redundancy in curriculum development and inefficient use of space and resources result in isolation of certain simulation centers and, consequently, suboptimal use of the simulated environment for SBE.[4,16,19,30] This was the driving force behind the formation of simulation networks such as the Oregon Simulation Alliance (OSA),[14,30] Idaho Simulation Network,[31] California Simulation Alliance (CSA),[32,33] Simulation & Training Environment Laboratory,[15] and others.[34] Formation of these alliances is an important step toward the promotion and establishment of collaboration and cooperation among simulation centers in a geographic region. Each of them brings a fresh perspective for collaborative opportunities in simulation-related education and research.

BC SIMULATION TASK FORCE

The BC Simulation Task Force was commissioned by the Dean of the Faculty of Medicine, University of British Columbia (UBC), to bring together key academic and health authority stakeholders from across the province to design a comprehensive SBE model for the province. The overall mission of the Task Force was to provide a unified cost effective simulation model for the enhancement of health care education and patient safety, with the ultimate benefit received by the general public and health care providers in British Columbia (BC). The intent was for the resulting interprofessional, patient-centered model to be inclusive of all groups of learners across BC, regardless of geographic location or organizational affiliation. A secondary goal was to develop a strategic operational plan for SBE in the province of BC based on the newly defined simulation model. The scope of the project was broad and aimed at integrating the educational needs of undergraduate and postgraduate health care trainees, along with the continuing professional development (CPD) requirements for all types of health care providers (physicians, nurses, paramedics, etc.) across the province. The strategy was to achieve this by formalizing a network of simulation sites across the province capable of collaborating and sharing infrastructure and other assets to support the advancement of simulation at the provincial level.

The BC Simulation Task Force was formally established in November 2009 with key stakeholders from each of the 6 provincial health authorities (5 regional authorities and 1 provincial authority) (Fig. 1) and academic representatives from universities, colleges, professional associations, and other organizations associated with health care education. Stakeholders were identified in partnership with the BC Academic Health Council, which holds information on all 38 of BC's health educational institutions, in addition to the UBC Faculty of Medicine and provincial health authorities. As such, the selection process of identification for stakeholders was thorough and inclusive. Once relevant stakeholders were identified a needs assessment addressing SBE was performed. Based on the data collected, a provincial model was developed, which is currently in the process of province-wide implementation. This article describes the methodology and results of the provincial needs assessment and highlights the key elements of the provincial model that was developed for delivering SBE in health care across the province of BC.

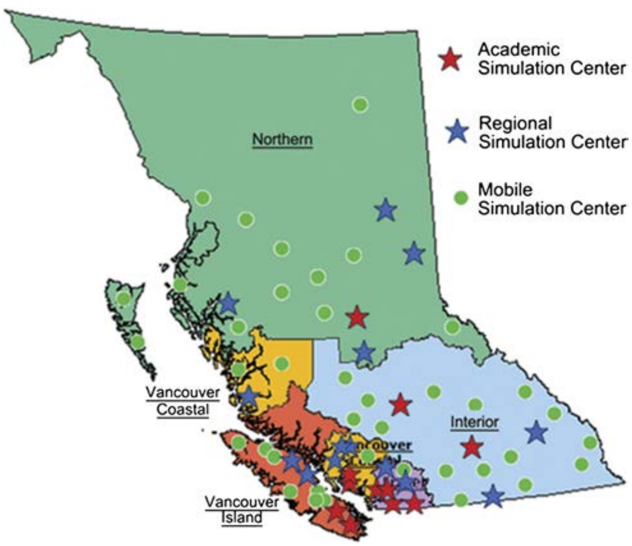

FIGURE 1. British Columbia map identifying the health regions and location of simulation centers.

METHODS

The Task Force recognized the importance of a thorough needs assessment to inform the development of the provincial model for SBE in health care. Table 1 provides a complete list of Task Force members with corresponding affiliations. Ethics approval for conducting this project was obtained from the UBC Faculty of Medicine.

To help provide a common understanding of simulation terminology throughout the needs assessment process, the Task Force developed a glossary of simulation terms with specific definitions (Appendix A). To develop this glossary, a key group of simulation stakeholders met for a full day to formulate definitions that were relevant to SBE. In total, 25 definitions of simulation-relevant terminology were developed, including a classification of simulators by realism (eg, low, medium, high) and by nature of the technology (eg, multimedia, virtual reality, task trainers, anatomic models) (Table 2). After agreeing on a standard set of definitions, the Task Force conducted a 3-phased needs

Table 1. BC Simulation Task Force Members

Task Force Member	Affiliation/Institution
Karim Qayumi, chair	CESEI, UBC
Monica Adamack	Interior Health Authority
Pat Bawtinhemier	School of Health Sciences, Vancouver Community College
Ron Bowles	Justice Institute of British Columbia
Ryan Brydges	Centre for Health Education Scholarship, UBC
Sue Carpenter	Emergency Services, Interior Health Authority
Adam Cheng	British Columbia Children's Hospital, UBC
Stuart Donn	British Columbia Ambulance Service
James Dutton	Island Medical Program, UBC
Tru Freeman	School of Health Sciences, British Columbia Institute of Technology
Noreen Frisch	School of Nursing, University of Victoria
Kathy Fukuyama	Nursing Program, Vancouver Community College
BJ Gdanski	British Columbia Academic Health Council
Allan Jones	Interior Southern Medical Program, UBC
Karen Joughin	Undergraduate Programs, Faculty of Medicine, UBC
Claudette Kelly	Community and Health Sciences, Kwantlen Polytechnic University
Jennifer Keryluik	University of Northern British Columbia
Anthony Knezevic	Southern Medical Program, UBC
David Lampron	Technology Enabled Learning, Faculty of Medicine, UBC
Andrew McLaren	Department of Family Practice, UBC, Nanaimo
Yvonne Moritz	School of Health Sciences, British Columbia Institute of Technology
Lynda Pattie	University of Northern British Columbia
Jeff Plant	Interior Health Authority, UBC
Khairrunnissa Rhemtulla	Vancouver Coastal Health Authority
Pat Semeniuk	Vancouver Coastal Health Authority
Karyn Smith	School of Nursing, University of Northern British Columbia
David Snadden	Northern Medical Program, UBC
Brian Warriner	Department of Anaesthesiology, Pharmacology and Therapeutics, UBC
Carl Whiteside	Department of Family Practice, UBC
Lynne Young	School of Nursing, University of Victoria
Bin Zheng	CESEI, UBC

Table 2. Inventory and Usage of Simulators in BC

Simulator Type	No. Units (%)	Hours Used per Month (% Total Usage)
Human patient simulators (high/medium realism)	59 (7.7)	855 (19.4)
Human patient simulators (low realism)	169 (22.0)	960 (21.7)
Task trainers	318 (41.4)	786 (17.8)
Tissues/specimens	90 (11.7)	102 (2.3)
Virtual reality workstations	14 (1.8)	85 (1.9)
Online simulation modules	118 (15.4)	1630 (36.9)
Total	768	4418

assessment involving (1) a province-wide survey, (2) individual interviews and focus groups, and (3) a 1-day stakeholder workshop.

Province-Wide Survey

Two of the main goals of the needs assessment were to determine the amount of SBE in BC and to understand the differing needs of health care educators from various parts of the province. To help achieve these goals, a needs assessment survey was designed to address SBE in both academic and nonacademic health care institutions. The survey was delivered to the key stakeholders at various institutions across BC via mail and email. Data were analyzed at the Centre of Excellence for Simulation Education and Innovation (CESEI) in Vancouver, BC, Canada.

The needs assessment survey consisted of several parts, including the current status of simulation activity, future needs, and general comments. The initial part of the survey collected information about the existing simulation programs (including existing curricula, numbers and categories of learners, teaching hours, and instructor expertise), the types of simulators used by each program (eg, models, number of units, hours of use), and simulation infrastructure available at each site (eg, dedicated manpower, funding, space). Survey respondents had the opportunity to identify strengths and weaknesses of their respective programs. In the second half of the survey, respondents were asked to rate a predetermined list of simulation content (on a 5-point Likert scale) that might be offered at their institution. Stakeholders were also asked to describe their ideal list of simulators, educators, space, staffing, and funding.

Individual Interviews and Focus Groups

After completion of the survey, individual interviews and focus groups were conducted via site visits and videoconferencing/teleconferencing. Interviews and focus groups were conducted in each of the 6 health authorities, with relevant stakeholders from each region present. Simulation leaders from each individual institution were identified by the Task Force and interviewed. Focus group participants consisted of individuals involved in existing simulation programs and others who were interested in starting a new simulation program. At least 1 representative from each of the 34 institutions was present in each of the focus group sessions. Interviews were conducted by 1 investigator (K.Q.) during site visits and teleconferencing. Individual interviews were 30 to 60 minutes in duration, whereas focus groups lasted for 1 to 2 hours and included simulation educators and staff from each program. An interview template was provided to help standardize the process, addressed the 4 main objectives for this portion of the needs assessment. The objectives were as follows:

- To confirm and clarify the results of the survey (parts 1 and 2),
- To identify available physical space and resources,
- To capture the scope of simulation activity within specific organizations and health regions, and
- To identify the common needs of simulation programs.

The workshop consisted of presentations and discussion of the survey, interviews, and focus groups, followed by small-group discussion, and ended with a concluding session that was conducted by a third party (BC Academic Health Council), aimed at synthesizing the information that was gathered during the day.

RESULTS

Part 1: Needs Assessment

Survey

Leaders from 34 (89%) of 38 institutions responded to the survey by indicating that they use simulation in their existing educational programs. The 4 institutions that did not respond were small private nursing schools without simulation programs. Table 2 describes the inventory of simulators in BC according to type and usage. Of 34 institutions in BC, 14 (41%) had formal curricula designed for their simulation programs with 64% of the curricula developed based on a needs assessment. Of 34 institutions, 12 (35%) indicated that they had peer-reviewed (ie, online review by 3 experts in the field) curricula, and 13 (38%) of these institutions performed assessments of their simulation curricula. The results of the survey indicated that a wide spectrum of learners uses simulation as a learning modality. In summary, approximately 18,500 learners per year were exposed to SBE, with the highest proportion of those being

Table 3. Category of Learners, Number of Learners in BC, and Number of Learners for Each Category Exposed to Simulation per Year

Category of Learner	No. Learners in BC	No. Individuals Exposed to Simulation (%)	Participants in the Same Learner Group (%)
Medicine-undergraduate	1035	585 (3.2)	56.5
Medicine-postgraduate	1100	602 (3.3)	54.7
Nursing, allied health-undergraduate	21,435	7111 (38.6)	33.2
Physician-CPD	13,478	3004 (16.2)	22.3
Nursing-CPD	32,772	7133 (38.7)	21.8
Total	69,820	18,435	26.4

licensed nurses (39%) and undergraduate nursing and allied health professionals (39%). Table 3 summarizes the

categories of learners exposed to simulation in BC.
Among the 34 institutions providing health care education in BC, only 12 institutions (35%) have simulation staff at their premises to run their programs. The total amount of renovated, dedicated space for simulation and clinical skills at the time of the survey was 24,525 sq ft that is distributed among 20 institutions in BC. Twentyfive start-up grants were given to 16 institutions to support simulation infrastructure. Most funds came from institutional budgets (10/25) and special projects (9/25). Of the 34 institutions providing SBE, 19 (56%) reported having an operating budget.
The 3 main strengths of existing simulation programs in BC, which were identified by participants, included curriculum development and implementation, support from institutional leaders, and collaboration with other leading centers. The 3 most important barriers identified in the survey were lack of financial support, lack of simulation instructor training, and lack of dedicated simulation technicians. According to stakeholders, the highest priority activities requiring development for all simulation programs were assessment of competency, team training, and programs for undergraduate and postgraduate education. Table 4 lists the types of simulation content that was considered to be most important for development at simulation facilities across the province.

Table 4. Priority List of Simulation Content Identified by the Survey to Be Developed in BC

Type of Content	Average Likert Score*
Highest priority content	
Assessment of competency	4.4
Team training	4.3
Undergraduate and postgraduate programs	4.2
Remediation	4.1
Other high priority content	
Basic emergency skills for health professionals (nonphysician)	3.8
Pain management (nonphysicians)	3.6
Pharmacology and drugs	3.5
Basic trauma management (nonphysicians)	3.3
Advanced trauma and resuscitation for physicians	3.2
Disaster response training	3.2
Social and cultural sensitivity training	3.1

*Range is from 1 to 5, where 1 indicates ‘‘lowest’’ and 5 indicates ‘‘highest’’ priority.

Individual Interviews and Focus Group Sessions

In total, 20 individual interviews and 4 focus group sessions were conducted with representation from all health authorities in the province. Of the preidentified stakeholders, 95% were present at the focus group sessions. The individual interviews and focus group sessions confirmed the data received in the survey and provided additional information about the respective institutions. Simulation was identified as an integral part of most medical and health care education curricula, and active plans to expand the range and use of simulation were already in place within most programs. The common elements of simulation infrastructure identified as key targets for collaboration were instructor training, scenario design and development, technical expertise, assessment and evaluation tools, combined purchasing to optimize cost savings, and a common audiovisual (AV) platform to enable province-wide collaboration.

Stakeholder Workshop

In total, 50 participants representing 27 institutions from all 6 health authorities in the province attended the stakeholder workshop. Participants reached consensus on the core content that should be offered at simulation programs across the province. These are shown in Table 5 as core content. Additional content represented offerings that would meet the specialized needs of particular specialties (specialty content; Table 5) or groups of learners in a specific region of the province (supplementary content; Table 5).
Stakeholders identified several strategies to ensure optimal delivery of simulation-based content across various simulation programs. Participants stressed the importance of matching fidelity to context and to desired outcome. In some contexts, low-realism simulation was deemed a better and more cost-efficient fit Mobile simulation units in rural settings were identified as the preferred alternative over stand-alone simulation

centers. Second, stakeholders stressed the importance of linking simulation training to competencies

Table 5. List of Core, Specialty-Specific, and Supplementary Contents

Core Content	Specialty-Specific Content	Supplementary Content
• Procedural skills training for rural practitioners	• Advanced cardiac life support	• Maintenance of competency
• Basic safety—infection control and hand washing	• Advanced trauma life support obstetric care	• Remediation
• Team training	• Pediatric advanced life support	• Team training/crisis resource management
• Communication skills	• Mass casualty	• Continuing medical education for all health care providers in the rural setting
• Critical thinking		• Informed consent/end-of-life care discussions
• Pharmacology and therapeutics		• Nursing curriculum for undergraduate and postgraduate levels
• Emergency birth/delivery		

within and across disciplines and to ensure engagement of regulatory bodies. Participants also stressed the importance of aligning simulation with curricula, embedding simulation into existing course design, and reworking educational programs to ensure that they met the requirements of various regulatory bodies. Participants were wary of new simulation centers being built in cities solely based on numbers of learners in a particular region. Stakeholders put forward a multifactorial approach to choosing locations for future simulation facilities, articulating the importance of institutional support and leadership, appropriate infrastructure, technical support, and reasonable distance for travel by learners, while recognizing that the final decision would be dependent on discussion with leaders in government and provincial health authorities. Stakeholders believed that it was important to closely model the new system after the distribution and delivery of health care (eg, clinics, hospitals) in the province. Although academic institutions would seem to be the most viable homes for the proposed simulation centers, those same academic centers are located in highly populated areas in the most southern part of the province, often seen as restrictive to making simulation available to all providers throughout the province.

In the second half of the workshop, discussion focused on the benefits and barriers of a new provincial model for interprofessional SBE. Participants felt that a shared model and overarching governance structure would help to address financial constraints and limited resources at individual institutions. In particular, sharing curricula and simulation scenarios and implementation of a shared scheduling system and AV system were identified as key concepts to help ensure collective success across the province. Participants felt that this new provincial simulation model would help to foster collaboration in education and research between various institutions, which have traditionally been working in individual silos.

Despite the many benefits of the proposed model, various regional challenges to implementation were identified, including internal barriers within individual institutions to collaborate; the vast geography of the province, making it challenging to deliver educational programs to remote areas; and lack of a technology infrastructure for simulation. To proactively address these issues, the Task Force recommended that dedicated positions in simulation leadership be established at all sites to help foster collaboration and to support faculty development and training and that a simulation technology task force be established at the provincial level immediately to identify (*a*) the optimal simulation-based AV software for the province and (*b*) the ideal methods for training technologic support staff across the province.

Part 2: The Provincial Model

Knowledge gained from needs assessment provided the details required to create a provincial model best suited to address the issues unique to the province and its learners. The model provides a framework for delivery of SBE for an interprofessional network of simulation sites across the province. The basic principles of this model focus on the importance of equitable access to and sharing of simulation infrastructure and curriculum, along with providing a structure whereby development of standards for simulation-based practice, education, and research can be achieved at the provincial level.

Model Structure

The number of simulation centers allocated for each health region is determined by the population of learners, availability of space and equipment, and the relative distance between centers with simulation facilities (ie, to avoid duplication of services) (Fig. 1). In this model, simulation centers are categorized as academic, regional, or mobile centers based on predefined criteria. British Columbia is divided into 5 health regions with a total learner population of approximately 70,000 individuals. A schematic diagram of the proposed interprofessional model for SBE in health care is illustrated in Figure 2.

Academic Simulation Center

In these centers, an academic institution (university or college) is affiliated with 1 or more teaching hospitals. Key criteria for this type of center include the following:

- It must have at least 5 groups of learners in the following categories: undergraduate (any profession), postgraduate (any profession), physicians, nurses, and other allied health care professionals.
- It must coordinate assessment of simulation programs for the health region.
- It must develop curriculum modules that can be disseminated and shared with regional and mobile centers.
- It must conduct simulation-based research and collaborate in research with others.
- It must support and coordinate the regional and mobile simulation activities. Academic centers provide

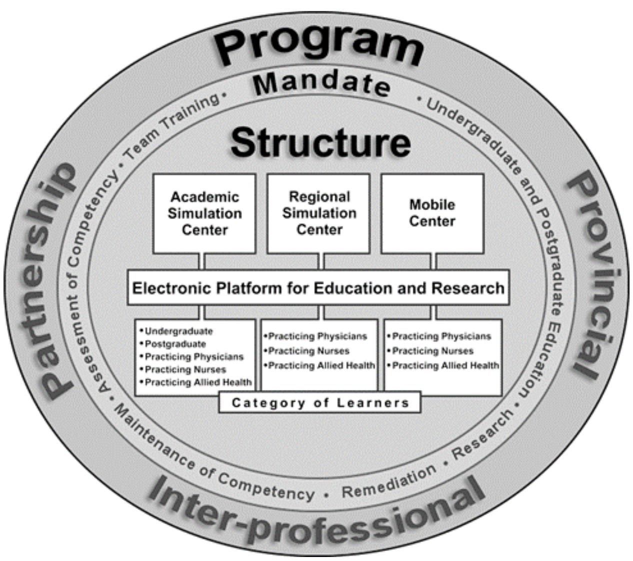

FIGURE 2. A schematic diagram of the proposed platform of the BC interprofessional model for simulation in healthcare education. In the outer ring, the concept of the program is described; the second ring represents the main mandate of the program; the third inner circle depicts the structures of the model.

oversight and act as the coordinating centers in each health region. They have the responsibility to support the educational programs of the various regional and mobile simulation centers within that particular area of the province.

- It must possess the necessary technology for curriculum delivery, Webcasting, videoconferencing, and distance simulation. This includes conducting simulation and debriefing sessions from a distance through broadcasting simulation events online.
- It must have a lecture room, high-fidelity simulation laboratories, debriefing room(s), clinical skills laboratory, and storage space.
- It must have qualified simulation instructors, technology support, and staff.
- It must have the necessary simulation equipment to deliver specified curricula (task trainers, benchtop

simulators, high-fidelity mannequins, and other specialized equipment such as trainers for robotic surgery) for an academic simulation program.
- It must share common resources and infrastructure with all stakeholders in the region.

Regional Simulation Center

These centers will be located in less densely populated areas in regional or referral hospitals or in an academic institution near a regional hospital. Criteria for these centers include the following:
- Must provide simulation environments to at least 3 groups of learners in the following categories: undergraduate (any profession), postgraduate (any profession), physicians, nurses, and other allied health care professionals;
- Must provide data on the amount and types of simulation activities;
- Must participate in assessment of simulation pro- grams for the region;
- Must have technology for curriculum delivery, broadcasting, Webcasting, videoconferencing, and distance simulation;
- Must have the physical space required for a regional simulation center (at least 1 small lecture room, 1 high-fidelity simulation laboratory, 1 debriefing room, and some storage space);
- Must have the necessary simulation equipment to deliver the specified curricula (task trainers and high-fidelity mannequin); and
- Must share the infrastructure with the academic center and other stakeholders in the region.

Mobile Simulation Centers

These centers will provide simulation services to the remote and rural areas using specially designed mobile units and existing clinical spaces for in situ simulation. The Task Force endorses the use of refurbished ambulances in BC for developing mobile simulation centers. The criteria for these centers include all the criteria for regional simulation centers, except for space that is specified as follows:
- Must have a satisfactory vehicle, tent, or other type of mobile unit for delivery of core simulation programs; and
- Must have a cooperative agreement in place with rural hospitals, primary care units, and other stakeholders in the region for the space required for in situ simulation.

Space Requirements and Cost Estimates

Currently, there are no specific standards that are generally accepted by the simulation community to be applied in the development of a simulation center.[35,36] It was therefore necessary to prepare an estimate based on available information from existing centers. The Task Force made an attempt to make the best estimate of space and costs for different types of simulators. Variation in space requirements for simulators depends on their size and functionality. In our estimate, the average space required for a simulator is 400 sq ft, with a range of 75 sq ft for a simple task trainer to 800 sq ft for a high-fidelity full-body simulator. Table 6 provides space requirements for common simulators. The estimate is based on analysis of the actual measurements

Table 6. Space Required for Holding Common Simulators

	Simulator (sq ft)	Free Space (sq ft)	Control Room (sq ft)	Total (sq ft)	Maximum Student Capacity
HPS	150	450	200	800	5
SimMan	150	350	200	700	5
PediaSIM/BabySim	75	350	200	625	5
Vascular interventional simulation	250	350		600	5
Harvey	150	550		700	10
GI Mentor	150	250		400	2
URO Mentor	150	250		400	2
SurgicalSIM	200	250		450	1
Minimally invasive surgery training	100	150		250	1
Intravenous catheter trainer	80	120		200	1
Pelvic examination trainer	80	120		200	1
Prostate examination trainer	80	120		200	1
Other task trainers	80	120		200	1

CyberPatient	75			75	1
Basic surgical techniques	75	75		150	1

Data are obtained from actual measurement and maximum number of students trained in a session at the CESEI.

Table 7. Estimation of Minimum and Expected Space Required for the Development of the Academic and Specialized Academic Simulation Center

Simulation Equipment and Functional Space	Minimum No.	Expected No.	Minimum Space (sq ft)	Maximum Space (sq ft)
Full-sized mid-fidelity mannequins (5	2	8	1200	4800
Debriefing space (5 students)	1	4	250	1000
Simulation ward (4 training tables)	1	2	1200	2400
Wet laboratory (4 training tables)	1	1	1200	1200
Lecture theater with AV technology (24 students)	1	1	600	600
Skills training laboratory (10 students)	1	1	500	500
Harvey (10 students)	1	2	700	1400
Computer-based learning laboratory (10 students)	1	1	500	500
Administrative office	1	1	400	400
Reception	1	1	250	250
Sum			6800	13,050
Estimated cost for infrastructure (Can $)			2,720,000	5,220,000

This table is a derivative of our needs assessment data that are reflected on the prior tables or text in the needs assessment section. In this table, the type of simulation equipment is based on the functionality of the center reflected on the wish list of BC educators. The minimum number of simulators is a derivative from the number of learner in each health region of BC and minimum hours of simulation (1 hour per student per month). The maximum is driven from the number of learners in each health region of BC and maximum hours of simulation (5 hours per student per month). Considering the information previously mentioned, the minimum and maximum amount of space is driven from adaptation of Table 6 where the amount of space for each simulator is rationalized using standard space allocation for medical education (published standards) measurement of simulators and space required for their functionality. For the estimated number of people around simulators, we used the standard of our practice [5 people around a full-body mannequin (ie, HPS) at the same time, 10 around the Harvey, etc]. It is may be that other people will use different standards, but we had to start from somewhere. The issue of stratifi ation from minimum (1 hour per student per month) to maximum (5 hours per student per month) for full-time students and stratifi tion from 25% to 100% for CPD is mainly based on the fi capacity and infrastructural requirements that will be varied from one place to another. It is important to understand that these data are specifi to the BC population needs. However, the methodology can be used to come up with some estimate of infrastructural needs for other simulation networks.

of space allocated for operation at (CESEI, Vancouver, BC, Canada) and standards provided for general medical education.[35,36]

Tables 7 to 9 demonstrate the required space for simulation activities specific to each type of center in the model. The minimum space reflects the start-up of the project, and the maximum space reflects on the potential growth of the center to its full capacity. Cost estimation is based on $400 Canadian per square foot (for construction in a hospital- based setting), although recognizing the cost of construction will vary in different provinces, states, and countries.

Model Function

In describing the function of the model (Fig. 3) in this schematic diagram, a commonly shared electronic platform, currently located and functioning at www.cesei.org, is used to deliver knowledge and online simulation to all the distributed sites. This electronic platform has been in existence for several years and has been used successfully to facilitate hundreds of courses at CESEI. As such, it was decided by the Task Force to adopt this as a provincial resource. The Web site is a learning management system with advanced capabilities, including interactive course materials and virtual classrooms, discussion boards, assessment tools with an accompanying database, and a research portal to help facilitate collaborative, multisite simulation-based research.

After obtaining ''Web-based education,'' students will be able to attend simulation sessions in mobile, regional, and/or academic simulation centers. In this model, two thirds of the courses may be delivered to the site where the learner is working, and one third of the courses, which require more resources (ie, for high-fidelity simulation), will take place at the academic simulation centers. All simulation centers provide the core learning activities (Table 5) for at least 3 categories of learners. The academic simulation centers also provide more specialized simulation courses. This advanced environment houses high-cost, high-maintenance equipment for a very specific subset of learners, such as robotic surgery trainers for surgeons, arthroscopy task trainers for

orthopedic surgeons, and endoscopy task trainers for urologists and gastroenterologists.
Regional and mobile simulation centers are each customized to the needs of the health care population being served. In both settings, the centers provide the opportunity for development and maintenance of competency and re- mediation. The simulation model is designed to have sufficient capacity and flexibility to accommodate future growth and customization in each of the service sites. The

Table 8. Illustration of Minimum and Expected Space Required for the Development of the Regional Simulation Center

Purpose/Function of Space	Minimum No.	Expected No.	Minimum Space (sq ft)	Expected Space (sq ft)
Full-sized mid-fidelity mannequins (5	1	4	600	2400
Debriefing space (5 students)	1	2	250	500
Lecture theater with AV technology (24 students)	1	1	600	600
Computer-based learning laboratory (10 students)	1	1	500	500
Administrative/reception space	1	1	400	400
Sum			2350	4400
Estimated cost ($ Canadian)			940,000	1,760,000

Cost estimation is calculated at $400 Canadian per square foot.

Table 9. Illustration of Minimum and Expected Space Required for the Development of the Mobile Simulation Center

Purpose/Function of Space	Minimum No.	Expected No.	Minimum Space (sq ft)	Expected Space (sq ft)
Fully equipped, electronically enabled ambulance with mid-fidelity mannequins	1	3	450	950
Shared space for in-hospital training (5 students)	1	3	300	600
Sum (temporary space)			750	1550
Estimated cost for each ambulance ($ Canadian)			150,000	300,000

academic, regional, and mobile simulation centers within a particular health region act as one cohesive unit, with the academic center holding the responsibility to provide oversight and guidance of the regional and mobile simulation activities in that area.

DISCUSSION

In developing the provincial model for simulation in BC, we reviewed the literature to understand how other similar networks have functioned to deliver simulation across wide regions and populations. In North America, formation of the OSA[14] in 2005, the Idaho Simulation Network[31] in 2007, and the CSA[32] in 2007 represents efforts at serving a broad community of simulation users. Table 10 compares and contrasts the OSA and CSA with the BC network. The OSA is a statewide organization that provides services to the Oregon simulation community. The organization was able to secure initial funding from the state and to coordinate simulation purchases and programs at the statewide level. The CSA is a statewide network whose goal is to offer a voice for simulation in nursing and health care education. It is led by the California Institute for Nursing and Health Care. The CSA is an umbrella organization of 7 regional collaboratives. All these networks have many functional similarities to the BC model. These include support of centers in advising for the purchase of the equipment, developing training curriculum and scenarios that can be easily shared among organizations, using experts to train educators, standardization of curricula, and advocacy to policy makers in health care institutions and governments to help promote the growth of simulation.
However, there are distinct differences between these networks and the BC model. First, these organizations are mostly acting as simulation societies, providing service to joining members for coordinating simulation resources, sharing ideas, and increasing bargaining power for purchasing simulation equipment. Most of these alliances are not organizations with jurisdiction over shared space and facilities, regulation on use of equipment, or establishment of standards for development and delivery for simulation practice. In those cases when the government mandates statewide simulation, the strategy and the plan to achieve this goal will be dependent on the existing financial, political, and geographic landscape of the state-which is essentially

different than the BC model that presents a high-level framework for delivery of simulation to health care providers and educators across the province. Second, the unique characteristic of the BC model is its focus on the delivery of SBE to various health care professions. Simulation services are designed to be inclusive and deliver equal education opportunity and access to all categories of learners, whereas other networks may focus on only 1 or 2 categories of

Table 10. Comparison of OSA, CSA, and BC Networks

Specific Features of Each Network	BC Simulation Model	Oregon Simulation Alliance	CSA
Shared governance	Yes	No	No
Inclusivity	Yes	No	No
Learner groups (CPD)			
Nursing	Yes	Yes	Yes
Physicians	Yes	Yes	No
Respiratory therapy	Yes	No	No
Paramedics	Yes	No	No
Other allied health professionals	Yes	No	No
Learner groups (trainees)			
Nursing	Yes	Yes	Yes
Physicians	Yes	No	No
Respiratory therapy	Yes	No	No
Paramedics	Yes	No	No
Other allied health professionals	Yes	No	No
Simulation model: developed based on provincial or statewide needs assessment?	Yes	No	Yes
Curriculum: developed based on provincial or statewide needs assessment?	Yes	No	Yes
Shared provincial or statewide technology platform (for education and research)	Yes	No	No
Shared technology support	Yes	No	No
Distance simulation (mobile units)	Yes	No	No
Shared governance structure (for simulation facilities across the province/state)	Yes	No	No
Shared business model (for simulation facilities across the province/state)	Yes	No	No
Improved purchasing power for simulation equipment	Yes	Yes	Yes
Membership fees	No	Yes	No

learners. The BC model is also designed to provide access to simulation programs for pockets of the population, which are unequally distributed across a vast geographic region. Many other networks do not consider how to pro- vide simulation to underpopulated areas of their respective regions. Last, the model that we have developed facilitates sharing of common infrastructure, thus fostering what we anticipate will be a more cost-effective approach to the delivery of SBE. The sharing of resources and the use of a province-wide electronic platform promote dissemination of established curriculum and collaboration for simulation- based research and assessment.

In the development of the new model for the delivery of interprofessional SBE in BC, we identified and addressed various other factors that we believed were important contributors to ensure success. These factors were as follows:

Number of learners: The greater the number of learners, the greater the need for a larger simulation facility with a corresponding higher initial capital cost. At the same time, a greater number of learners can reduce the operating cost per learner by ensuring a high utilization rate. Creating a model for delivering education to all areas of BC will help to optimize use of simulation resources throughout the province.

Optimal amount of simulation activity: How much time within a particular curriculum should be allocated for each learner to undertake simulation activities? The opinion of experts on how much simulation to use varies, and there are no established guidelines to follow. Because there is no common understanding of the optimal time to be spent using simulation within individual curricula, experience from a nonmedical arena was taken as the reference point. In aviation training, the requirement for simulation time for each learner is between 4 and 5 H/mo. This simulation time is the minimum mandatory time and serves as a criterion for accreditation. Roscoe[37] developed criteria for simulation efficacy and calculated a transfer effectiveness ratio (TER). The TER is equal to 0.5 in the airline industry, which means that each hour spent on a flight simulator reduces the time to achieve efficiency by 30 minutes. Aggarwal et al[11] investigated TER in the medical environment using a ‘‘virtual realty trainer'' and a virtual reality laparoscopic training curriculum followed by laparoscopic cholecystectomy in a swine model. He demonstrated the TER to be 2.28 in the medical environment. This means that each hour spent on a virtual reality simulator reduces the time to achieve proficiency in a porcine laparoscopic cholecystectomy by almost 2.3 hours. The comparison of TER for a medical setting to TER for an aviation setting also suggests that fewer hours of simulation training may be required for health care education. However, this cannot be used as a benchmark in medical education because within health care education, there is the complexity of human systems, the variety of pathologies, the complexity of treatment interventions, and the complexity of the interprofessional team. Considering all these factors, the aviation standard may provide only some initial insight into this issue. Extending the airline standards and logic provided a very preliminary and rough estimate of 4 to 5 H/mo of simulation training per full-time student and 5 hours of simulation per year for CPD. This was considered a starting point because future research may bring more precise recommendations for the optimal number of hours required for specific learning outcomes.

Engagement of key partners: The engagement of key partners such as academic and health care organizations, government agencies, private industry, and regulatory bodies will lead to a strong partnership for the support of an interprofessional simulation model.

Sustainability, funding, and governance: Financial support of this project has been obtained through a P3 (public, private, and partnership) funding model. In Canada, P3 projects are financed by private entities in partnership with public entities, but stakeholders in the public entities control the regulations and quality assurance. The BC simulation network will have this type of shared governance structure that is controlled through a provincial consortium consisting of stakeholders from every region. Other stakeholders include members from the Government of BC and regulatory bodies such as the College of Physicians and Surgeons of British Columbia. The P3 funding model will provide equipment, services, manpower, maintenance, and full operational support. The provincial consortium will oversee the following mandates:

- Enforce standards and accreditation criteria,
- Support educationally sound curriculum development,
- Ensure equal access of learners to all BC simulation centers,
- Support the use of simulation for evaluation and assessment,
- Provide quality control,
- Support research and development,
- Facilitate faculty development in simulation, and
- Advocate for the use of SBE and patient safety to the local, provincial, and federal governments in Canada.

A schematic diagram of the governance structure is presented in Figure 4, and a description of the BC Simulation Consortium is provided in Appendix B.

Other factors: Other factors that can affect the success of the BC simulation model are listed, which have been addressed by the development of provincial sub- committees to move these agenda forward.

- Facilitator and technician training,
- Audiovisual technology integration and implementation and support for the e-platform across all simulation centers in the province, and
- Development of interprofessional curriculum and integration into existing curricular activities.

IMPLEMENTATION

The model is currently in the implementation phase.

Considering the scope of the work, including financial planning, curriculum development, and logistics, it is estimated to take approximately 5 years to fully implement the plan.

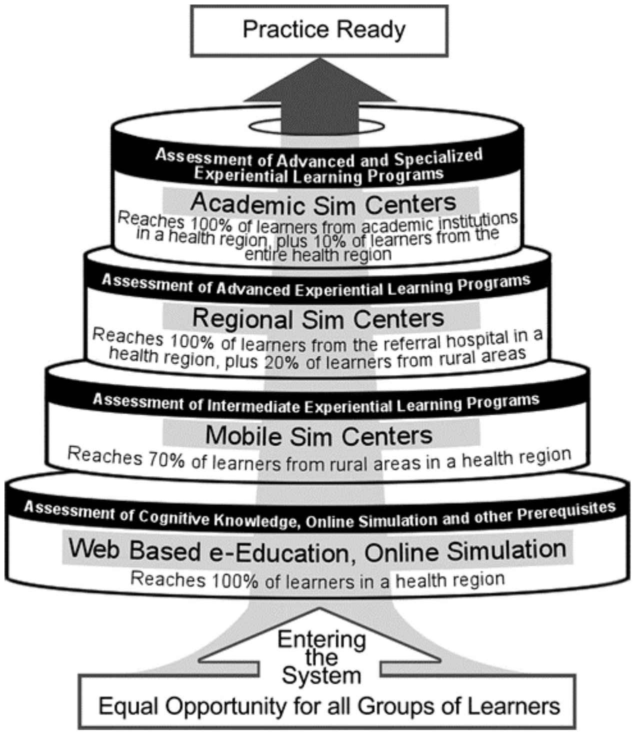

FIGURE 3. A schematic diagram of the program function depicts the flow of learners through the system. All learners will be able to reach the Web-based cognitive knowledge and online simulation. After assessment and evaluation, they can move to experiential learning. Intermediate simulation experience for 70% of the learners in the rural area will be completed using mobile and in situ simulation to become practice ready. The remaining 30% of learners that will require advanced or specialized simulation experience will be able to access regional simulation centers (20%) and academic simulation centers (10%) to become practice ready. The academic and regional centers will serve 100% of their learners in addition to learners for advanced and specialized simulation from the rural area.

The implementation has started with the construction of new space for academic and regional simulation centers around the province. In the Northern Health Region, 1 academic simulation center (Prince George) and 2 regional simulation centers (Quesnel and Terrace) are completed and functional. In Vancouver Island (Victoria), an academic simulation center is under construction, and a regional simulation center is open for operation (Nanaimo). In the Interior Region of BC, an academic center is under construction, and plans for 2 regional centers are in progress. Functioning new centers have been able to immediately access the existing educational resources on the provincial e- platform. The Interior Region is the leader in mobile simulation and has been doing this program for the past several years. We are in the negotiation phase with the government for receiving and converting 10 used ambulances that can be used for implementation of mobile simulation units across BC. In the meantime, a provincial umbrella organization for SBE in health care along with strong provincial governance is in the process of formation to replace the BC Simulation Task Force and expedite the implementation phase.

FUTURE DIRECTIONS

Plans and goals for the BC simulation initiative include the following:

- Providing at least 5 to 10 hours of simulation per month to all undergraduate and postgraduate full time students all over BC;
- Providing at least 3 to 9 days of simulation activity per year for every practicing physician, nurse, allied health professional, and affiliated groups in the province of BC;
- Providing research opportunities for evaluation and assessment of the education process such as efficacy, validity, and reliability, as well as cost-effectiveness of the new simulation model;
- Providing a common infrastructure for an inter- professional curriculum development plan that will eliminate redundancy and provide benefit to health care practitioners in BC by making the health education more effective, convenient, and less costly;
- Obtaining accreditation status for BC simulation facilities from accreditation bodies such as the Society for

Simulation in Healthcare, the RCPSC, and the American College of Surgeons; and
- Developing courses in partnership with regulatory bodies such as the RCPSC.

The BC model for simulation in healthcare education provides a framework for collaboration and delivery of SBE to health care providers all across the province. By building the model based on information gathered from a thorough needs assessment, we believe that we have identified and addressed critical issues required to ensure collective success when implementing this model. Future work will need to be done to evaluate various aspects of the model, but in the meantime, we hope this work will provide insight for others who are trying to achieve similar goals in their simulation communities.

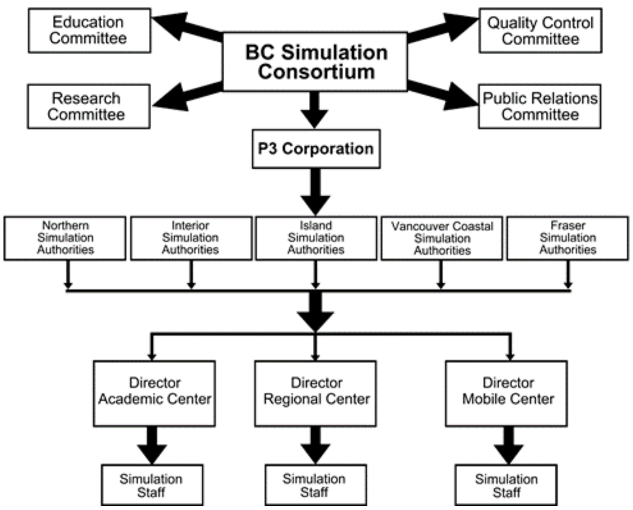

FIGURE 4. Governance model.

ACKNOWLEDGMENTS

The authors thank Dr. Gavin Stuart, Dean of the Faculty of Medicine and Vice Provost Health, UBC, for the initiation and financial contributions toward this project. The authors thank all members of the BC Simulation Task Force and individuals and organizations who participated in this project. The authors thank the BC Academic Health Council and the Rural Education Action Plan, Department of Family Practice, UBC, for their contributions and active participation and continuous support.

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APPENDIX A: GLOSSARY

Simulation refers to a system, model, or device used in a health care education setting, which imitates characteristics or behaviors of a patient, in part or as a whole, on a wide range of anatomic, physiologic, and pathologic conditions.

Simulation is classified as follows:

Life simulation is when real people act on real people to simulate a condition or situation. In this case, the simulator is a live person such as an actor.

Standardized patient is an individual who has been carefully trained to act as a real patient to simulate a set of symptoms or problems. A standardized patient presents an illness history and physical, emotional, and personality characteristics during physical patient interactions. The standardized patients have been successfully used in medical education, evaluation (such as objective structured clinical examination), and research.

Virtual simulation is when real people from the real world act on specific equipment to trigger a simulation process in a virtual environment. Today, many of the workstations, workbenches, mannequins, and other equipment available for medical training fall into this category and provide medical simulation in a virtual environment.

Constructive simulation is when people act on simulation equipment initially to perform a simulation in a virtual environment. These elements then act on other elements of the simulation to trigger another specific response. These internal elements can create a chain of infinite simulation environments for task performance and/or response to the command. In this type of simulation, once the simulation is started (by real people), 1 part of the machine/computer will act on other parts of the machine/computer and continue to initiate or maintain multiple specific tasks or conditions. A good example of this type of simulator in the medical field is the mannequin made by Medical Education Technologies, Inc, (METI) and the interactive online software CyberPatient.

Simulators can be classified by the nature of technology as:

Computer-based interactive multimedia training systems are a good example of online virtual environment, which include CyberPatient and Learning Objects. (Learning Objects are online computer-based virtual education tools that can be used and reused infinitely.)

Digitally enhanced mannequins are commercial off-the-shelf technology, suitable for individual and team training. A good example of this type of digitally enhanced mannequins may include HPS and ECS made by METI, SimMan made by Laerdal, Harvey (a cardiopulmonary simulator), and others.

Virtual reality workstations are computer-based simulators, which represent visual or other realisms in response to the user's actions. Examples include GI Mentor for endoscopic and SurgicalSIM for laparoscopic skills training.

Task trainers refer to physical simulators designed to train specific tasks, such as plastic simulators for training skills of lumbar puncture, eye examination, intravenous injection, central line, surgical skills, and other tasks for practice of health care delivery.

Basic anatomic models are noninteractive anatomic parts of the body or the whole body, which are used for education. For the purpose of this survey, basic models should not be considered as a simulator.

Total immersion virtual reality is an evolving technology that provides realistic simulation for the entire environment in virtual space. This type of technology is under development and may not be applicable for your institution.

Comprehensive computational models (combining function and structure) are integrated modeling of human systems, from molecular to system level, which predicts problems and simulates responses to countermeasures or interventions. This type of technology is under development and may not be applicable for your institution.

Simulators can be classified by the complexity of functionality and interactivity as:
Low-fidelity simulators (low degree of realism and functionality) are physical models that are capable of passive display of a specific function and/or procedure but have no capacity to react automatically or have a precondition response. Good examples of this type of simulators are basic anatomic models, urology training or laparoscopic training boxes, and others.
Medium-fidelity simulators (some degree of realism and functionality) have an automatic preconditioned response to a limited number of physiologic functions and procedures under the human body structure, which are controlled by a computer. For example, SimMan (Laerdal) or ECS (METI), GI Mentor, LAP Mentor, and others.
High-fidelity simulators (high degree of realism and functionality) are real-time interactive simulators that simulate a variety of body functions and procedures, which can be altered automatically in response to drug injection oxygenation or other factors. The high-fidelity simulators can be programmed to create simulations of life-threatening emergencies. HPS (METI) and Pedia- SIM (METI) are 2 examples.
Virtual patient refers to computer-based interactive patients simulating various illness conditions. Virtual patients provide opportunities for health care professionals to develop clinical skills such as making diagnoses and therapeutic decisions during patient interactions.
Expert systems are intelligent systems integrating experiences and rules from health care experts for diagnosis and treatment. Expert system provides a tool to improve the decision-making process of health care providers.
Simulation-based education in health care aims at teaching diagnostic and therapeutic procedures, medical concepts, and decision-making processes to health care professionals using simulators as a tool.
Simulation course is a discreet curriculum developed to address a specific objective(s).
Simulation center is a physical structure that offers simulation courses and/or is the base of a simulation program.
Simulation program is an organization that consolidates and organizes simulation courses under a common mission statement and goals.
Simulation research is a systematic and/or academic approach to evaluating simulation courses for the purpose of validating the course/modality, improving the curriculum, advancing simulation science, or addressing patient safety. This would include quality improvement/assurance.
Personnel are employees of the simulation program. Faculty/instructors are primarily appointed to departments/institutions outside the simulation program and use the program for education and research.
Instructional design is how a course is developed and
delivered using a variety of technologies teaching and learning strategies (including debriefi that refl t the course learning objectives.

APPENDIX B: BC SIMULATION CONSORTIUM
Structure: BC Simulation Consortium consists of Chairs of Regional Simulation Authorities, Government of BC representatives (Ministers of Education, Health and Innovation), BC Academic Health Council, licensure/regulatory bodies (College of Physicians and Surgeons of BC, BC Medical Association), academic institutions, professional health societies, family physicians, nurses, BC Ambulance Services, BC Patient Safety & Quality Council, members of the public and others. This is a reporting and decision-making body that meets twice/year with a steering committees that meets once/month.
Function: The consortium enforces the international standards and accreditation criteria; supports educationally sound curriculum development; ensures equal access of learners to all BC simulation centers; supports evaluation and assessment research; provides quality control; supports R&D; advocates for the use of simulation in health care education and patient safety to local and federal governments in Canada, health care workers, the public, and others; facilitates train-the-trainer programs for an adequate number of simulation specialists and technicians; and facilitates faculty development in simulation. The consortium receives feedback from 4 committees (education, research, quality control, and public relations).

P3 Corporation
Structure: Public Private Partnership is between private investors, the Government of BC, and academic and health- care institutions. Private investors will provide funding to support the infrastructure and operating expenses of the network. The government will provide space, expertise, and guarantee payments for the

services provided by the corporation. Academic and health care partners provide expertise and are looking for quality and standards of education and research activities.
Function: P3 Corporation is responsible for the finances (including infrastructure and operating), education and research services, advocacy, and overall management of the network.

Regional Simulation Authorities
Structure: Regional simulation authorities consist of regional academic leaders (nursing schools, universities, coleges) and health care leaders as well as simulation champions in the region who are serving in a variety of capacities in academic simulation centers, regional simulation centers and mobile simulation centers and others.
Function: They are responsible for the implementation of the program, curriculum delivery in the region, and collaboration and cooperation in the region and with the rest of the network; research activities such as data collection, data analysis, and other; and keeping the standards and quality assurance, needs assessment, curriculum development, and others.

Reporting
Academic, regional, and mobile centers report to the Regional Committee. The Regional Committee is responsible for administration and day-to-day business of their centers and reports to the corporate headquarters; the corporation reports to the consortium on finances, administration, services and other business.
A separate 2-way reporting/controlling mechanism between regional simulation authorities and the consortium is established through consortium committees that include education, research, quality control and public relations committees.