



HAL
open science

How simulation teaching is revolutionizing our relationship with cardiology

Théo Pezel, Augustin Coisne, Fabien Picard, Pascal Gueret

► **To cite this version:**

Théo Pezel, Augustin Coisne, Fabien Picard, Pascal Gueret. How simulation teaching is revolutionizing our relationship with cardiology. Archives of cardiovascular diseases, 2020, 113, pp.297 - 302. 10.1016/j.acvd.2020.03.010 . hal-03490957

HAL Id: hal-03490957

<https://hal.science/hal-03490957v1>

Submitted on 22 Aug 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

How simulation teaching is revolutionizing our relationship with cardiology

Abbreviated title: Simulation teaching in cardiology

Théo Pezel^{a,b,c,*}, Augustin Coisne^{c,d,e,f}, Fabien Picard^{c,g,h}, Pascal Gueret^{c,i}, for the French Commission of Simulation Teaching (Commission d'enseignement par simulation [COSI]) of the French Society of Cardiology

^a *Department of Cardiology, Lariboisière Hospital, AP-HP, Inserm UMRS 942, University of Paris, 75010 Paris, France*

^b *Division of Cardiology, Johns Hopkins University, Baltimore, MD 21287-0409, USA*

^c *French Commission of Simulation Teaching (Commission d'enseignement par simulation [COMSI]) of the French Society of Cardiology, France*

^d *Department of Cardiovascular Explorations and Echocardiography, Heart Valve Clinic, CHU de Lille, 59000 Lille, France*

^e *Inserm UMR 1011, 59019 Lille, France*

^f *Institut Pasteur de Lille, 59000 Lille, France*

^g *Department of Cardiology, Cochin Hospital, Hôpitaux Universitaires Paris Centre, AP-HP, 75014 Paris, France*

^h *INSERM U970, Paris Cardiovascular Research Center (PARCC), Georges Pompidou European Hospital, 75015 Paris, France*

ⁱ *Department of Cardiology, Foch Hospital, 92150 Suresnes, France*

* Corresponding author at: Centre Hospitalo-Universitaire Lariboisière, AP-HP, 2 rue Ambroise Paré, 75010 Paris, France.

E-mail address: theo.pezel@live.fr (T. Pezel).

KEYWORDS

Simulation education;

Cardiology;

Cardiovascular imaging;

Interventional cardiology

Abbreviations: TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography.

Background

Education has changed in recent decades, moving from text-based manuals to multimedia education readily accessible by e-learning [1]. Indeed, the new generation of physicians is calling for more personalized training focused on clinical practice. Thus, European and American cardiology societies have developed e-learning programmes with numerous webinars. However, these e-learning programmes do not entirely replace face-to-face teaching with an experienced trainer. The evolution of this personalized education is probably simulation teaching, with students raised with this type of support. Indeed, in a recent international survey of 172 young cardiologists from 43 countries, only 48% of the participants had already participated in simulation training, while 91% considered this teaching method as “necessary” in cardiology [2].

Importance of simulation education

Education using simulators is already a well-established teaching technique in aeronautics, with standardized and mandatory simulation training. In this field, simulation is used to hone individual cognitive and psychomotor skills in a low-risk environment [3]. The adage “see one, do one, teach one” was based on an old tradition of medical education, where patients were used as both the primary source and subject of our education. However, we know that no patient would willingly subject themselves to be the test case for a completely unprepared trainee in a risky procedure, such as coronary angiography, transseptal puncture or transoesophageal echocardiography (TOE). Therefore, the common adage “never the first time on the patient” clearly articulates the need for simulation education. More precisely, it should say “never the first times on the patient”, as the basics of a procedure are not usually mastered after only one attempt [4]. To go further, we could even hope that in the near future, this adage will be reversed and replaced by “never the first time without simulation training” [5]. Widely used in foreign countries, such as the USA, the use of simulation is still under development in cardiology in France. Indeed, the development of simulation teaching in cardiology is faced with certain challenges, such as the need for an educational background in simulation for trainers; it is also a time-consuming teaching method.

A summary of the main studies assessing simulation training in cardiology is given in [Table 1](#).

Simulation using serious games and scenarios

The transfer of learning from simulation to clinical practice in cardiology is based on two complementary methods: serious games at an individual level; and scenarios, with debriefing at a team level.

“Serious games” is the term given to computer software in which “real-life” environments are replicated to emphasize educational messages. Serious games have the advantage of being accessible on computer or smartphone, and therefore to not necessitate the purchase of additional equipment. The flexibility is also appreciated by learners [4], as they can perform their training basically whenever they want. One real limitation is the perception of the learner, who is aware of the artificial aspect of the simulation, with the risk of a different response between simulation and real-life.

An additive value is the possibility of creating uncommon scenarios, rarely encountered during clinical practice, using high-fidelity patient simulators [4]. These emergency scenarios (e.g. cardiac arrest) are important to assess team communication and efficiency of emergency protocols in a centre. Indeed, studies have demonstrated a clear benefit from the use of simulation over traditional resuscitation training, with an increase in cardiac arrest survival in centres with these programmes running [6].

Role of simulation in cardiovascular imaging

Great knowledge of transthoracic echocardiography (TTE) and TOE is the backbone of cardiovascular imaging programmes [7] in cardiology in Europe and the USA. Indeed, a complete training programme with theoretical and practical sections is necessary for learning complete TTE [8]. However, this training could, at least in part, be based on a short self-study programme, such as Bernard et al. showed in a population of novices in echocardiography, with the acquisition of basic knowledge in TTE through practice on a simulator [9]. In addition, Fredericksen et al. showed that novices in echocardiography obtained an 86% rate of interpretable images after only 2 hours of teaching and practice on two healthy volunteers [10].

Experience in echocardiography that allows the trainee to move from a basic to an advanced level requires them to see many different cases – for instance, to provide guidance during surgery or percutaneous procedures. In addition, support for these procedures has very recently been a prerequisite for acquiring the “cardiovascular imaging expert” option of the French cardiology diploma. This learning curve to become self-sufficient takes time [4]. Indeed, in real-life training, most trainees

feel the gap between formal learning and actual expected performance, together with considerable stress and a lack of preparedness [11].

In simulation-based learning, it is essential to acquire high-quality ultrasound reference views to be able to interpret them as precisely as possible [4]. Using mannequin-based TTE and TEE simulators is a modern way to learn normal and abnormal cardiac anatomies and functions in a safe environment, promoting experience and instilling confidence without jeopardizing patient safety [12]. Indeed, Hammoudi et al. showed that undergraduate medical students can learn cardiac anatomy effectively through echocardiography simulation, with three-dimensional construction of the anatomy [13]. In a meta-analysis, Sidhu et al. showed that while real-life supervised TEE experience is irreplaceable, given its challenges (intubation, artefacts, etc.), teaching ultrasound techniques through simulation for diagnosis or certain interventional procedures enhanced the ability to acquire the main views of focused cardiac ultrasound and to carry out these examinations in real-life situations [14].

In addition, beyond the issue of acquiring high-quality images, simulation teaching is also a tool for developing interpretation capacity, by producing a relevant report using a multivariable approach. Indeed, practical workshops make it possible to simulate real situations from the replay station on a dedicated console [2].

Role of simulation in interventional cardiology

With continuing growth of invasive procedures that require technical expertise, fast changing unstable clinical scenarios with potential life-threatening complications, complex therapeutic options and well-documented steep learning curves, the demands placed on cardiologists in training and in practice are intense. Many simulators exist for practising endovascular procedures: coronary angioplasty, pacing, electrophysiological studies and structural interventions [4]. These simulators use mechanical haptic feedback, which refers to tactile feedback provided by active or passive resistance generated by the simulator itself in response to user movements. This tactile feedback allows the subject to manipulate the simulated instrument in real time with force feedback, which provides a mechanical simulation of the sense of touch and/or resistance. All simulators provide quantitative metrics regarding the use of contrast and fluoroscopy time [15]. Such training has been proven to improve students' knowledge and skills [16].

Hybrid simulation is the term applied to mixing modalities to enhance the experience. An example of this is the situation of an angiographic procedure simulator under drapes alongside an actor playing the part of an anxious patient, to allow both the practical skills of cardiac catheterization and the communication skills required during the procedure [17].

Conclusions

Unlike abroad, especially the USA, simulation is not yet used for recertification of doctors in France, but is currently used only as a training tool. Simulation training could probably be a means of providing education in cardiology, allowing trainees to progress under expert supervision, without risk to patients and in agreement with the Continuing Professional Development advocated by the French Health Authority. In addition, commercial availability of inexpensive realistic simulators would aid medical education and reduce the risk posed to patients. Finally, the absence of a validated educational programme in simulation for cardiology is an important limitation. The collegial development of a national training curriculum should be our next target to promote simulation.

Sources of funding

None.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References

- [1] Cosyns B, De Diego JJ, Stefanidis A, et al. E-learning in cardiovascular imaging: another step towards a structured educational approach. *Eur Heart J Cardiovasc Imaging* 2015;16:463-5.
- [2] Pezel T, Coisne A, Mahmoud-Elsayed H, et al. EACVI communication paper: first international young dedicated multimodal cardiovascular imaging simulation education event organized by the ESC. *Eur Heart J Cardiovasc Imaging* 2020;21:124-6.
- [3] Scalese RJ, Obeso VT, Issenberg SB. Simulation technology for skills training and competency assessment in medical education. *J Gen Intern Med* 2008;23 Suppl 1:46-9.
- [4] Gosai J, Purva M, Gunn J. Simulation in cardiology: state of the art. *Eur Heart J* 2015;36:777-83.
- [5] Westerdahl DE. The Necessity of High-Fidelity Simulation in Cardiology Training Programs. *J Am Coll Cardiol* 2016;67:1375-8.
- [6] Mundell WC, Kennedy CC, Szostek JH, Cook DA. Simulation technology for resuscitation training: a systematic review and meta-analysis. *Resuscitation* 2013;84:1174-83.
- [7] Ryan T, Berlacher K, Lindner JR, Mankad SV, Rose GA, Wang A. COCATS 4 Task Force 5: Training in Echocardiography: Endorsed by the American Society of Echocardiography. *J Am Soc Echocardiogr* 2015;28:615-27.
- [8] Labbe V, Ederhy S, Pasquet B, et al. Can we improve transthoracic echocardiography training in non-cardiologist residents? Experience of two training programs in the intensive care unit. *Ann Intensive Care* 2016;6:44.
- [9] Bernard A, Chemaly P, Dion F, et al. Evaluation of the efficacy of a self-training programme in focus cardiac ultrasound with simulator. *Arch Cardiovasc Dis* 2019;112:576-84.
- [10] Frederiksen CA, Juhl-Olsen P, Nielsen DG, Eika B, Sloth E. Limited intervention improves technical skill in focus assessed transthoracic echocardiography among novice examiners. *BMC Med Educ* 2012;12:65.
- [11] Dreyfus J, Donal E, Pezel T. Moving Into a New Era for Echocardiography Education With Simulation and Workshop-Based Training. *JACC: Case Reports*;March 2020. Epub ahead of print.
- [12] Ziv A, Wolpe PR, Small SD, Glick S. Simulation-based medical education: an ethical imperative. *Acad Med* 2003;78:783-8.

- [13] Hammoudi N, Arangalage D, Boubrit L, et al. Ultrasound-based teaching of cardiac anatomy and physiology to undergraduate medical students. *Arch Cardiovasc Dis* 2013;106:487-91.
- [14] Sidhu HS, Olubaniyi BO, Bhatnagar G, Shuen V, Dubbins P. Role of simulation-based education in ultrasound practice training. *J Ultrasound Med* 2012;31:785-91.
- [15] Green SM, Klein AJ, Pancholy S, et al. The current state of medical simulation in interventional cardiology: a clinical document from the Society for Cardiovascular Angiography and Intervention's (SCAI) Simulation Committee. *Catheter Cardiovasc Interv* 2014;83:37-46.
- [16] Fischer Q, Sbissa Y, Nhan P, et al. Use of Simulator-Based Teaching to Improve Medical Students' Knowledge and Competencies: Randomized Controlled Trial. *J Med Internet Res* 2018;20:e261.
- [17] LeBlanc VR, Tabak D, Kneebone R, Nestel D, MacRae H, Moulton CA. Psychometric properties of an integrated assessment of technical and communication skills. *Am J Surg* 2009;197:96-101.
- [18] Sharma V, Chamos C, Valencia O, Meineri M, Fletcher SN. The impact of internet and simulation-based training on transoesophageal echocardiography learning in anaesthetic trainees: a prospective randomised study. *Anaesthesia* 2013;68:621-7.
- [19] Matyal R, Montealegre-Gallegos M, Mitchell JD, et al. Manual Skill Acquisition During Transesophageal Echocardiography Simulator Training of Cardiology Fellows: A Kinematic Assessment. *J Cardiothorac Vasc Anesth* 2015;29:1504-10.
- [20] Sohmer B, Hudson C, Hudson J, Posner GD, Naik V. Transesophageal echocardiography simulation is an effective tool in teaching psychomotor skills to novice echocardiographers. *Can J Anaesth* 2014;61:235-41.
- [21] Damp J, Anthony R, Davidson MA, Mendes L. Effects of transesophageal echocardiography simulator training on learning and performance in cardiovascular medicine fellows. *J Am Soc Echocardiogr* 2013;26:1450-6 e2.
- [22] Ferrero NA, Bortsov AV, Arora H, et al. Simulator training enhances resident performance in transesophageal echocardiography. *Anesthesiology* 2014;120:149-59.
- [23] Ogilvie E, Vlachou A, Edsell M, et al. Simulation-based teaching versus point-of-care teaching for identification of basic transoesophageal echocardiography views: a prospective randomised study. *Anaesthesia* 2015;70:330-5.

- [24] Casey DB, Stewart D, Vidovich MI. Diagnostic coronary angiography: initial results of a simulation program. *Cardiovasc Revasc Med* 2016;17:102-5.
- [25] Schimmel DR, Sweis R, Cohen ER, Davidson C, Wayne DB. Targeting clinical outcomes: Endovascular simulation improves diagnostic coronary angiography skills. *Catheter Cardiovasc Interv* 2016;87:383-8.
- [26] Hauguel-Moreau M, Adjedj J. Managing Pregnancy as an Interventional Cardiologist Fellow-in-Training: My Experience With a Simulator. *J Am Coll Cardiol* 2016;68:1916-9.
- [27] Bagai A, O'Brien S, Al Lawati H, et al. Mentored simulation training improves procedural skills in cardiac catheterization: a randomized, controlled pilot study. *Circ Cardiovasc Interv* 2012;5:672-9.
- [28] Voelker W, Petri N, Tonissen C, et al. Does Simulation-Based Training Improve Procedural Skills of Beginners in Interventional Cardiology?--A Stratified Randomized Study. *J Interv Cardiol* 2016;29:75-82.
- [29] De Ponti R, Marazzi R, Ghiringhelli S, Salerno-Uriarte JA, Calkins H, Cheng A. Superiority of simulator-based training compared with conventional training methodologies in the performance of transseptal catheterization. *J Am Coll Cardiol* 2011;58:359-63.
- [30] De Ponti R, Marazzi R, Doni LA, Tamborini C, Ghiringhelli S, Salerno-Uriarte JA. Simulator training reduces radiation exposure and improves trainees' performance in placing electrophysiologic catheters during patient-based procedures. *Heart Rhythm* 2012;9:1280-5.

Table 1 Summary of the main studies investigating simulation-based training in cardiology.

Study	Year	No. of students	Study design	Session type	Blind assessment	Improvement in procedural ability	Simulated or real procedures	Conclusions
TOE								
Observational studies								
Sharma et al. [18]	2013	28	Single group before/after SBT intervention	Self-directed	No	Not investigated	Simulated	Improving knowledge
Matyal et al. [19]	2015	6	Single group before/after SBT intervention	Fixed-time simulation sessions	No	Yes	Simulated	Reduction of acquisition time to obtain adequate images
Sohmer et al. [20]	2014	33	Single group before/after SBT intervention	Self-directed versus fixed-time simulation sessions	No	Yes	Simulated	No difference in improvement by SBT between supervised and self-directed sessions
RCTs								

Damp et al. [21]	2013	27	Apprenticeship training and SBT versus apprenticeship training alone	Fixed-time simulation sessions	No	Yes	Real	At 1 month, the SBT group significantly outperformed the non-SBT group
Ferrero et al. [22]	2014	42	SBT versus lecture-based education.	Fixed-time simulation sessions	Yes	Yes	Real	Students with the lowest baseline experience level had the best learning curve
Ogilvie et al. [23]	2015	52	SBT versus theatre-based training	Fixed-time simulation sessions	No	Not investigated	Real	Improving knowledge

CA

Observational studies

Casey et al. [24]	2016	10	Single group before/after SBT intervention	Fixed-time simulation sessions	No	Yes	Simulated	Reduction in procedure time
Schimmel et al. [25]	2015	14	Single group before/after SBT intervention	Fixed-time simulation sessions	No	Yes	Simulated	Reduction in procedure time

Hauguel-Moreau & Adjedj [26]	2016	1 ^a	Single group before/after SBT intervention	Fixed-time simulation sessions	No	Yes	Simulated	Improved angioplasty skills after SBT
RCTs								
Bagai et al. [27]	2012	27	Apprenticeship training and SBT versus apprenticeship training alone for CA	Mastery learning	Yes	Yes	Real	Reduction in procedure time
Voelker et al. [28]	2015	18	SBT versus lecture- based training for CA	Fixed-time simulation sessions	Yes	Yes	Simulated	Improved angioplasty skills after SBT
Fischer et al. [16]	2018	118	Traditional face-to-face teaching versus SBT for CA interpretation	Fixed-time simulation sessions	Yes	No	Simulated	Improved angioplasty skills after SBT
Electrophysiology								
De Ponti et al. [29]	2011	14	RCT: SBT versus apprenticeship training for transseptal catheterization	Mastery learning	Yes	Yes	Real	SBT reduced training time (reduction of 27 days compared with conventional training)

De Ponti et al. [30]	2012	7	Single group before/after SBT intervention for the ability to position electrophysiology catheters at standard intracardiac sites	Fixed-time simulation sessions	No	Yes	Real	SBT reduced radiation exposure (reduction of 262 seconds of the fluoroscopy time per patient)
----------------------	------	---	---	--------------------------------------	----	-----	------	---

CA: coronary angiography; RCT: randomized controlled trial; SBT: simulation-based training.

^a A pregnant cardiologist.