Virtual Patients:
Where are we? Where are we going?

Paul Gauguin, *Where Do We Come From? What Are We? Where Are We Going?* 1897

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What is a virtual patient?

DECISION

„The student [is presented] with a choice from a list of various drugs, activities, diet and nursing care, some of which would be beneficial to the patient, some of them harmful"

CONTEXT

„In order to help convey an image of a real patient (…) a three minute film is incorporated in the (…) lesson"

FEEDBACK

„Whenever the student performs an experiment, e.g., gives the patient oxygen, all of the information available on the patient changes accordingly to show the effect on the patient"

Bitzer 1966, The Plato Simulated Laboratory

Bitzer M "Clinical nursing instruction via the PLATO simulated laboratory." *Nursing Research* 15.2 (**1966**): 144-150.

- tested with 1st year nursing students class at Mercy Hospital School of Nursing, Urbana, Illinois
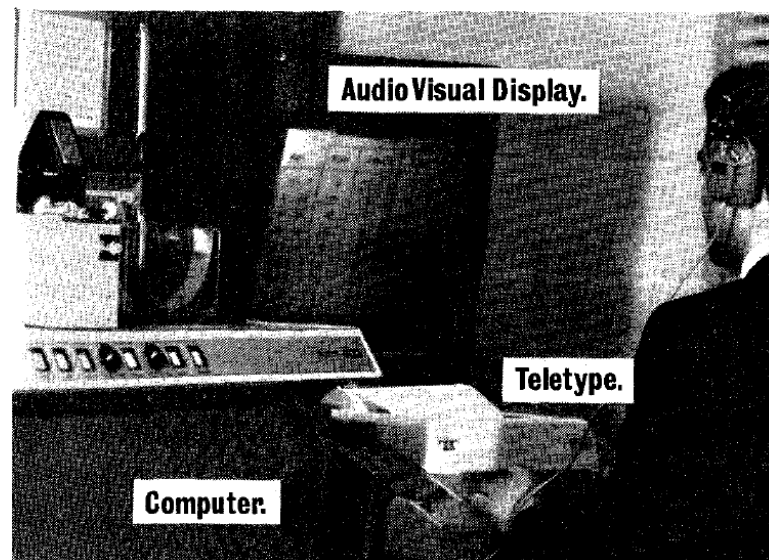
de Dombal et al. 1969, Leeds C.A.L. for clinical diagnosis

Virtual patients – What are we talking about?

- The term „Virtual Patients" first mentioned in 1991

- From 791 articles including this term in title or abstract by 2013

  - **330 (62%) Medical Education**
  - 135 (25%) Clinical research
  - 39 (7%) E-health
  - 26 (5%) Clinical procedures

- Classification by competency & technology

Competency	Multimedia system	Virtual world	Dynamic simulation and mixed reality	Manikin and part task trainer	Conversational character
Knowledge	8 *Case presentation*		3 ●		
Clinical reasoning	98 *Interactive patient scenario*	23	10		4
Team training		*Virtual patient game*	1 ●	3 ● *High fidelity manikin*	
Procedural & basic skill	5	1 ●	50 *High fidelity software simulation*		1 ●
Patient communication	11 *Human standardized patient*	4			41 *Virtual standardized patient*

Technology (top axis), *Competency* (left axis)

Kononowicz AA, Zary N, Edelbring S, Corral J, Hege I: *Virtual patients - what are we talking about? A framework to classify the meanings of the term in healthcare education.* BMC Med Educ. 2015 Feb 1;15(1):11

Interactive Patient Scenarios

CASUS **Open Labyrinth** **Web-SP**

Instruct AG; LMU Munich

http://openlabyrinth.ca

Karolinska Institutet

Linear („string of pearls")

Branched
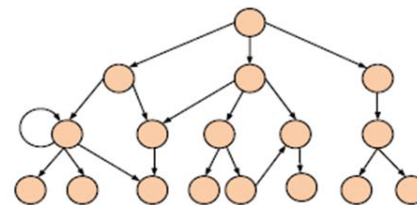
Problem-solving
(Template-based)

Narrative design

Virtual Patient Games (Virtual Worlds)

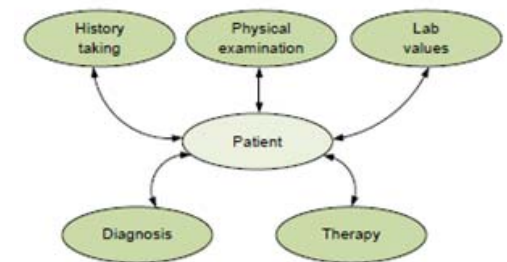CliniSpace™ – A Virtual Patient Game CliniSpace. Immersive Learning Environments for Healthcare. Available from: http://www.clinispace.com

Virtual Standardized Patient
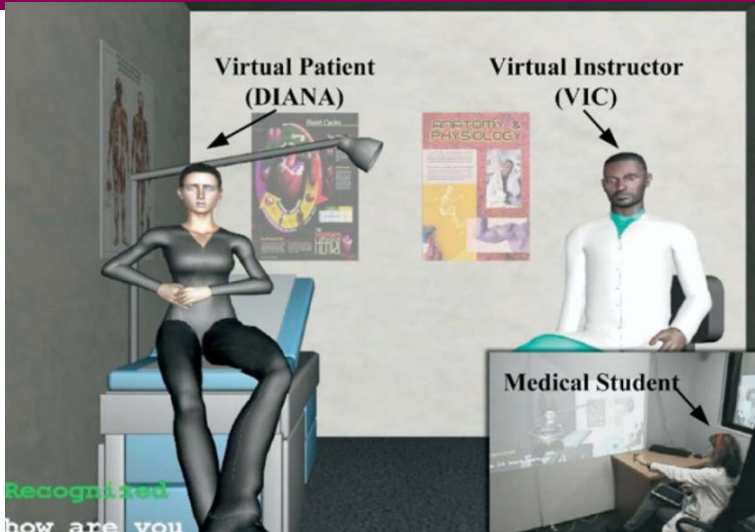
Stevens A, et al. The use of virtual patients to teach medical students history taking and communication skills. Am J Surg. 2006;191(6):806–11.

Talbot et al, 2012

Rossen B & Lok B. A crowdsourcing method to develop virtual human conversational agents. *Int J Hum Comput Stud*. 2012;70(4):301–319.

High Fidelity Software Simulations

Dynamic simulations of physiology (e.g. GOLEM)

Kofránek, Jiří. "Komplexní modely fyziologických systémů jako teoretický podklad pro výukové simulátory." *Medsoft 2011, pp. 73-105.*

Complex geometric models
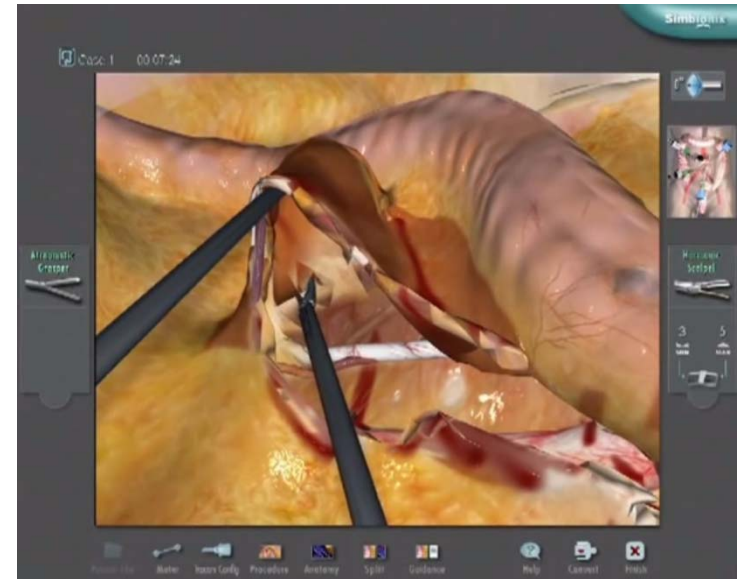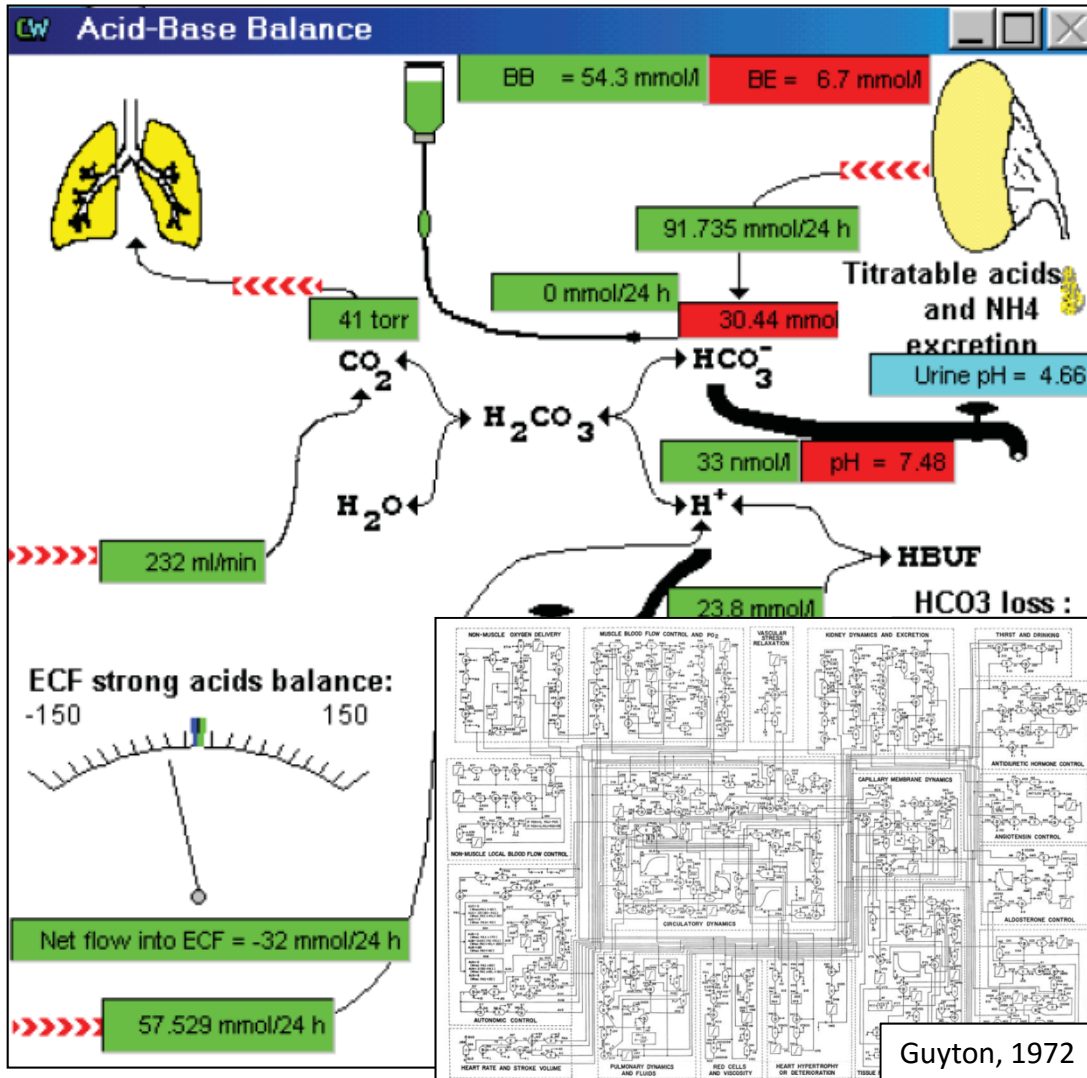
Simbionix LAP Mentor

High fidelity
- **Structural fidelity** – how the simulator appears? (*physical resemblance*)
- **Functional fidelity** – what the simulator does? (*functional task alignment*)

Hamstra SJ et al. "Reconsidering fidelity in simulation-based training" Acad Med. 2014 Mar;89(3):387-92.

Virtual patients in medical curricula

- Individual learning
  - Virtual patient repositories (e.g. eViP project repository)
  - Exam relevance (before formal assessment)
  - Prerequisite for practice (flipped classroom mode)
  - Extracurricular activities (e.g. student competitions)
  - Learn by design (construction of virtual patients by senior students)

- Collaborative learning
  - Discussion in small groups 2-3
  - Problem-based learning sessions
  - Interactive lectures

- Assessment
  - Practical skills examination (e.g. OSCE)
  - High-stakes testing

Virtual patients in Kraków

	Kononowicz AA. et al. 2012
Journal	BMC Medical Education
University	Jagiellonian University Kraków (Poland)
Participants	226
Setting	Extension of BLS course lecture (1st year medicine)
Comparison	Gr. B: VP voluntary access Gr. A: Control (just lecture + book)
Outcomes	• MCQ knowledge test (60 items) • BLS skills test (Cardiff Test)
Platform	CASUS® (Linear; Web)
Content/ Duration	6 cases (unlimited time: spaced activation) BLS with AED
Collaboration	Flipped classroom (individual, home in preparation to face-to-face classes)

Results

- 54% entitled students used the system at least once

- Average 15 min on each VP

- Most active time (9-10pm)

- Knowledge test
  - intention-to-treat comparison
  - 45.8 (control) vs 47.4 (VP);
  - $p = 0.01$; ES = 0.44

- Significant better skills performance at ($p<0.05$)
  - Opening the airway
  - Check for signal of circulation
  - Knows when to stop BLS

Kononowicz A.A., Krawczyk P., Cebula G., Dembkowska M., Drab E., Fraczek B., Stachon A.J., Andres J.: *Effects of introducing a voluntary virtual patient module to a basic life support with an automated external defibrillator course: a randomised trial.*, BMC Med Educ, 12(1), 2012, 41

Do Virtual Patients really work?
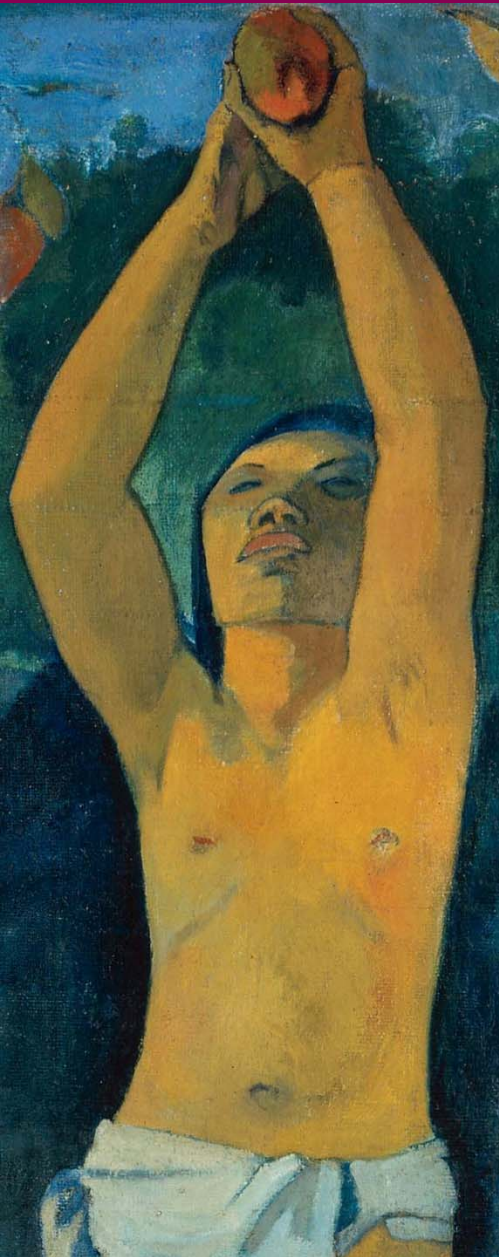
- First systematic review with meta-analysis
  - Cook DA, Erwin PJ, Triola MM. Computerized virtual patients in health professions education: a systematic review and meta-analysis. *Academic Medicine* 2010;**85**(10):1589–602.

- Conclusions from the review:
  - Virtual patients are associated with substantial knowledge, clinical reasoning and skills gains in comparison to non-intervention (pooled ES=0.80-0.94)
  - Virtual patients are associated with negligible differences in knowledge, clinical reasoning and skills with other active learning methods
  - No conclusions regarding the effectiveness of different virtual patient designs variations

eLefant initative

- Goal: Series of Cochrane reviews on effectiveness of e-Leaning
  - Knowledge, Skills, Attitudes, Satisfaction, Cost, Patient Outcomes

- Partners
  - NTU Lee Kong Chian School of Medicine, Singapore
  - Imperial College, London
  - Karolinska Institutet, Stockholm

- Assumptions (selection)
  - Include RCT and cluster RCTs only
  - Include all health allied profession both pre- and post-graduate
  - Exclude comparison to non-intervention
  - Special interest in evidence for middle and low-income countries

- Protocols - examples
  - M-Learning
  - Virtual reality environments
  - **Virtual patients**

    Kononowicz AA, Woodham L, Georg C, Edelbring S, Stathakarou N, Davies D, Masiello I, Saxena N, Tudor-Car L, Car J, Zary N: *Virtual patients simulations for health professional education (Protocol).* Cochrane Database of Systematic Reviews 2016; 5:CD012194.

Virtual patients in radiology (design)

	Maleck M. et al. 2001	Mahnken AH. et al. 2011
Journal	Radiographics	European Journal of Radiology
University	LMU Munich (Germany)	RWTH Aachen (Germany)
Participants	192 (3 year medicine)	96 (4 year medicine)
Setting	Extension of radiology lecture (45min/week) and textbook	Extension of radiology internship
Comparison	Gr. A: VP with interactive elements Gr. B: non-interactive e-cases Gr. C: Paper cases Gr. D: Control (just lecture + book)	Gr. B: VP voluntary access Gr. C: VP mandatory access Gr. A: Control (just internship)
Outcomes	• MCQ knowledge test (14 items) • Image interpretation (4 freetext) • Student Satisfaction (35 items)	• MCQ knowledge test (10 items) • Usage parameters
Platform	CASUS® (Linear; @Apple Macintosh)	CASUS® (Linear; Web-based)
Content/ Duration	10 cases (2 sessions each 2h) Chest radiographs; Bone imaging	10 cases (unlimited time avrg: 100-115 min) Img procedures: X-ray, CT, MRI, Ultrasound, Neuroradiology, Paediatric radiology
Collaboration	2-3	Self-directed (in-hospital computers & home)

CASUS 2001 and 2016

Maleck M. et al. 2001

eViP case repository, 2016

Virtual patients in radiology (outcomes)

Maleck M. et al. 2001

| | n | Pre/Post change (%) | | Satisfaction [1-5] | | |
		MCQ Exam	Radiographs	Lecture	Textbook	Cases
VP interactive	47	+ 11.2*	+ 15.7*	3.3	2.5	3.2
VP non-interactive	38	+ 15.1*	+ 15.1*	2.9	3.1	3.5
Paper cases	42	+ 13.0*	+ 10.2*	2.7	2.3	3.7
Lecture+book only	65	+ 0.6	+ 8.5	3.5	2.8	-
		* p<0.05		All: 3.2	2.7	3.4

Mahnken AH. et al. 2011

| | n | Pre/Post change (%) | | Processed | | |
		MCQ Exam	Total time	Screens %	VPs [n of 10]	Passed [n of 10]
VP voluntary	32	13.2	114.3	63.4*	5.2*	3.3*
VP mandatory	32	15.4	100.5	74.0*	7.8*	5.6*
Internship only	32	8.5	-	-	-	-
		p = 0.56	p = 0.59		* p<0.01	

Methodological limitations:
- High variability of results
- Assignment to the three study groups was performed consecutively

VP design studies

Author	Design	Conclusions (significant difference?)
Bearman 2001	narrative vs problem-solving structure	Narrative group better than problem-solving in communication skills after one week but three weeks later no difference
Dankbaar 2016	E-cases (Text-based VPs) vs Games-based VPs	No difference in clinical and communication competences
Davids 2014	VP vs VP with usability improvements	No difference in knowledge recall and transfer
Dickerson 2006	Recorded speech vs synthesized speech	No differences in the overall impression, speech intelligibility, and task performance
Harris 2013	VP with worked vs unworked approach	No difference
Mahnken 2011	Self-determined vs mandatory use	No difference
Maier 2013	VP space activated vs VP bolus activated	No difference
Maleck 2001	VP vs non-interactive VP	No difference (in knowledge)
Tolsgaard 2016	Constructing VP vs solving VPs	No difference in learning effects, 50% more time needed for constructing VP

Scalability & learning analytics

- Virtual patients in MOOCs
  - Karolinska Institutet joined edX in 2013
  - KIBEHMEDX course: **9 Sep – 21 Oct 2014**
  - registered participants: **19,236**
  - completed VP assignment: **2,317**
  - Open Labyrinth 3.1 virtual patient system
  - Hosted on the cloud infrastructure of VPH Share project
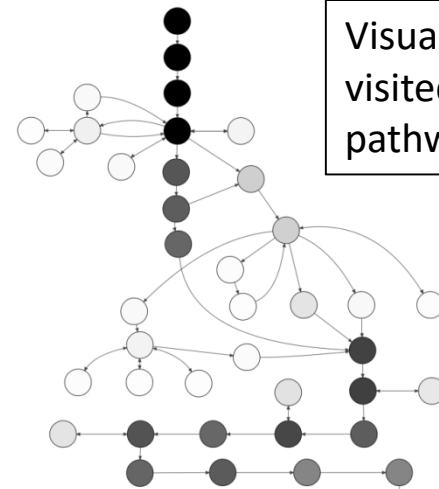
Visual analytics: visited nodes; pathways detection

Branching index
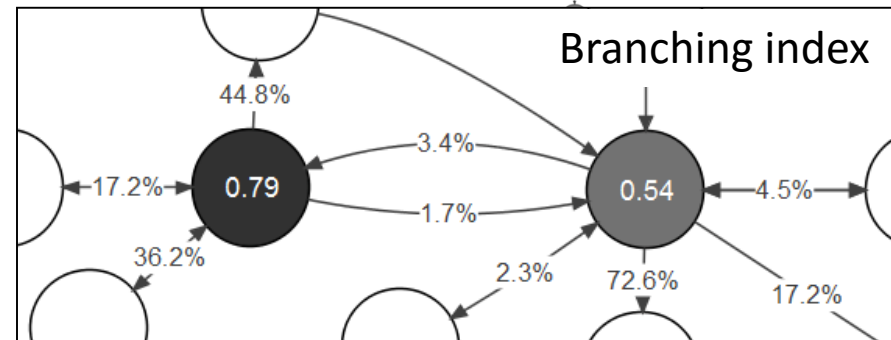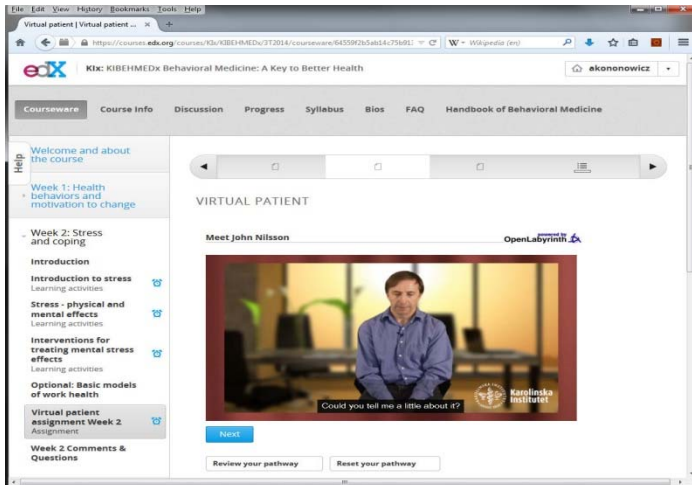
Kononowicz AA, Berman AH, Stathakarou N, McGrath C, Bartyński T, Nowakowski P, Malawski M, Zary N Virtual Patients in a Behavioral Medicine MOOC: A Case-based Analysis of Technical Capacity and User Navigation Pathways, JMIR Medical Education 2015; 1(2):e8

Where are we going?

- Ellaway et al. 2009 - the „practica continua" framework
  - need to rethink the binary divide between virtual and real-world learning – need for integrated continua of simulation
  - „the learner starts with simple models and tasks, and then works through increasing complexity and integration of simulation modalities"

  Ellaway RH, Kneebone R, Lachapelle K, Topps D. Practica continua: Connecting and combining simulation modalities for integrated teaching, learning and assessment. Med Teach 2009 Aug;31(8):725-731.

- Scenarios to use virtual patients in mixed-mode
  - Outcome of introductory virtual patient simulations influences initial configuration of successive simulations
  - Follow-up discussions and rehearsal after high-fidelity simulation events in on-line communities around virtual patients

- New opportunities for mix-mode simulations with virtual patients
  - Integration standards (xAPI)
  - Recognized need for interprofessional education
  - New hardware developments (mixed-reality smartglasses)
  - Development of medical simulation centres

Centre for Innovative Medical Education in Kraków

- „Dydaktyka, Innowacja, Rozwój"
  - A European Social Fund („POWER") project
  - ~ 5 mln EUR for Jagiellonian (2016-2023)
  - Higher quality of medical education through development of innovative simulation-based teaching methods
  - Adaptation and equipment of existing rooms to the needs of the simulation centre
    - simulated: operating room, emergency rooms (3), intensive care rooms (4), control rooms (7), delivery room, ambulance, ALS & BLS rooms (6+2), clinical & surgical rooms, OSCE & standardized patient (SP) rooms (20)
  - Resources for instructors
    - High fidelity simulation scenarios, OSCE checklists, SP scenarios, physical examination checklists, **adaptation of existing and development of new virtual patient cases (40 cases)**, summer school competition scenarios
  - Teach-the-trainer courses
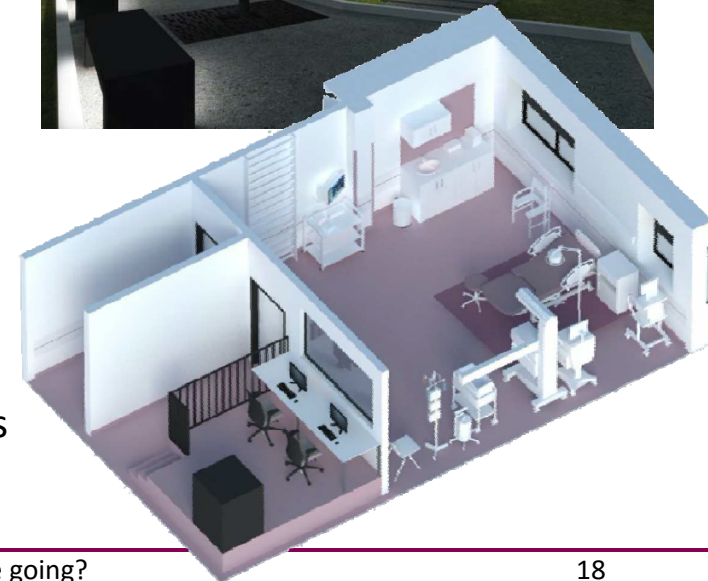
In summary

- Virtual patients
  - are not a new development
  - are heterogeneous in design and need adaptation
  - have in average small effects in comparison to other active learning interventions

but

- Virtual patients
  - have unquantified advantages
    - flexibility, scalability, safety, analytical potential
  - are a valuable extension of the curricula
  - can be combined with other forms of simulation

Děkuji !

Are there any questions?

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