

Preparing the Next Generation of Healthcare Professionals for the Era of AI

Who to Be in the Time Between Clinical Encounters

Shinki An, MD, PhD, MDiv

Professor and Chair, Department of Medical Education
Director, Yonsei Donggok Medical Education Institute
Yonsei University College of Medicine

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01 · TWO ANSWERS AND A THIRD QUESTION

Answer 1: Machines will replace people

2016

Geoffrey Hinton · Toronto

"People should stop training radiologists now."

Deep learning would read images better than radiologists within five years, ten at the most.

2026

Elon Musk · Moonshots podcast

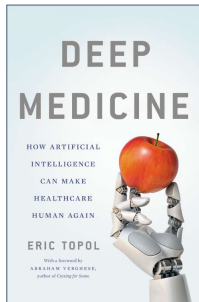
Robots will surpass the best surgeons within three years.

Host: "So don't go to medical school?"

Musk: "Pointless."

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Answer 2: In the time machines buy us, people become more human



“the gift of time”

Eric Topol, Deep Medicine (2019)

AI will not replace physicians. When machines take over reading images, documentation, and repetitive work, physicians can spend that time face to face with patients.



Machines take over routine work



People become more human again

I, too, have leaned on this answer in many lectures and writings.

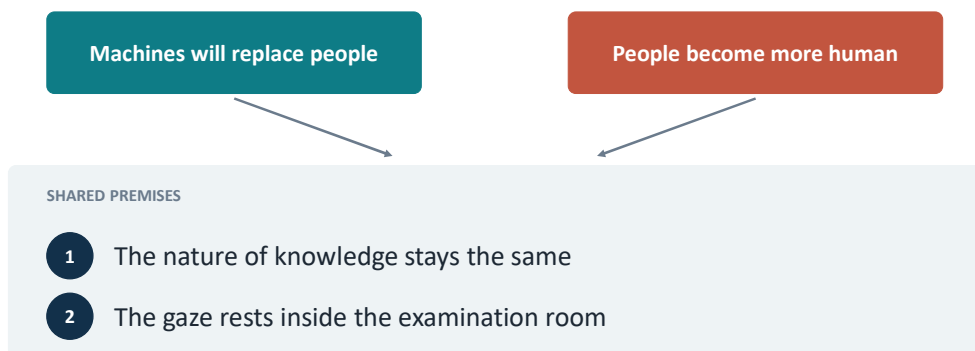
Topol EJ. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books; 2019

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Opposite answers, one shared premise



Topol is right. But that is not enough.

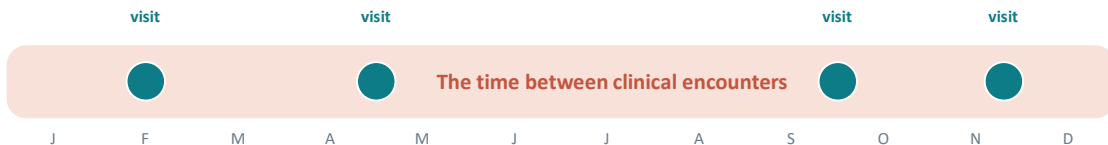
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Who fills the time between clinical encounters?

Inside the examination room: a few visits a year, a few minutes each



Through the rest of it, in everyday life outside the hospital, a person's body, illness, and recovery go on without rest.

Who fills that time?

A small scene: two months with a CGM



A continuous glucose monitor, worn for two months

- 1 My physician diagnosed diabetes, and I did not want to accept it
- 2 A curve showed my glucose all day long, outside the examination room
- 3 My long-standing eating habits changed

The change took place not in the examination room but in everyday life. Beside me in that time: a machine and myself.

“When machines and people come to fill together the time between clinical encounters, who must the next generation of healthcare professionals be in that place?”

Not what they must be able to do, but who they must be.
And measured not by the physician, but by the patient's time.

86% nurses
13% physicians

Share of the time health care workers stayed beside patients in one intensive care unit, measured by sensors

Butler R, et al. Am J Med. 2018;131(8):972.e9-972.e15

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02 • HEALTH CARE IS CHANGING

From cure to prevention: P4 medicine is already here

HUTCH NEWS

The Angelina Jolie effect: One year later

A year ago today, the actress revealed to the world she'd had a preventive mastectomy; experts weigh in on the lasting impact

May 14, 2014 | By Diane Mapes



You might call it her biggest blockbuster yet.

On May 14 of last year, actress Angelina Jolie published an op-ed in the New York Times detailing what she called “my medical choice.” Due to an extensive family history of breast and ovarian cancer and having the BRCA1 gene mutation that dramatically raises her risk of cancer,

“Life comes with many challenges. The ones that should not scare us are the ones we can take on and take control of,” wrote Angelina Jolie in a New York Times article published a year ago May 14 disclosing that she’d had a preventive mastectomy.
Photo by Andrew Medichini / AP file

Jolie made the decision to undergo a preventive double mastectomy.

<https://www.foxhutch.org/newscenter/news/2014/05/14/the-angelina-jolie-effect-one-year-later.html>

Angelina Jolie • “My Medical Choice” (NYT, 2013)

“My doctors **estimated that I had an 87 percent risk of breast cancer and a 50 percent risk of ovarian cancer,**” Jolie explained in the op-ed, quickly adding that **the risk is different in the case of each woman.**

“Once I knew that this was my reality, I **decided to be proactive and to minimize the risk as much as I could.**”

“from a reactive to a proactive discipline”

Leroy Hood & Stephen Friend (2011) • P4 Medicine

Current
~~Future Medicine~~
4P Medicine

- Predictive
- Personalized
- Preventive
- Participatory

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From cure to prevention, from hospital to everyday life

Future medical practice

Steven Wartman & Donald Combs (Academic Medicine, 2018)

- Care “wherever the patient happens to be”
- Health care teams of a new makeup
- Data from many sources, and AI
- Skill where medicine meets machines

THE EDUCATIONAL IMPERATIVE

Call for a “reboot” of medical education

Yet one thing must be preserved without fail:

*“the mastery of
compassionate care”*

Wartman SA, Combs CD. Medical education must move from the information age to the age of artificial intelligence. *Acad Med.* 2018;93(8):1107-1109

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Even admission can move into the home

38%

lower cost of acute care than usual hospital admission

7% vs 23%

readmission within 30 days, home vs usual admission

More active

less time lying down, more time physically active

HOW CARE REACHED THE HOME



Nurse and physician home visits



Intravenous medication



Remote monitoring



Video visits

Levine DM, et al. Hospital-level care at home for acutely ill adults: a randomized controlled trial. *Ann Intern Med.* 2020;172(2):77-85 (n=91, two institutions)

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Technology and institutions are moving the boundaries together



Digital twin

A virtual twin built from a person's data to simulate responses in advance: the "methodological realization" of P4 medicine



AI and care robots

Already rapidly changing the face of nursing practice



Korea, 2024 and 2025

Residents left their training hospitals; PA nurses filled part of the void. The Nursing Act passed in August 2024 and took effect in June 2025.

The boundary of who does what among the professions moved within the system.

Emmert-Streib F, et al. NPJ Digit Med. 2025;8(1):735 · Stokes F, Palmer A. Nurs Philos. 2020;21(4):e12306 · Nursing Act, Act No. 20445 (2024)

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Competencies change, and the first gap appears



Professionals must "communicate the meaning of the probabilities generated by massive amounts of data to patients, given their unique human complexities."

A demand that does not apply to physicians alone



The first gap

Precision medicine and digital twins become precise first for people whose data have accumulated.

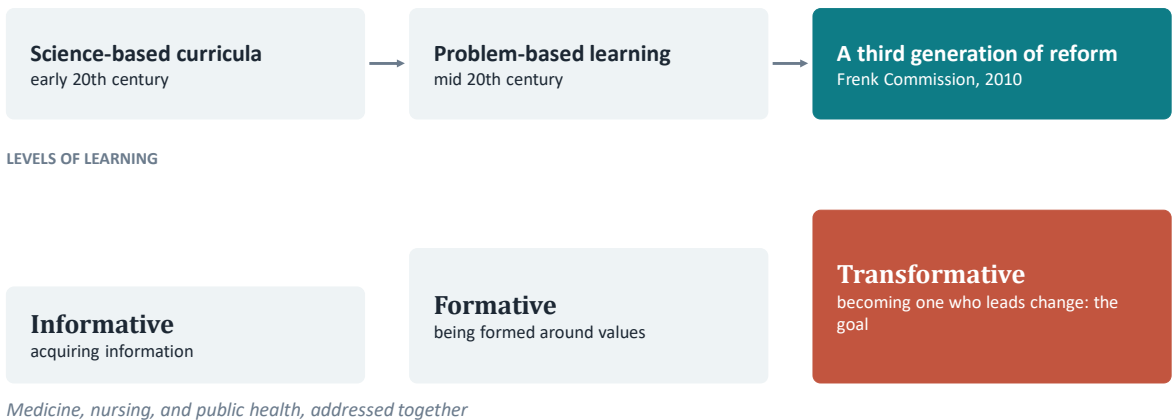
A "fifth P": the population perspective must be built into each of the other four.

Wartman SA, Combs CD. Acad Med. 2018 · Khoury MJ, et al. A population approach to precision medicine. Am J Prev Med. 2012;42(6):639-645

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Frenk 2010: education has not kept pace



Frenk J, et al. Health professionals for a new century. *Lancet*. 2010;376(9756):1923-1958

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Speed alone keeps us inside Frenk's argument

73 days

projected doubling time of medical knowledge by 2020



Since their release at the end of 2022, large language models have entered everyday learning and care.

"It changes faster, so let us follow faster."

This only repeats, more urgently, the Commission's diagnosis.

What is changing is not only the amount and speed of knowledge, but the form of knowing itself.

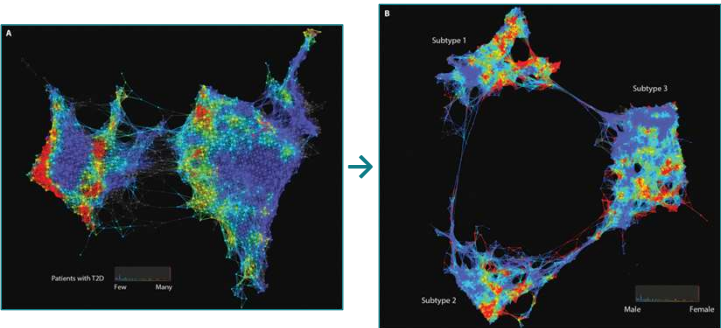
Densen P. Challenges and opportunities facing medical education. *Trans Am Clin Climatol Assoc*. 2011;122:48-58

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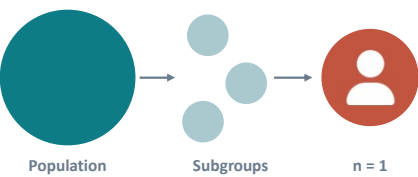
Precision divides the average patient

-  Evidence-based medicine compares groups and presupposes an average patient.
-  Multimodal data and AI reveal that single diseases consist of distinct subgroups.



More than 11,000 people · electronic medical records and genotype data · topological data analysis

Push the division to the end: n = 1



As in calculus, dividing without end converges to a limit: one person. A methodological convergence, not an absolute arrival.

Object

Time

Standard

Paradigmatic knowing	Narrative knowing
The group	One person
Cross-sectional comparison	Longitudinal trajectory
The group average	The person's own previous state

Paradigmatic knowing crosses over into the character of narrative knowing.

Push precision to the end, and it arrives at narrative

Fasting glucose · HbA1c

"Your blood glucose at this moment is such-and-such."

A snapshot at one point in time

Continuous glucose monitoring

How your body is living through its day

A trajectory unfolding in time



Same HbA1c, widely different glucose-spike profiles (Topol's own research group)

WHERE THIS TALK PARTS WAYS WITH TOPOL

Reading data as story is not an add-on in the time AI buys us. It is where precision medicine finally arrives.

Carletti M, et al. Multimodal AI correlates of glucose spikes. *Nat Med.* 2025;31(9):3121-3127

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The owner of the narrative changes



The patient

- Modern medicine took from patients the place of author of their own stories.
- With interpretable data and validated AI, the patient can decide what enters their own story.
- In the time between clinical encounters, the patient stands as the subject of their own healing narrative.



The professional

Diagnosis

"What's wrong?"

classifying



Management

"What should we do?"

priorities, trade-offs, values, relationship

Work that cannot be done without reading a person's story, and not work entrusted to physicians alone.

Frank AW. *The Wounded Storyteller*. 2nd ed. 2013 · Topol EJ. *The Patient Will See You Now*. 2015 · Jones RL, et al. *J Gen Intern Med.* 2026;41(8):2302-2305

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Medicine once stood in this place

“

*the secret of the care of the patient
is in caring for the patient*

Francis Peabody, “The Care of the Patient,” 1927

Peabody FW. The care of the patient. JAMA. 1927;88(12):877-882



History and story share a root

The biomedical turn: advancing diagnostics, multiplying information, more patients pressing on each physician's time



The conversation narrows to the chief complaint



Much was gained, and many lives saved. Something was missed.

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If the body cannot always recover, medicine must recover care

Healing

*“the personal experience of the
transcendence of suffering”*

Thomas Egnew, 2005

Twin obligations

*The relief of suffering and the cure
of disease: the “twin obligations”
of a profession “truly dedicated to
the care of the sick”*

Eric Cassell, 1982

Narrative competence

*“the ability to acknowledge,
absorb, interpret, and act on the
stories and plights of others”*

Rita Charon, 2001

Cure and care are not a choice between two.

Egnew TR. Ann Fam Med. 2005;3(3):255-262 · Cassell EJ. N Engl J Med. 1982;306(11):639-645 · Charon R. JAMA. 2001;286(15):1897-1902

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Nursing held this place more firmly, and called it knowing

Empirics

Esthetics

**Personal
knowledge**

Ethics

Fundamental patterns of knowing in nursing (Carper 1978)



Benner (1984)

Skilled nurses grasp the particular situation of a particular patient as a whole.



Carnegie reports (2010)

Nursing: from socialization and role-taking to formation. Medicine: professional identity formation. The same direction.

A place for all of us to stand together. As a medical educator, I ask to learn from it.

Carper B. *ANS Adv Nurs Sci.* 1978;1(1):13-23 · Benner P. *From Novice to Expert.* 1984 · Benner P, et al. *Educating Nurses.* 2010

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Keeping that place is not easy for nursing either

Boundary work in AI-assisted nursing

meta-synthesis of qualitative studies

"final verification authority"

"decision deviation authority"

"humanistic care" cannot be replaced

Barriers

legal liability

skills training

social trust



AI "is incapable of caring in the sense central to nursing and caregiving ethics."

Stokes & Palmer 2020, on touch and presence



Relational, person-centred fundamental care may give way to "algorithm-based care."

Richards 2026

Zhang Z, et al. *Soc Sci Med.* 2026;403:119385 · Stokes F, Palmer A. *Nurs Philos.* 2020 · Richards DA. *J Adv Nurs.* 2026

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Narrative or surveillance?

Vogt (2016): P4 holism is a “technoscientific holism” that can move toward “holistic medicalization.”



What separates the two is not the amount of data, but who is the author of that story, and who reads it for whom.

The place of narrative is not kept on its own. It must be kept through education.

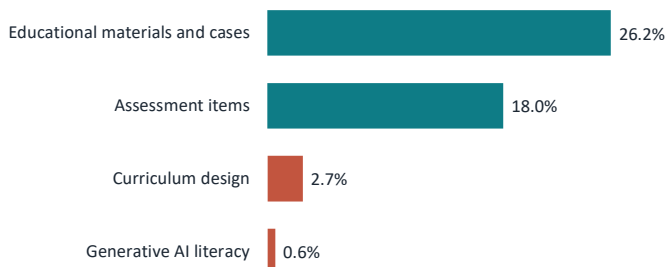
Vogt H, Hofmann B, Getz L. The new holism: P4 systems medicine and the medicalization of health and life itself. Med Health Care Philos. 2016;19(2):307-323

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Is such a discussion taking place?

Focus of 241 studies on generative AI in health professions education



43%

medicine

36%

nursing

of the 241 studies: both professions are actively engaged

- Hospital at home: short skills sessions, no standardized training program yet
- Hospital-centered curricula lead nursing students to place a low value on home care

AI is used to make current education more efficient, but hardly at all to ask anew what we educate for.

Basil M, et al. BMC Med Educ. 2026 · Denecke K, et al. Stud Health Technol Inform. 2024 · Jarrin OF, et al. Nurse Educ Today. 2019

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Deskilling, never-skilling, mis-skilling



Students upload lectures and past exams and ask AI to “summarize the key points of the lecture and suggest what might be on the exam.”

Deskilling

Competence already acquired declines through reliance on AI

Never-skilling

AI enters early in training, and foundational competence never forms

Mis-skilling

Learners absorb errors produced by AI as they are

28.4% → 22.4%

Adenoma detection in colonoscopy performed without AI, before and after AI tools were introduced at four centers in Poland

If experts, then learners even more

Abdulnour RE, et al. *N Engl J Med.* 2025;393(8):786-797 · Budzyński K, et al. *Lancet Gastroenterol Hepatol.* 2025;10(10):896-903

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What we measure still decides careers

GPA and class rank still decide the selection of interns and residents.



Uncertain predictive power

Disciplinary action by medical boards was more strongly associated with unprofessional behavior recorded in medical school than with grades or admission test scores.

2014

Yonsei

First in Korea to abolish GPA and class rank, and to adopt criterion-referenced assessment

YET, STILL

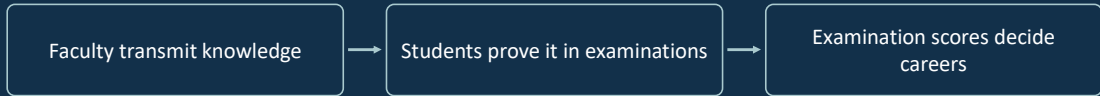
- Competition to earn Pass with Honor
- Portfolio assessment at an exploratory stage
- Intern and resident selection follows national criteria
- Clerkships still take place in the hospital
- Longitudinal integrated clerkships not yet embraced

Papadakis MA, et al. *Disciplinary action by medical boards and prior behavior in medical school.* *N Engl J Med.* 2005;353(25):2673-2682

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We, too, are still there.



The traditional educational paradigm

- We speak of health care practiced by teams, yet we form the people who will make up that team separately.
- I, too, once made the physician the subject of the future of health care, before nursing educators.

Not an indictment aimed outward, but a confession.

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06 · THE GAP: TECHNOLOGY IS DOUBLE-EDGED

The faster change comes, the wider the gaps



Between patients

Precision medicine and digital twins become precise first for people whose data have accumulated.



Between schools and countries

Devices, connectivity, scheduled power outages, data charges and subscription fees. AI output relying largely on Western values.



Between professions

Nurses' final verification authority runs into insufficient skills training. A profession whose education lags loses the strength to keep its boundaries.

The gap in education is not resolved merely by handing out tools.

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The counterargument: AI can narrow the gap

2σ

Tutored students performed two standard deviations above conventional classes: “the 2 sigma problem” (Bloom 1984)



Harvard physics RCT

With an AI tutor built on the same principles as proven active learning, students “learn significantly more in less time.”



Hassabis

A future in which every student has a great personal tutor

AI as a springboard that spreads good tutoring cheaply. This counterargument is not a light one.

Bloom BS. *Educ Res.* 1984;13(6):4-16 · Kestin G, et al. *Sci Rep.* 2025;15(1):17458 · Hassabis D, RSA interview, 2026

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Without design, AI becomes a crutch

Close to 1,000 high school students, two kinds of AI tutors

A familiar ChatGPT-like interface

A tutor built with prompts to protect learning

With AI

Both groups' grades rose

AI removed

The undesigned group scored below students who never used AI

With design

The designed tutor largely prevented this loss

17% lower

Scores without AI: students who had used the undesigned AI, compared with students who had never used AI

They had leaned on AI as a “crutch.”

Bastani H, et al. *Generative AI without guardrails can harm learning.* *Proc Natl Acad Sci U S A.* 2025;122(26):e2422633122

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The potential is realized only with design and alliance

1 Design, not the tool

In Kestin's study, the effect came from the educational design built into the tool.

2 Who can design?

Pedagogical expertise, validated content, adaptation to language and context, evaluation. These resources are not evenly distributed.

3 Formation needs places

Clinical placements, supervisors, and patients to meet cannot be downloaded and handed out.

Technology is double-edged.

Task 1: a form of knowing

Read data as one person's narrative, and interpret one person's narrative as data



Translate the meaning of probabilities into the language of a patient's life



Management reasoning: choose with a person between longevity and independence



Patterns of knowing beyond empirics (Carper)

Precision medical education (PME)

"a systematic approach that integrates longitudinal data and analytics to drive precise educational interventions that address each individual learner's needs and goals"

Learners as "co-producers"

Here medical education can lean on the long experience of nursing education.

Data-driven PME: educational data is not a report card

Data-Driven

Evidence-based decisions,
not intuition alone

Learner-Centered

Individual growth trajectory,
not the average student

Predictive & Proactive

Early warning & support,
not post-hoc grading

Outcome-Focused

Connected to patient &
community outcomes

TRADITIONAL DATA (REPORT CARD)

Admission & Written Exam Scores (GPA, Rank)

- Uncertain power to predict a good clinician or nurse, yet decisive power over careers
- Drives learners to upload lectures & past exams to AI for high scores with minimal effort

→ *Risk of deskilling, mis-skilling, and never-skilling*

NEW NORMAL · MULTIMODAL LONGITUDINAL DATA INTEGRATION

1. Clinical Experience Logs

Which patients were cared for and which procedures were performed

2. Narrative Faculty Evaluations

Qualitative records of attitude, reflection, and growth potential

3. Teamwork & Trust Indicators

Peer feedback and collaborative interprofessional problem-solving

4. AI-Assisted Learning Patterns

LMS log analytics and self-directed learning trajectories

5. Early Professionalism Signals

Early detection of tardiness, lapses in responsibility, or risk

6. EHR-Linked Clinical Exposure

Real-world patient care and clinical documentation data

"What does the student know?" (Knowledge & Rank) → "Where is the student struggling, and what support do they need?" (Growth)

Triola MM, Burk-Rafel J. Acad Med. 2023;98(7):775-781 · Papadakis MA, et al. N Engl J Med. 2005;353(25):2673-2682 · An S. Korean Med Educ Rev. 2025;27(3):191-193

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From patient digital twin to learner dynamic portfolio

CLINICAL DOMAIN

Patient Digital Twin

- **Real-time biological data sync:** Genomics, continuous lifelogs (CGM), and clinical/nursing records
- **Virtual care simulation:** Forecasting drug response, adverse events, and individual disease trajectories
- **Precision intervention:** Tailored care in everyday life



EDUCATIONAL DOMAIN

Learner Digital Twin (Dynamic Portfolio)

- **Longitudinal K-S-A & identity data:** Integrating knowledge, clinical skills, attitudes, and professional identity
- **Trajectory visualization & risk detection:** Early warning for academic struggle, burnout, or professionalism lapses
- **Tailored educational intervention:** Timely coaching & mentoring

DYNAMIC PORTFOLIO PROCESS & CURRICULUM REDESIGN

1. Multimodal Input

360° feedback, real-time clinical observation, TBL & simulation, EDW

2. AI Trajectory Modeling

Longitudinal, multi-dimensional pattern & growth modeling

3. Proactive Prediction

Early warning signals of struggle, burnout, or ethical lapses

4. Tailored Intervention

Timely mentoring, reflective portfolio coaching & PIF

Longitudinal · Multi-dimensional · Predictive → Making invisible competencies visible (Technology [Data] ⊕ Humanity [Mentorship] = Future Healthcare Professional)

Triola MM, Burk-Rafel J. Acad Med. 2023;98(7):775-781 · Moor M, et al. Nature. 2023;616(7956):259-265 · An S. Korean Med Educ Rev. 2025;27(3):191-193

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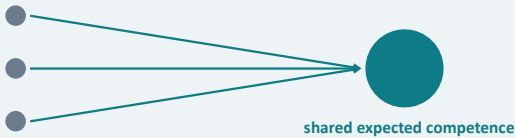
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PME individualizes the path, not the expectation

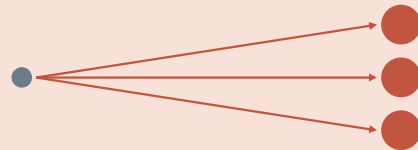
Individualized

Vary the path toward common goals



Differentiated

Vary the goals themselves: research, global health, and more



The two can stand together, but must not be confused.

A glucose curve is read as one person's story, yet against target ranges set by international consensus. **n = 1 sets aside the ranking of learners, not the shared standard.**

An S. Korean Med Educ Rev. 2025;27(3):191-193 · Battelino T, et al. Diabetes Care. 2019;42(8):1593-1603 · Triola & Burk-Rafel 2023

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Task 2: a sequence that protects the fundamentals



"AI is not inherently harmful to learning; its educational impact depends on how and when it is introduced."

About AI

With AI

Aside from AI

Learning about, with, and aside from AI: faculty and students at a Japanese medical school



Nurses' final verification authority becomes real only with the competence to verify.

Ke Y, et al. AI-induced never-skilling in medical education. Nat Med. 2026;32(6):1997-2006 · Shimizu I, et al. JMIR Med Educ. 2023;9:e53466

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Task 3: collaboration that fills the time between encounters

Interprofessional education: students “learn about, from and with each other”

WHO 2010

Ward and simulation room



Hospital at home and community

THE TEAM BETWEEN ENCOUNTERS



Patients and families



Nurses



Physicians



Pharmacists



Machines

Netherlands

Nurse practitioner education in hospital at home: hospitals and community care share responsibility

AI facilitator RCT

90 final-year medical, nursing, and pharmacy students in three-person teams: better clinical performance, more satisfaction, lighter cognitive load

Samson Pavilion (2019) gathers students on campus. Where is the practice outside it?

WHO 2010 · van Dongen LJC, et al. *Nurse Educ Pract.* 2025;85:104365 · Wu Y. *Nurse Educ Today.* 2026;168:107415

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The condition: an educational alliance

1

A form of knowing

2

A sequence that protects the fundamentals

3

Collaboration between encounters

An educational alliance

No single school can take on the three tasks alone.

ACROSS BOUNDARIES

- Between universities
- Between medical and nursing education
- Between countries with resources and without

BUILD AND SHARE TOGETHER

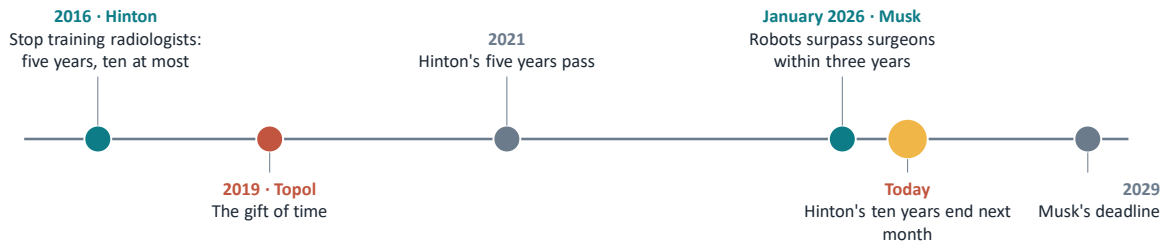
- Educationally designed AI tutors and cases
- Practice sites in hospital at home and the community
- Faculty development and data infrastructure

An S. KMEC 2026 keynote manuscript (in Korean)

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All of these were forecasts



All of their words looked ahead into the future. They were forecasts.

DEMIS HASSABIS · RSA ALBERT MEDAL · SEPTEMBER 2026

"the future is really not written"

"Are we going to get the economics of it right so everyone shares in it?"

The future of the healthcare workforce is not a forecast we receive.

It is a curriculum we write.

WHO IS "WE"?

Nursing educators · medical educators · students · patients as authors of their own stories

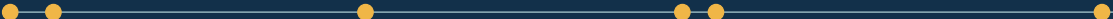
I ask that we write that curriculum together.

Schools that can build designed AI, hospitals that can open practice sites, and countries with educational resources in their own languages will write it first. The gap begins where those who can write part from those who cannot.

Who can write that curriculum now?

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Thank you

Questions and discussion

Shinki An, MD, PhD, MDiv
Yonsei University College of Medicine

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