WORKSHOP "INNOVAZIONE"

Intelligenza Artificiale Alleata di Medici e Pazienti?

Doctor I.A.: Basta un click?

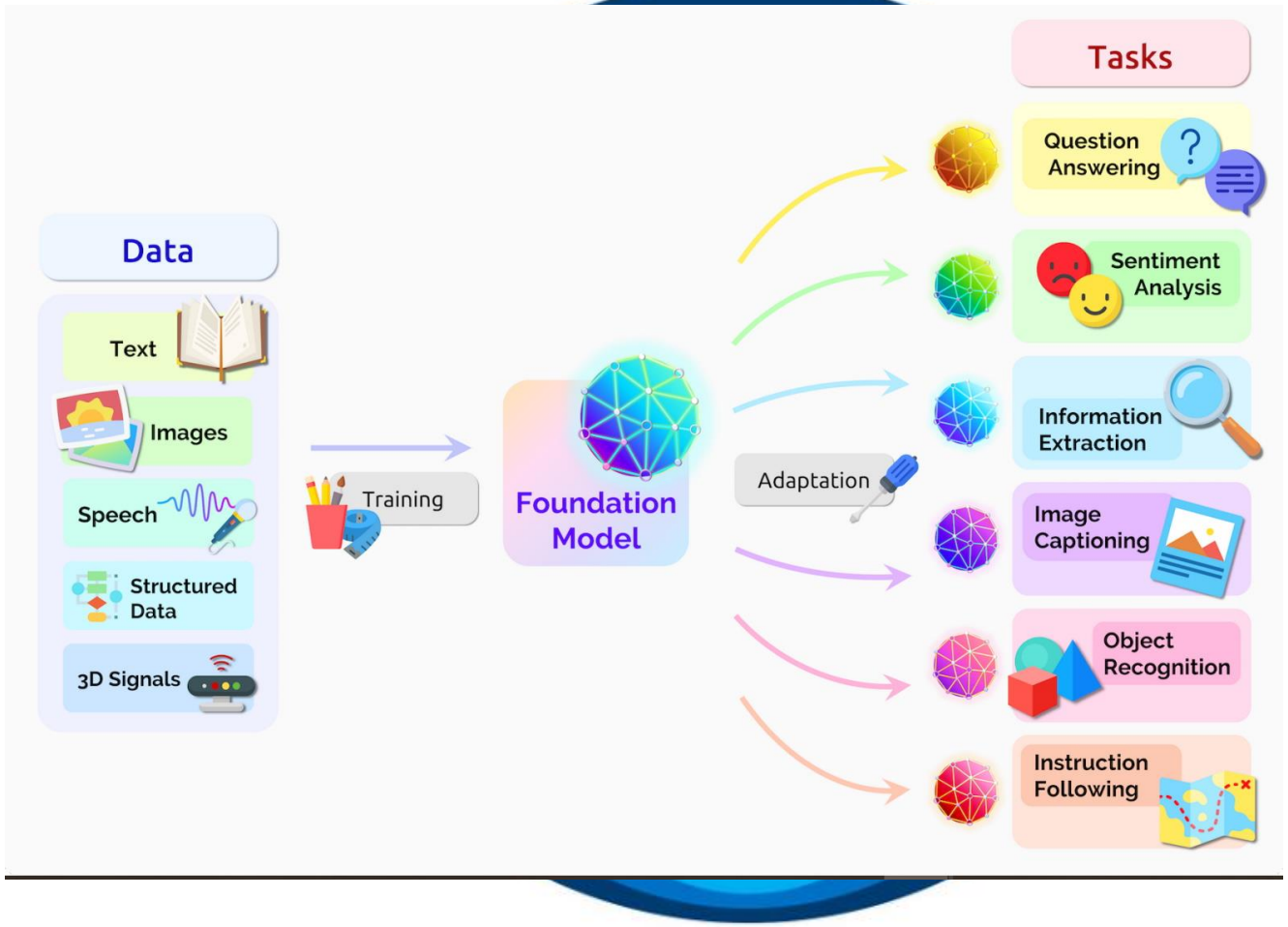
I.A. in Diagnostica per Immagini

Andrea Laghi

Direttore UOC Radiologia, AOU Sant'Andrea, Roma
Facoltà di Medicina e Psicologia, "Sapienza", Università di Roma
Consiglio Superiore di Sanità – Sezione V
andrea.laghi@uniroma1.it

INTELLIGENZA ARTIFICIALE E RADIOLOGIA

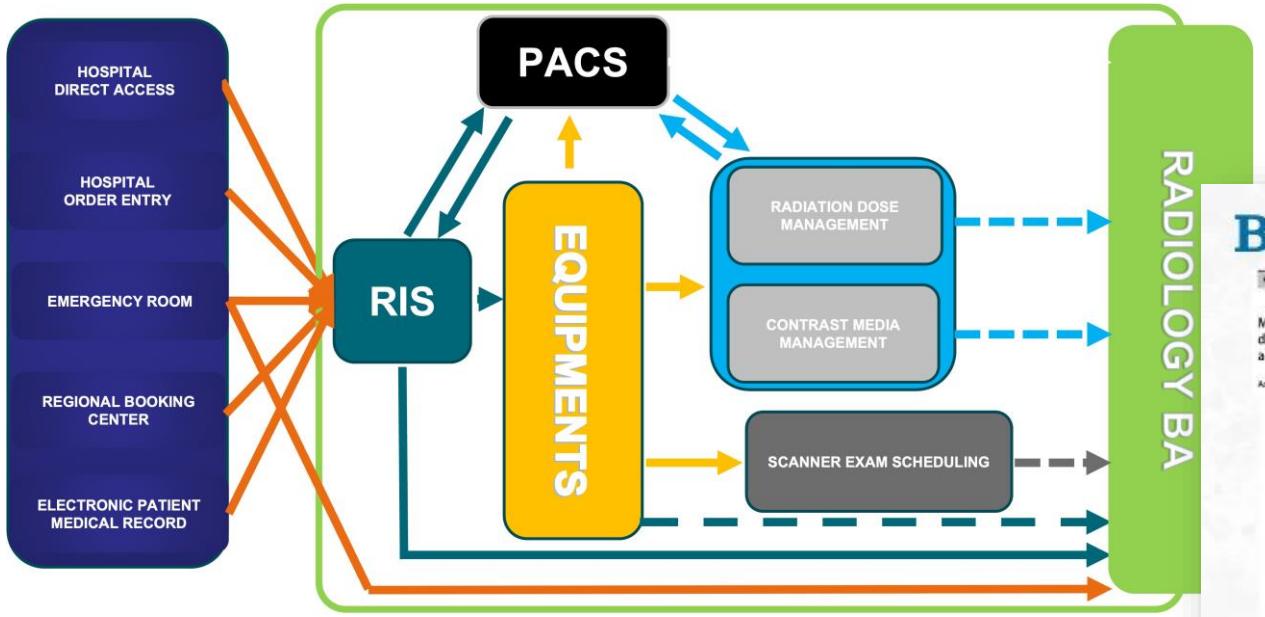
- Gestione dei processi
- Percorso diagnostico
- Formazione e Ricerca

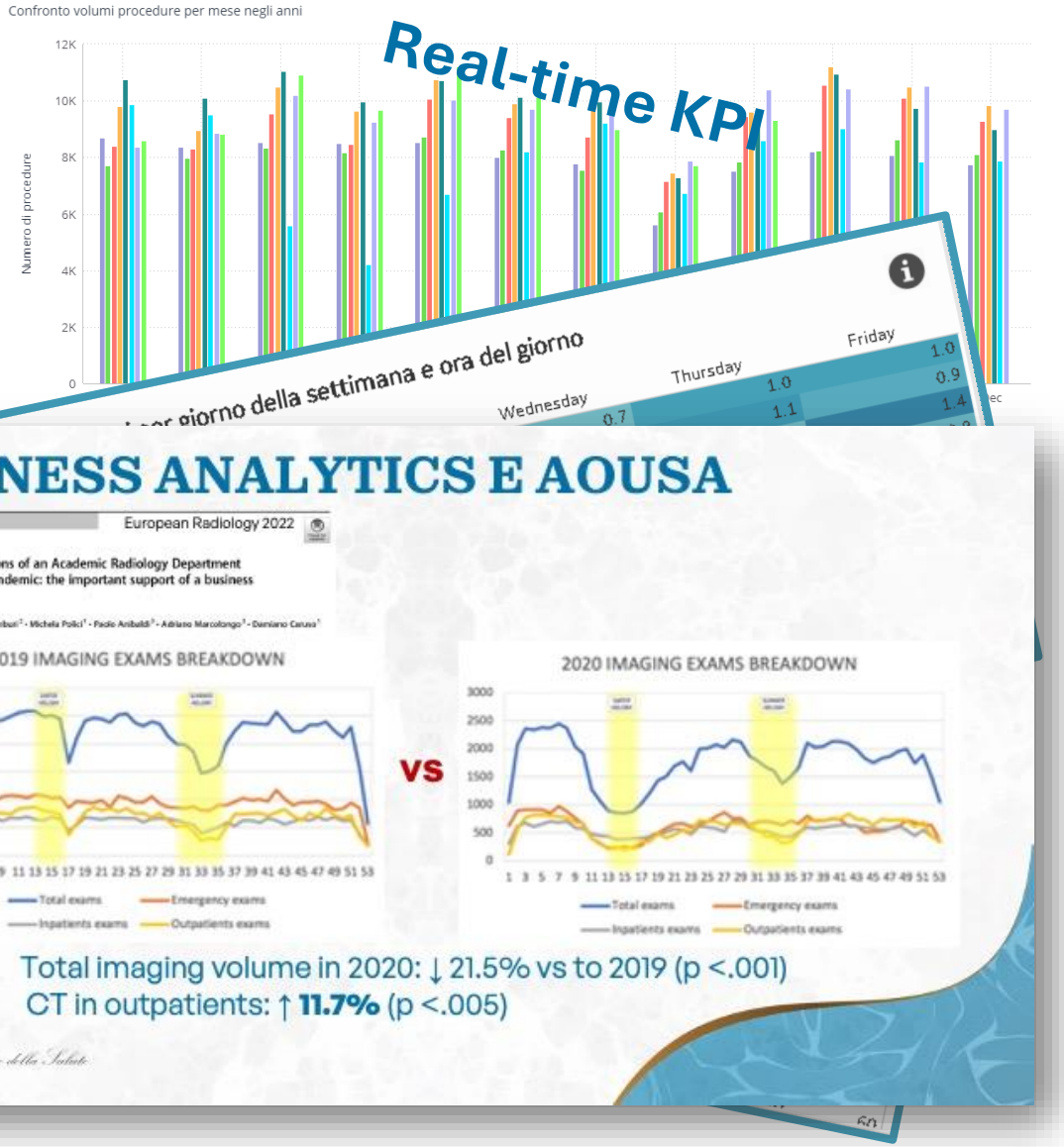



IA E GESTIONE DEI PROCESSI
“FROM EMOTIONAL TO DATA-DRIVEN DECISIONS”

IA E GESTIONE DEI PROCESSI

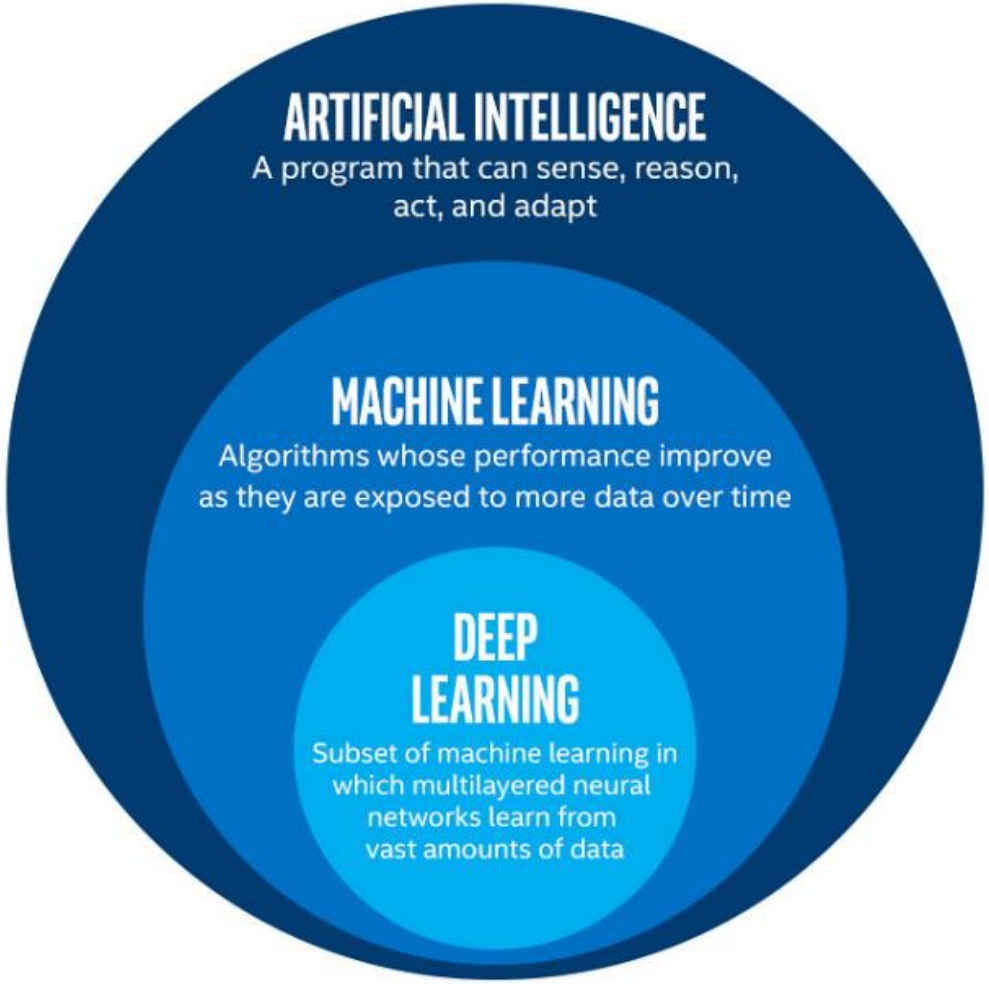
UOC Radiologia - AOUSA





INTELLIGENZA ARTIFICIALE E RADIOLOGIA

- Gestione dei processi
- **Percorso diagnostico**
- Formazione e Ricerca



IA E PERCORSO DIAGNOSTICO

Prenotazione

- Valutazione appropriatezza esame diagnostico
- Creazione di liste di lavoro «intelligenti»

Accettazione

- Triage del Paziente (PS)
  - Appropriatezza richiesta
  - Percorsi «ad hoc»

Esecuzione

- Riduzione dose radiazioni
- Riduzione tempo di esame
- Automazione protocolli

Refertazione

- Prioritarizzazione
- Anamnesi sintetica Pz
- Sinossi referti precedenti
- Generazione pre-referto
- Sintesi «Conclusioni»
- «Super Radiopaedia»

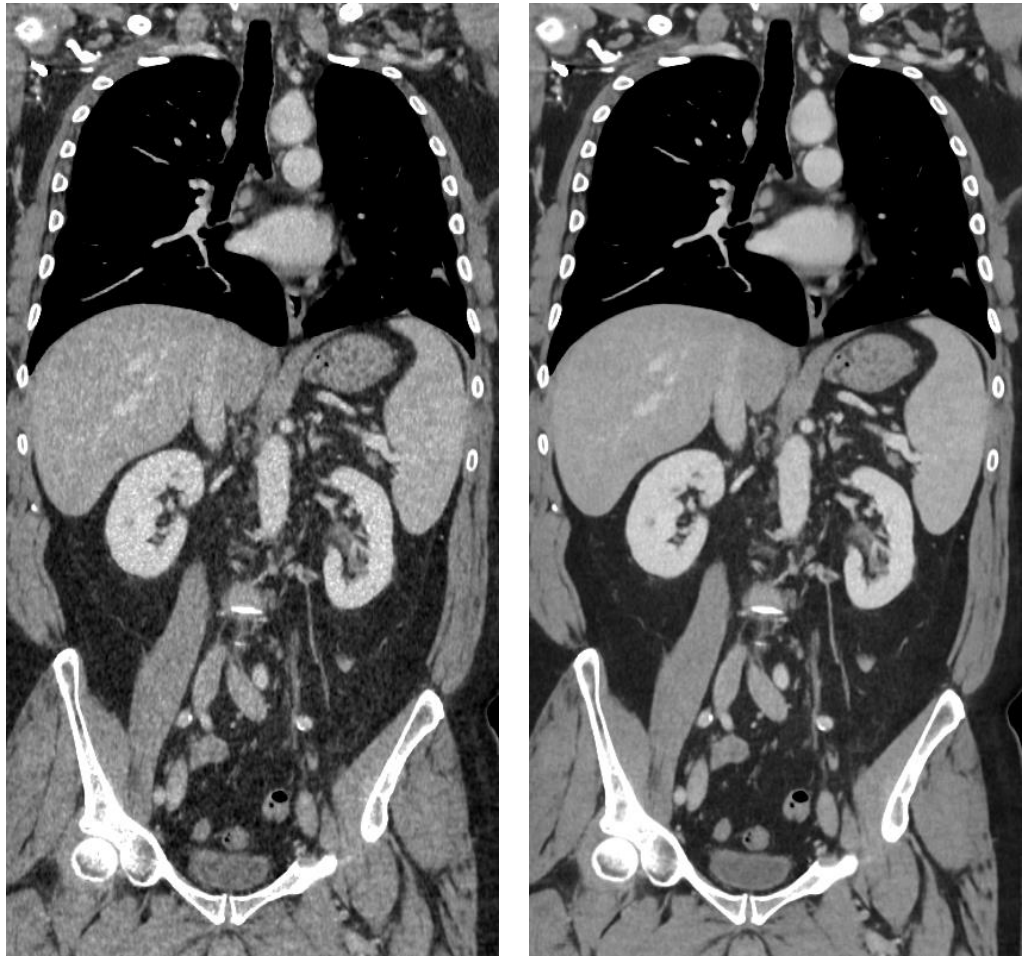
Comunicazione

- Comunicazione con il Paziente
- Risposta FAQ
- Spiegazione del referto

«INVISIBILE»

- «Deep learning»
  - Riduzione dose in TC (-60%)
  - Riduzione tempo in RM

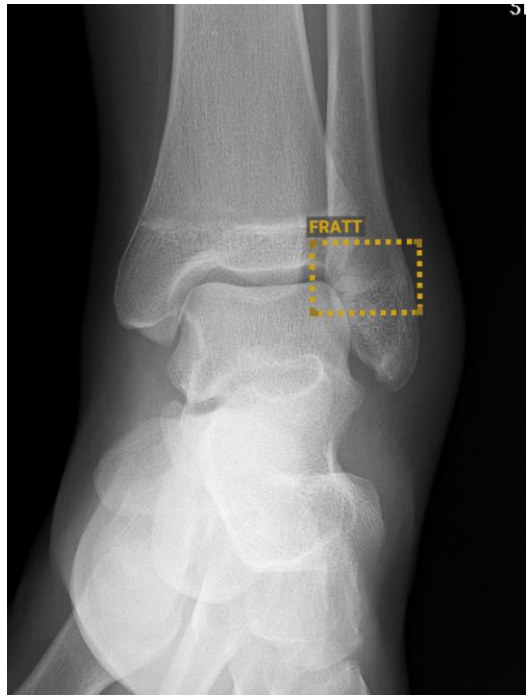
- Gestione automatica protocolli
  - Ottimizzazione qualità esami / riproducibilità

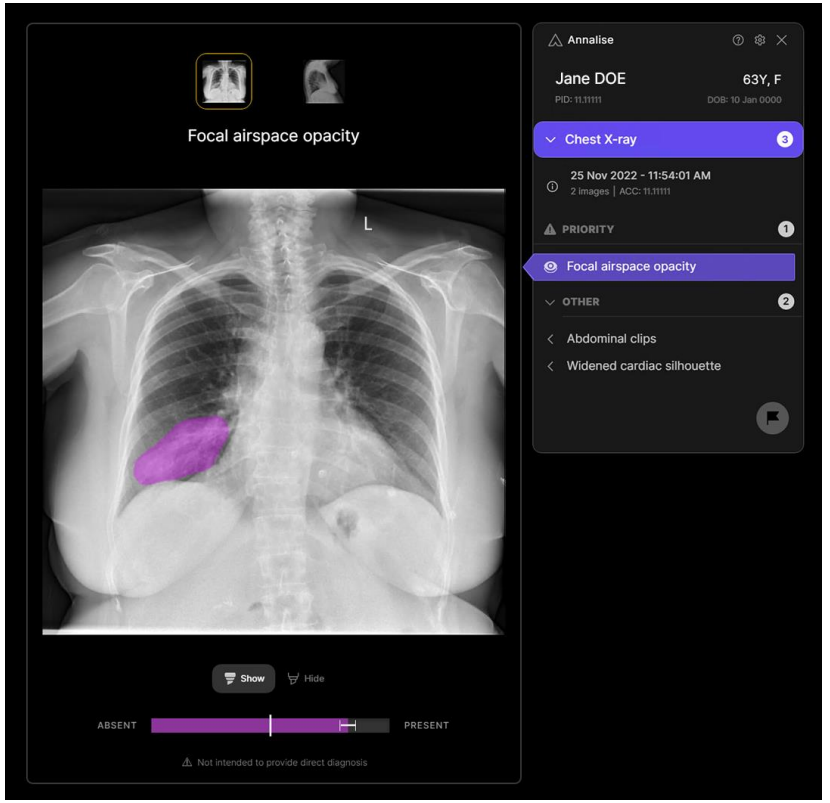


«VISIBILE»

- Sistemi «semplici» di supporto alla decisione diagnostica





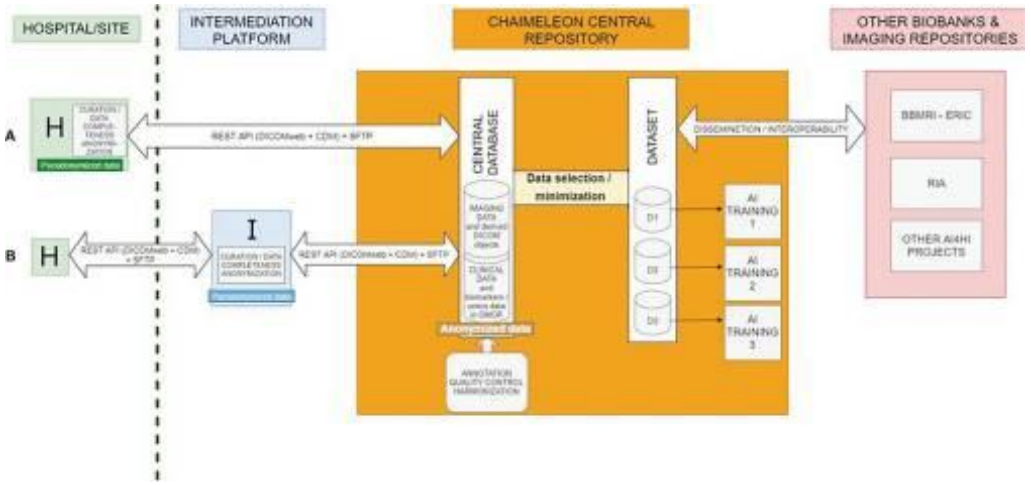


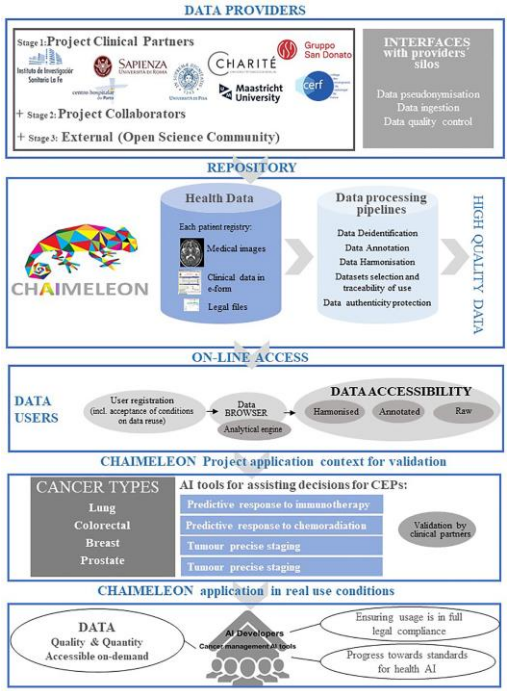
- Sistemi «complessi» (predizione di risposta alla terapia; prognosi, PFS, OS; supporto decisione terapeutica)
  - Sistemi multidisciplinari (multi-omici); WIP

Front Oncol. 2022; 12: 742701. PMCID: PMC8913333
Published online 2022 Feb 24. doi: 10.3389/fonc.2022.742701 PMID: 35280732

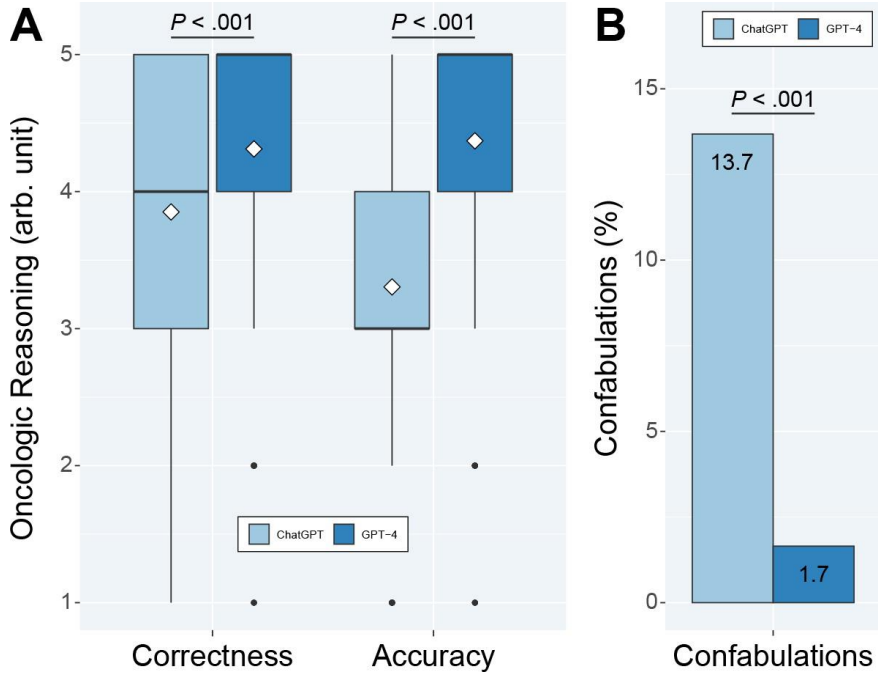
CHAIMELEON Project: Creation of a Pan-European Repository of Health Imaging Data for the Development of AI-Powered Cancer Management Tools

Luis Martí Bonmatí,[✉1,*] Ana Miguel,[1] Amelia Suárez,[2] Mario Aznar,[2] Jean Paul Beregi,[3] Laure Fournier,[3] Emanuele Neri,[4] Andrea Laghi,[5] Manuela França,[6] Francesco Sardanelli,[7] Tobias Penzkofer,[8] Phillipe Lambin,[9] Ignacio Blanquer,[10] Marion I. Menzel,[11,12] Karine Seymour,[13] Sergio Figueiras,[14] Katharina Krischak,[15] Ricard Martínez,[16] Yisroel Mirsky,[17] Guang Yang,[18,†] and Ángel Alberich-Bayarri[19,†]





- Sistemi «semplici» di supporto alla decisione diagnostica
- Prioritarizzazione
- Anamnesi sintetica Pz
- Sinossi referti precedenti
- Generazione pre-referto e/o «Conclusioni»
- «Super Radiopaedia»



Fink MA, et al Radiology 2023

Comunicazione Medico-Paziente

- Large Language Models (LLMs)
  - Chatbot/assistenti virtuali
    - Risposta quesiti dei Pz
    - **Aumento** del tempo di lettura, **nessuna riduzione** del tempo di risposta, **incremento** della lunghezza del testo della risposta

JAMA Internal Medicine | Original Investigation

Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum

John W. Ayers, PhD, MA; Adam Poliak, PhD; Mark Dredze, PhD; Eric C. Leas, PhD, MPH; Zechariah Zhu, BS;

JAMA Network Open

Original Investigation | Health Informatics

AI-Generated Draft Replies Integrated Into Health Records and Physicians' Electronic Communication

Ming Tai-Seale, PhD, MPH; Sally L. Baxter, MD, MSc; Florin Vaida, PhD; Amanda Walker, MS; Amy M. Sitapati, MD; Chad Osborne, MD; Joseph Diaz, MD; Nimit Desai, BS; Sophie Webb, MS; Gregory Polston, MD; Teresa Helsten, MD; Erin Gross, MD; Jessica Thackaberry, MD; Ammar Mandvi, MD; Dustin Lillie, MD; Steve Li, MD; Geneen Gin, DO; Suraj Achar, MD; Heather Hofflich, DO; Christopher Sharp, MD; Marlene Millen, MD; Christopher A. Longhurst, MD, MS

JAMA Network Open. 2024;7(4):e246565. doi:10.1001/jamanetworkopen.2024.6565

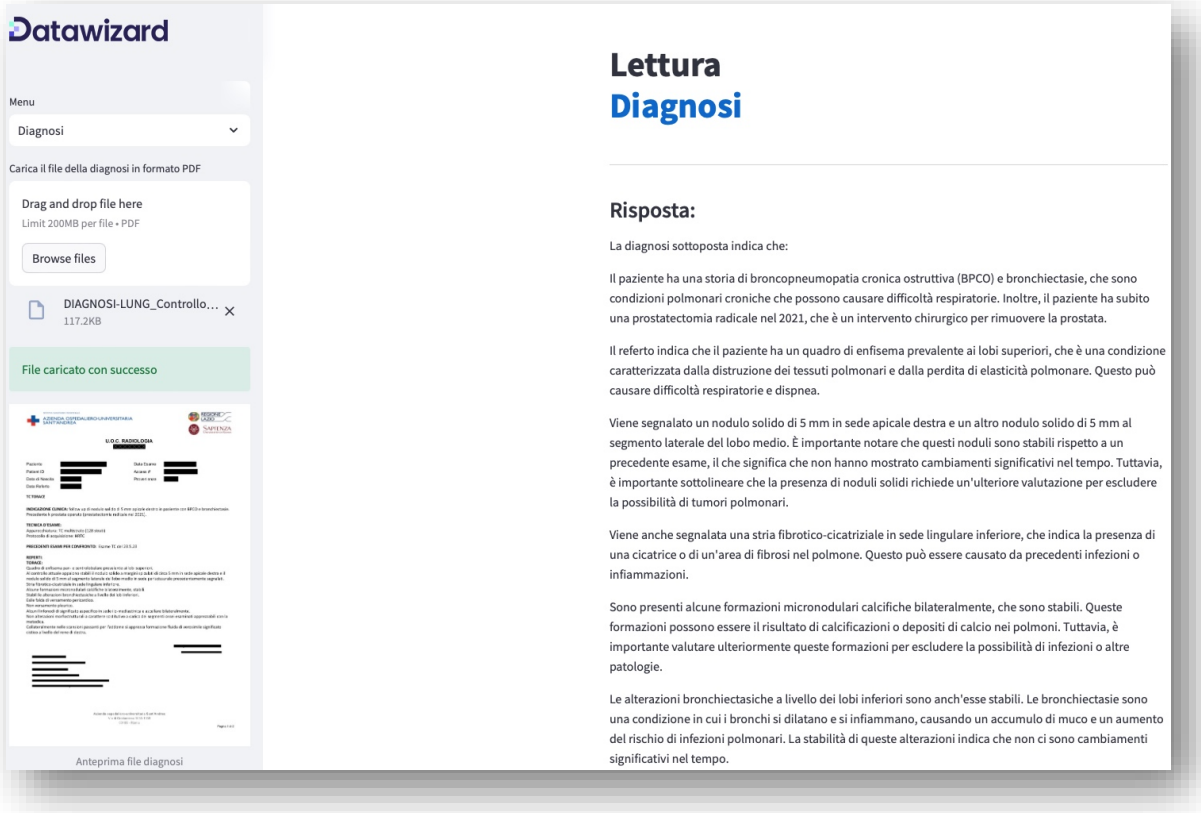
and empathy.

Meaning These results suggest that artificial intelligence assistants may be able to aid in drafting responses to patient questions.

JAMA Internal Medicine Published online April 28, 2023

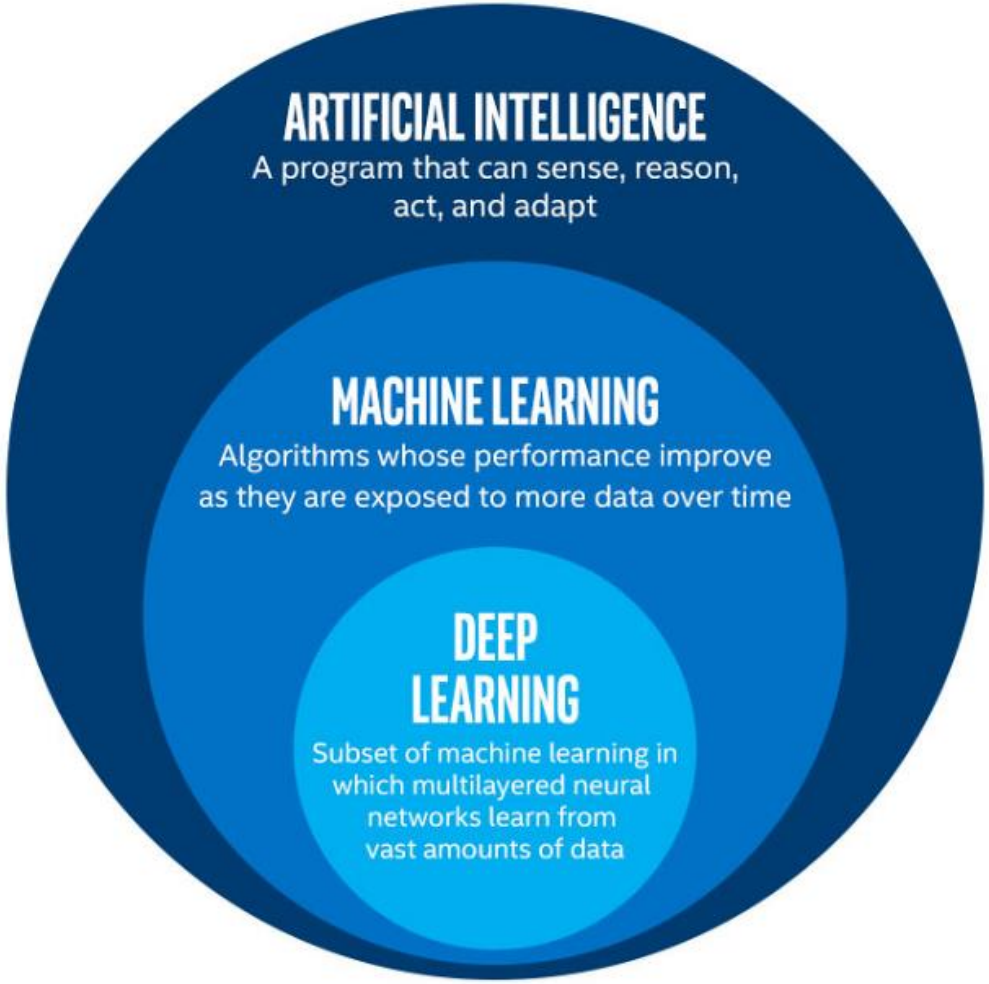
Comunicazione Medico-Paziente

- Large Language Models (LLMs)
  - Chatbot/assistenti virtuali
    - Risposta quesiti dei Pz
    - «Semplificazione» referto medico
    - «Spiegazione» esame di laboratorio



INTELLIGENZA ARTIFICIALE E RADIOLOGIA

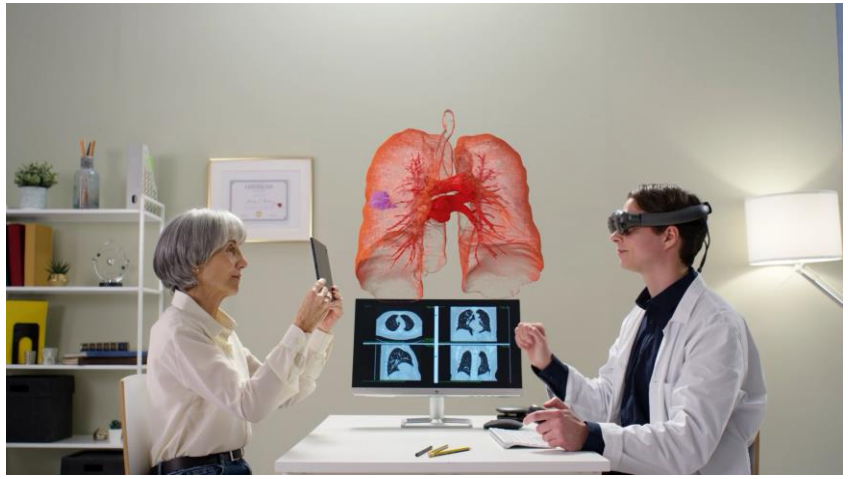
- Gestione dei processi
- Percorso diagnostico
- **Formazione e Ricerca**



IA E FORMAZIONE/RICERCA

REALTA' VIRTUALE/AUMENTATA

- Formazione e addestramento in procedure interventistiche / chirurgiche
- Accessibilità / ripetibilità
- Assenza di rischi per pz e operatori
- Costi



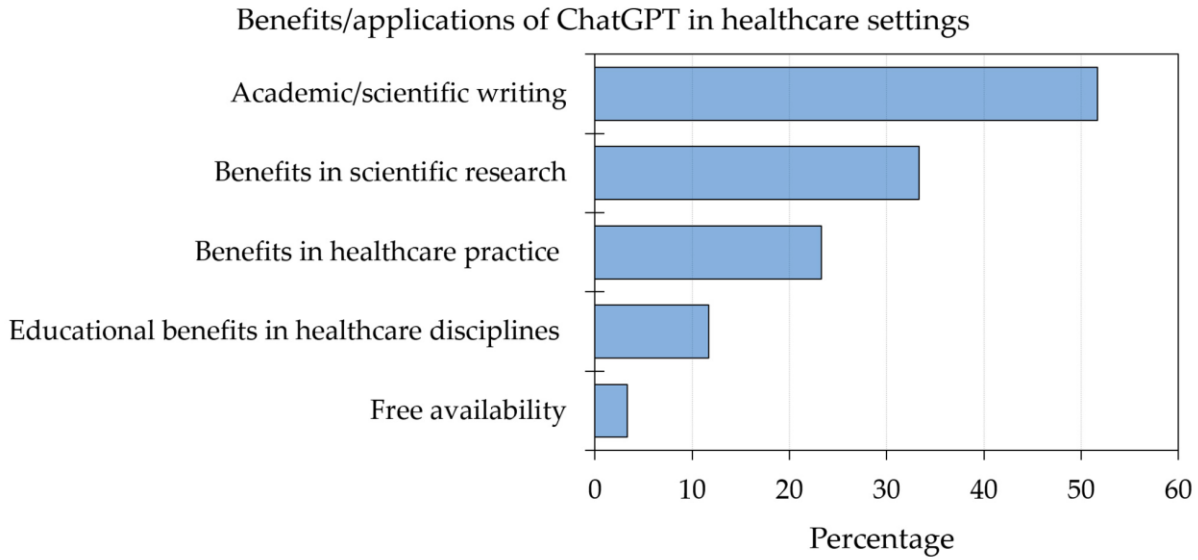


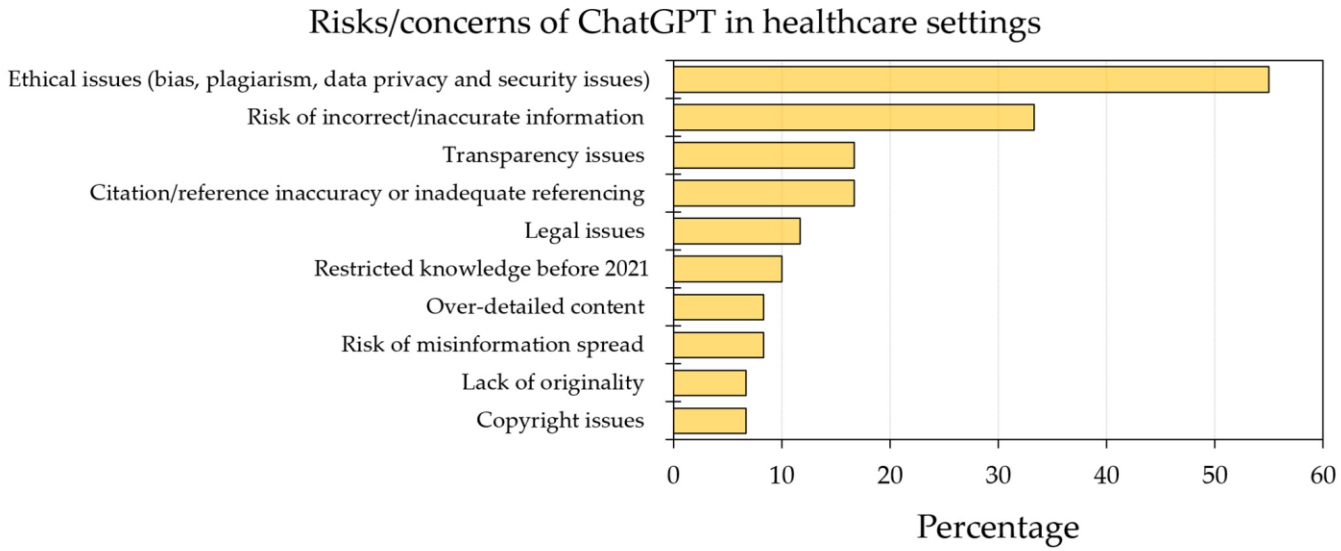
IA E FORMAZIONE/RICERCA

Large Language Model (LLM) basati su IA

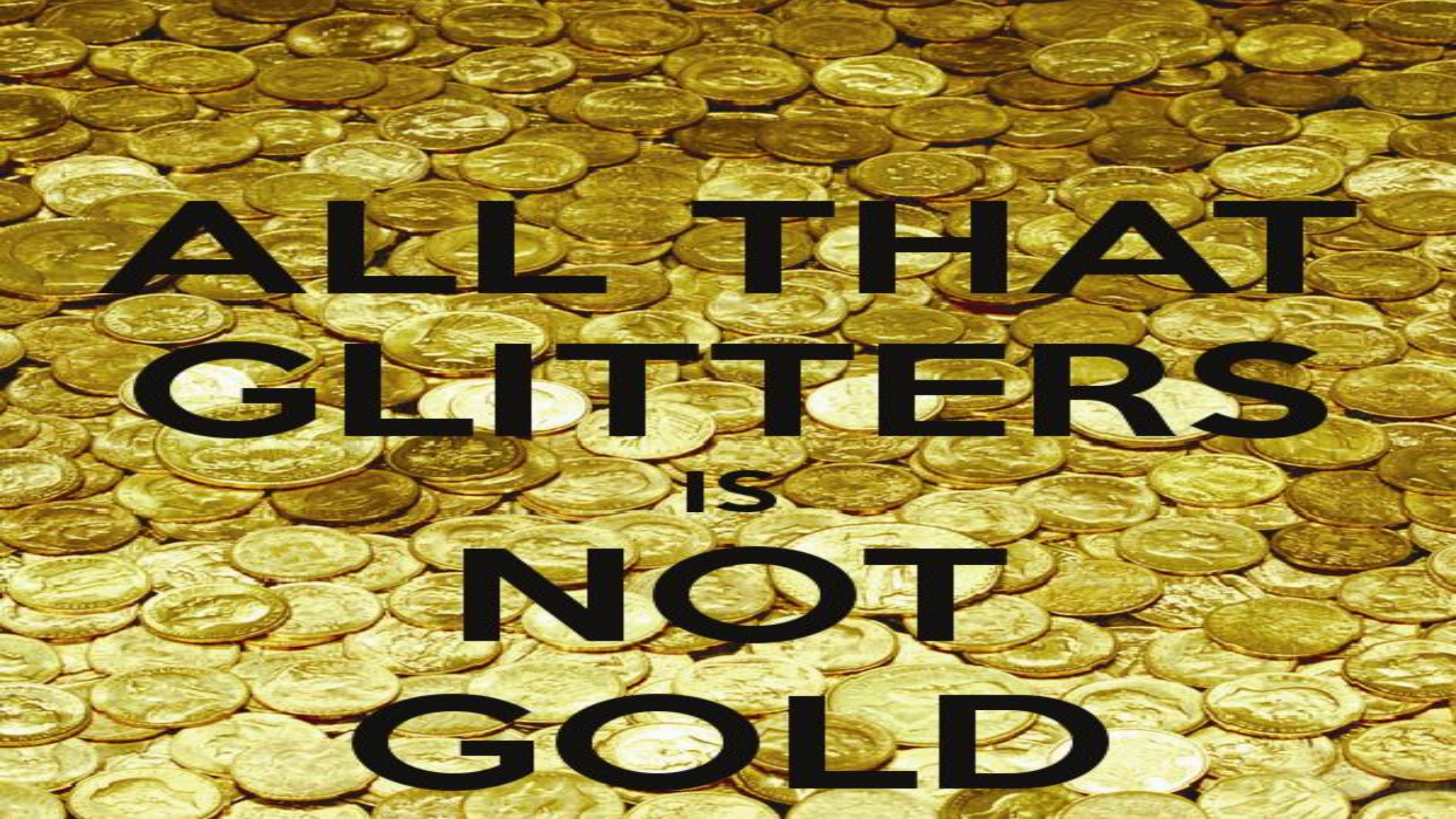
- PubMed, pubblicazioni: 4 (2022), 2082 (2023), 1488 (16.05.2024)







Sallam M, Healthcare 2023, *11*, 887


ALL THAT
GLITTERS
IS
NOT
GOLD

SFIDE PER L'IMPLEMENTAZIONE

- **LIVELLO INFRASTRUTTURALE**
  - Infrastrutture organizzative, informatizzate, a livello locale, regionale o nazionale, per la data stewardship e data governance (Cloud nazionale; FSE 2.0; EHDS)
  - Interoperabilità dei sistemi
  - Cybersicurezza


Ministero della Salute

Consiglio Superiore di Sanità

Sezione V°

"I sistemi di intelligenza artificiale come strumento di supporto alla diagnostica"

- **LIVELLO NORMATIVO**
  - Tutela della privacy (General Data Protection Regulation, GDPR)



- **LIVELLO GESTIONALE LOCALE**
  - "Engagement" delle Direzioni
  - Resistenze interne ("Middle management")
  - Complessità del team di lavoro (CFO, IT, DPO, Ingegneri biomedici, Data Scientists, Clinici)

- **LIVELLO PROFESSIONALE**
  - Personale sanitario e Dispositivi medici

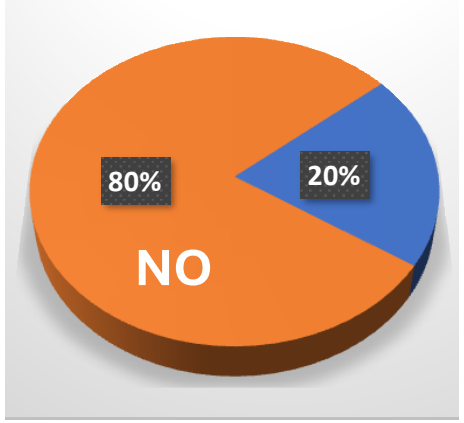
SFIDE PER L'IMPLEMENTAZIONE

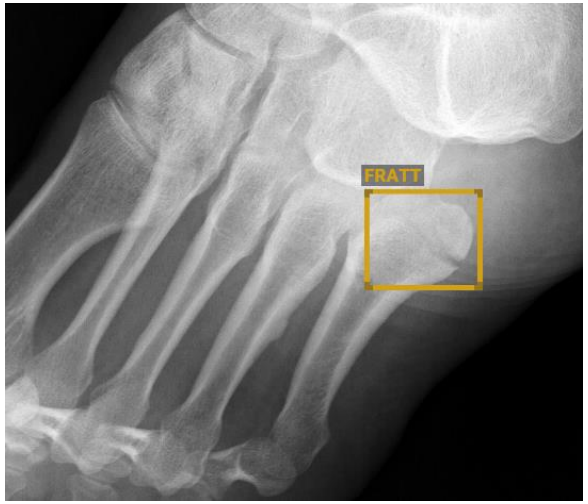
- **PERSONALE SANITARIO**
  - "Digital gap"
  - Scarsa conoscenza/diffidenza/autoreferenzialità



- Analisi retrospettiva su 2669 Pz ammessi al DEA AOUSA con sospetta frattura ossea

Utilizzo software



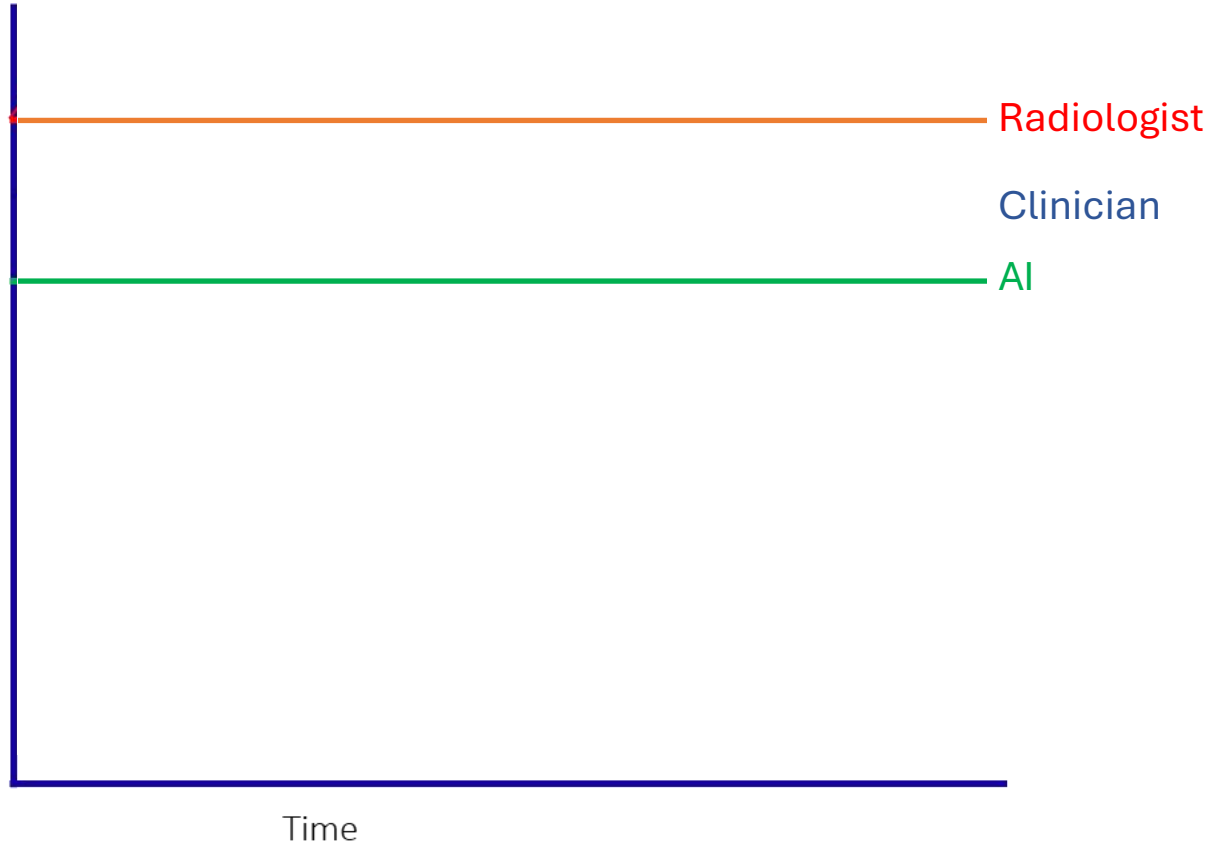


SFIDE PER L'IMPLEMENTAZIONE

Diagramma prestazionale del radiologo durante il giorno

NHS
University Hospitals of Morecambe Bay
NHS Foundation Trust

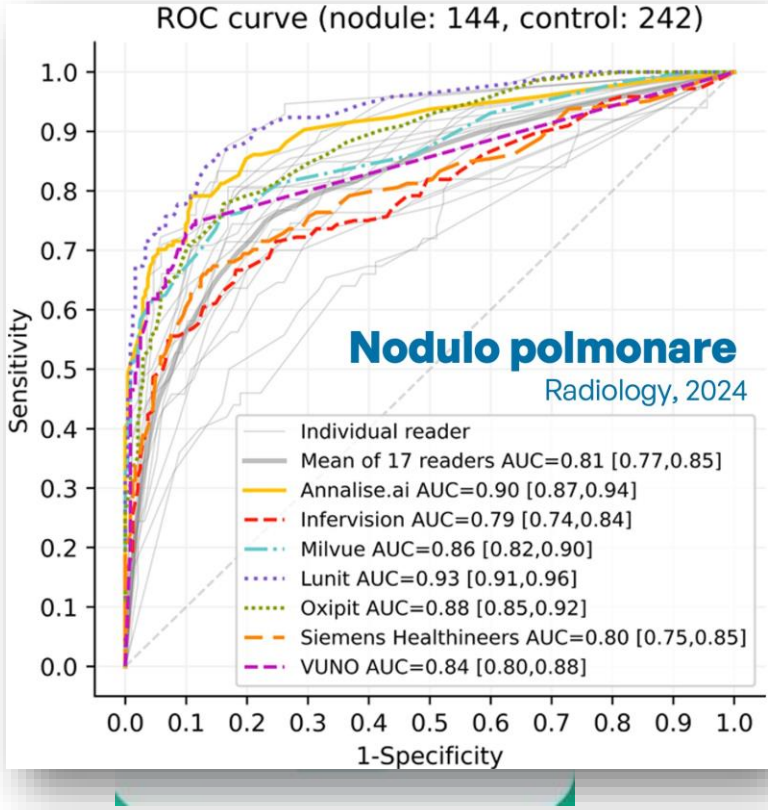




SFIDE PER L'IMPLEMENTAZIONE

- **DISPOSITIVI MEDICI (AI)**
  - Progetto AIR, (Radboud Univ, NL)
    - "Insoddisfacente" trasparenza sui dati di accuratezza
      - 64/100 prodotti CE-marked mancano di evidenza scientifica
      - 18/100 hanno un impatto clinico potenziale

van Leeuwen KG et al. Eur Radiol 2021



- **RISCHIO**: spreco di risorse; perdita credibilità; ritorno all"inverno" dell'IA
- **SOLUZIONE:** attenta vigilanza delle agenzie regolatorie

PERCHE' NON TEMERE L'IA

- «AI won't replace radiologists, but radiologists who use AI will replace radiologists who don't» - Curtis Langlotz, Radiologist/US
- «Rather than a replacement of jobs, it is a replacement of functions»
- «Dull, dirty, dangerous»

P. LIN - K. ABNEY - G. BEKEY, Robot ethics: Mapping the issues for a mechanized world, in Artificial Intelligence 175 (2011), 944

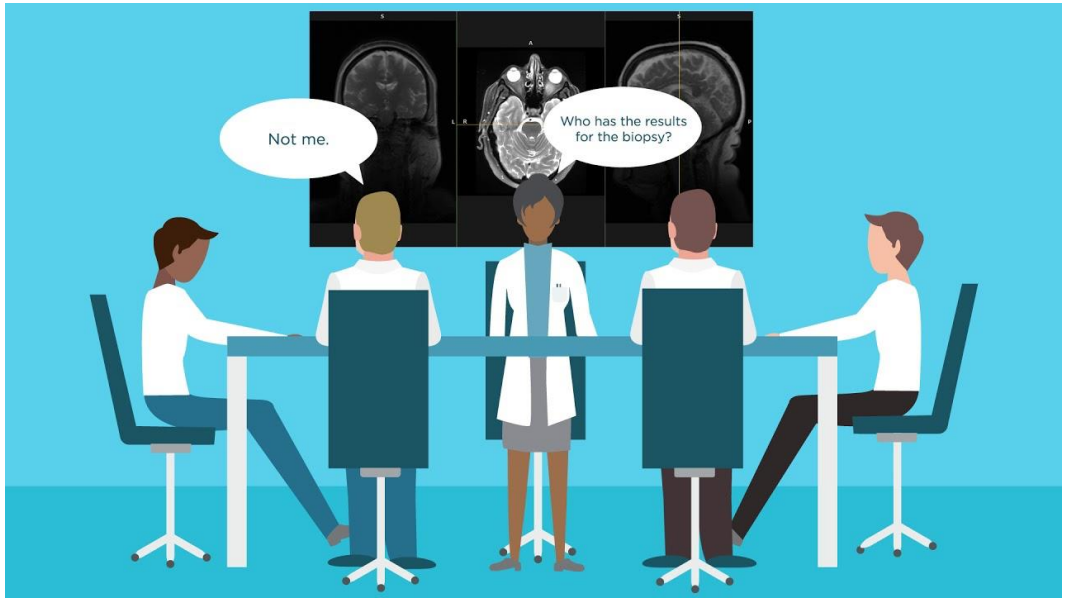


PERCHE’ NON TEMERE L’IA

IDENTIFICAZIONE NODULO POLMONARE



TUMOR BOARD MULTIDISCIPLINARE



“Science can help me make predictions, not make decisions”

Richard Feynman, Physicist (1918-1988)

CONCLUSIONI

June 8, 1964

The Challenge of the Computer

The average physician is unlikely to build a computer in his basement from a kit. But the principles of computer analysis are not difficult to master. Evidence of the growing importance of these complex electronic machines is found in the announcement that the potential of the computer in medicine will be discussed at the 13th Annual Meeting of the American Medical Association in San Francisco on Thursday, June 25th.

Besides the data carrier, which may be magnetic tape, punched paper tape, or punched cards, an electronic computer usually has four main parts: an input device, a storage pool, a processing unit, and an output device. Input devices transmit information from a carrier by means of electrical current to a "store." In the store, coded information is magnetically recorded and laid away in specified locations. The processing unit removes information from the store or directly from the input device. After various mathematical operations, the results are made accessible via the output device, which provides the data on one of the carriers mentioned above.

Computer analysis of medical data has been carried out with increasing frequency over the past five years. Although, according to Warner et al,[1] rapid advances are being made in the collection of data from a patient concerning his illness, similar progress has not been made in analyzing and improving the logical process by which the diagnosis is reached. In essence, a computer system attempts to translate the deductive processes, by which a physician moves from signs and symptoms to a diagnosis, into mathematical formulae.

Hard work is required to program a specific computer system for a particular disease problem. For example, in applying computer procedures to the diagnosis of thyroid function, Overall and Williams[2] evaluated 21 variables (sign, symptom, or laboratory finding) from 879 patients. Next, the relative likelihood of occurrence of each variable was estimated for hypothyroid, euthyroid, and hyperthyroid populations. A program was then set up to evaluate the probability with which a patient with any combination of the 21 signs, symptoms, and laboratory measures would belong to the three diagnostic types. The last computation is the one of interest, since the ultimate aim of the computer system is to assist in the diagnosis of disease. Other situations in which the computer has been used include the diagnosis of congenital heart disease, classification of cardiopulmonary disability, prediction of coronary artery disease, analysis of electrocardiograms, and the diagnosis of psychoses. Smith[3] proposes that computers are applicable also to medical record-keeping.

The accuracy of diagnosis by a suitably programmed computer compares well with that by expert clinicians in problems such as the diagnosis of thyroid function and congenital heart disease. Of course, the more pertinent variables there are for analysis, the more likely is an accurate diagnosis. In psychiatric diagnosis it was found that, whereas "typical" archetypal profiles could be effectively classified by the computer ... the specific computer diagnosis disagreed with the specific clinical diagnosis in a high percentage of cases. Nevertheless Overall and Hollister,[4] in a recent evaluation of computer procedures, note substantial validity for the computer in selecting the proper treatment. This would be expected, since psychopharmacologic therapy is determined usually along broad, archetypal lines rather than for the specific disease.

The future of the computer in medicine is summarized by Smith,[3] who defines their challenge clearly, as follows:

"A great deal depends on what we are willing to spend, rather than on what engineers can do. Industry and commerce will foster the necessary technical developments whether medical men take part or not in the computer revolution. We have on hand an invention which will probably transform our lives and our society as strikingly as they were transformed by the harnessing of electricity. If we are to apply it to the development of more informative recording of medical observations, we shall need intensive research and much development work. The results may permit a revolution in our ability to interpret medical observations for the benefit of individual patients and of medical science."

Published Online: May 16, 2024. doi:10.1001/jama.2023.18312

1. Warner, H.R., et al: Mathematical Approach to Medical Diagnosis, *JAMA* 177:177 (July 22) 1961.
2. Overall, J.E., and Williams, C.M.: Conditional Probability Program for Diagnosis of Thyroid Function, *JAMA* 183:307 (Feb 2) 1963.
3. Smith, A.: Automation of Medical Record-Keeping, *Lancet* 1:395 (Feb 22) 1964.
4. Overall, J.E., and Hollister, L.E.: Computer Procedures for Psychiatric Classification, *JAMA* 187:583 (Feb 22) 1964.

"A great deal depends on what we are willing to spend, rather than on what engineers can do. Industry and commerce will foster the necessary technical developments whether medical men take part or not in the computer revolution. We have on hand an invention which will probably transform our lives and our society as strikingly as they were transformed by the harnessing of electricity. If we are to apply it to the development of more informative recording of medical observations, we shall need intensive research and much development work. The results may permit a revolution in our ability to interpret medical observations for the benefit of individual patients and of medical science."

JAMA. 1964;188(10):928-929.

CONCLUSIONI

“**Molto dipende d** **ere, piuttosto che**
su ciò che gli i n e il commercio
favoriranno gli sv **entemente dalla**
partecipazione d **one informatica**.
Abbiamo a por e probabilmente
trasformerà le n modo altrettanto
sorprendente qu llo sfruttamento
dell'elettricità. Se li registrazioni più
informative delle **gno di un'intensa**
ricerca e di molt ebbero consentire
una rivoluzione r e le osservazioni
mediche a benefi a medica”.



JAMA. 1964;188(10):928-929.