

# AI predittiva in allergologia

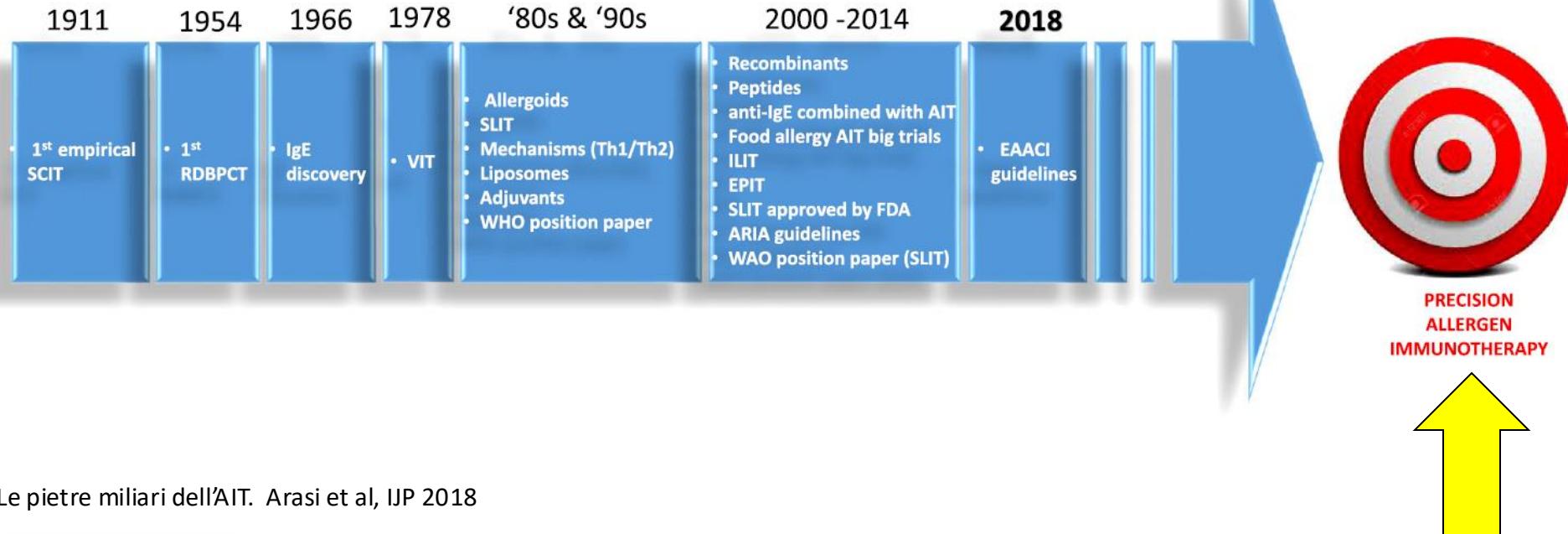
Salvatore Tripodi  
Roma

[salvatore.tripodi@gmail.com](mailto:salvatore.tripodi@gmail.com)

# Allergy Immunotherapy (AIT)

Unico strumento che può **modificare** la storia naturale della malattia allergica:

- Riducendo i sintomi della RCA anche dopo la sua fine
- Prevenendo lo sviluppo di asma bronchiale
- Prevenendo la comparsa di nuove sensibilizzazioni



Le pietre miliari dell'AIT. Arasi et al, IJP 2018

# AIT e RINO- CONGIUNTIVITE



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**POSITION PAPER**

**WILEY Allergy** EUROPEAN JOURNAL OF ALLERGY  
AND CLINICAL IMMUNOLOGY EAACI

## EAACI Guidelines on Allergen Immunotherapy: Allergic rhinoconjunctivitis

G. Roberts<sup>1,2,3\*</sup>  | O. Pfaar<sup>4,5\*</sup>  | C. A. Akdis<sup>6,7</sup> | I. J. Ansotegui<sup>8</sup> | S. R. Durham<sup>9</sup> |  
R. Gerth van Wijk<sup>10</sup> | S. Halken<sup>11</sup> | D. Larenas-Linnemann<sup>12</sup> | R. Pawankar<sup>13</sup> |  
C. Pitsios<sup>14</sup> | A. Sheikh<sup>15</sup> | M. Worm<sup>16</sup> | S. Arasi<sup>17,18</sup> | M. A. Calderon<sup>9</sup> | C. Cingi<sup>19</sup> |  
S. Dhami<sup>20</sup> | J. L. Fauquert<sup>21</sup> | E. Hamelmann<sup>22</sup> | P. Hellings<sup>23,24</sup> | L. Jacobsen<sup>25</sup> |  
E. F. Knol<sup>26</sup> | S. Y. Lin<sup>27</sup> | P. Maggina<sup>28</sup> | R. Mäsges<sup>29</sup> | J. N. G. Oude Elberink<sup>30,31</sup> |  
G. B. Pajno<sup>17</sup> | E. A. Pastorello<sup>32</sup> | M. Penagos<sup>9</sup> | G. Rotiroti<sup>33</sup> | C. B. Schmidt-Weber<sup>34</sup> |  
F. Timmermans<sup>35</sup> | O. Tsilochristou<sup>36</sup> | E-M. Varga<sup>37</sup> | J. N. Wilkinson<sup>38</sup> | A. Williams<sup>39</sup> |  
L. Zhang<sup>40</sup> | I. Agache<sup>41</sup> | E. Angier<sup>42</sup> | M. Fernandez-Rivas<sup>43</sup> | M. Jutel<sup>44,45</sup> | S. Lau<sup>46</sup> |  
R. van Ree<sup>47</sup> | D. Ryan<sup>48</sup> | G. J. Sturm<sup>49,50</sup> | A. Muraro<sup>51</sup>

**Table 1** General considerations for AIT for allergic rhinoconjunctivitis\*

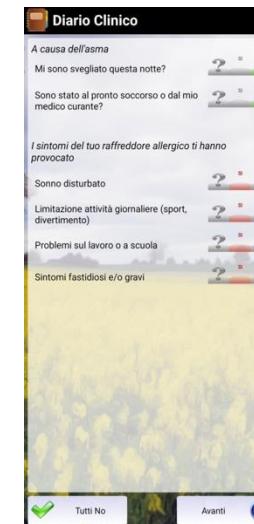
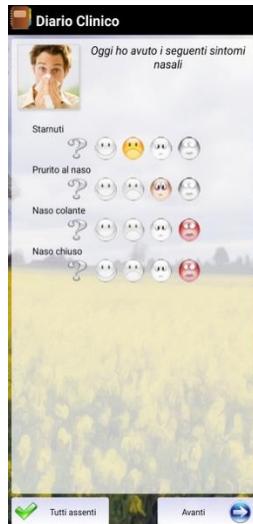
| General indications  | Key references                            | Contextual considerations  |
|--|---|--|
| <p>AIT should be considered when all of these criteria are met:</p> <ul style="list-style-type: none"> <li>• symptoms strongly suggestive of AR, with or without conjunctivitis</li> <li>• there is evidence of IgE-sensitization (positive SPT and / or serum specific-IgE) to one or more clinically relevant allergen</li> <li>• experience moderate-to-severe symptoms which interfere with usual daily activities or sleep despite regular and appropriate pharmacotherapy and/or avoidance strategies</li> </ul> | Dhami 2017 (14)                           | A diagnosis of AR and evidence of IgE-sensitization were entry criteria for RCTs in the systematic review.   |
| <p>AIT may also be considered in less severe AR where a patient wishes to take advantage of its long-term effect on AR and potential to prevent asthma with grass pollen AIT</p>   | Kristiansen 2017 (25)<br>Halken 2017 (23) | AIT has the potential to alter the natural history of disease reducing AR symptoms after completing an adequate period of immunotherapy and preventing the development of asthma in the short term, up to 2 years post AIT.  |
| <p>Standardized AIT products with evidence of efficacy in the clinical documentation should be used</p>  | Dhami 2017 (14)                           | <p>These products have consistent formulations and so different batches are likely to have similar effects.</p> <p>The meta-analysis (14) reveals a considerable heterogeneity in effectiveness between products and therefore a product-specific evaluation of efficacy is recommended.</p> |

\*The Summary of Product Characteristics (SmPC) should be checked for licensed indications which may differ between preparations.



## Diario elettronico AllergyMonitor

Questionario giornaliero: 6 schermate, emoticon, 90 secondi



Apparato oculare

Apparato respiratorio superiore

Apparato respiratorio inferiore

QoL

VAS

Terapia farmacologica





BackOffice Monitor

Elenco dei pazienti

N.Cartella Sigla Cognome

privato privato 6835 privato 3739 2986 235 3569 1827 1941 3659 6460 7988 3738 3712 1794 3619 3677 3691 3615

N.Cartella Cognome Nome Età  
G 25A, 8 M, 26 A  
G 2022  
F M A M G L A S  
Vas: Farmaci: Riassunto Farmaci Immunoterapia Grafici

Prima registrazione: 14/04/2021 Da: 09/04/2022  
Ultima registrazione: 26/09/2022 A: 09/06/2022

Grafico: RTSS

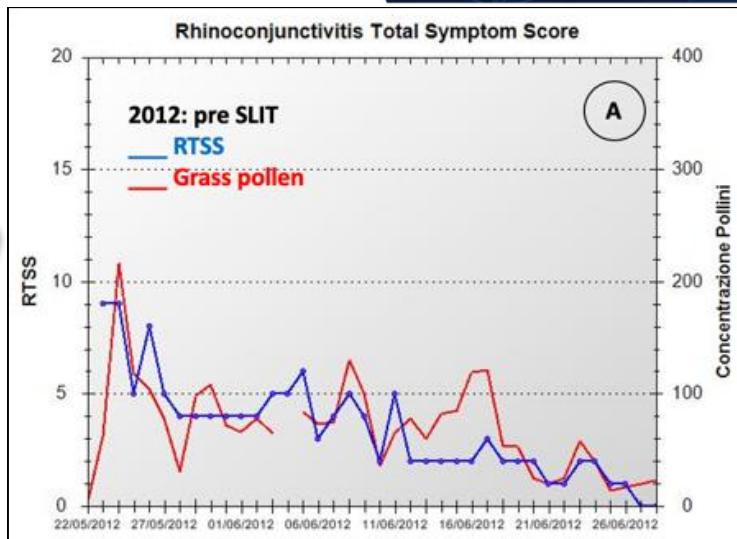
Rhinoconjunctivitis Total Symptom Score

RTSS Graminas

Chiudi

Mostra un menu: **Salvatore Tripodi** Pazienti: 140

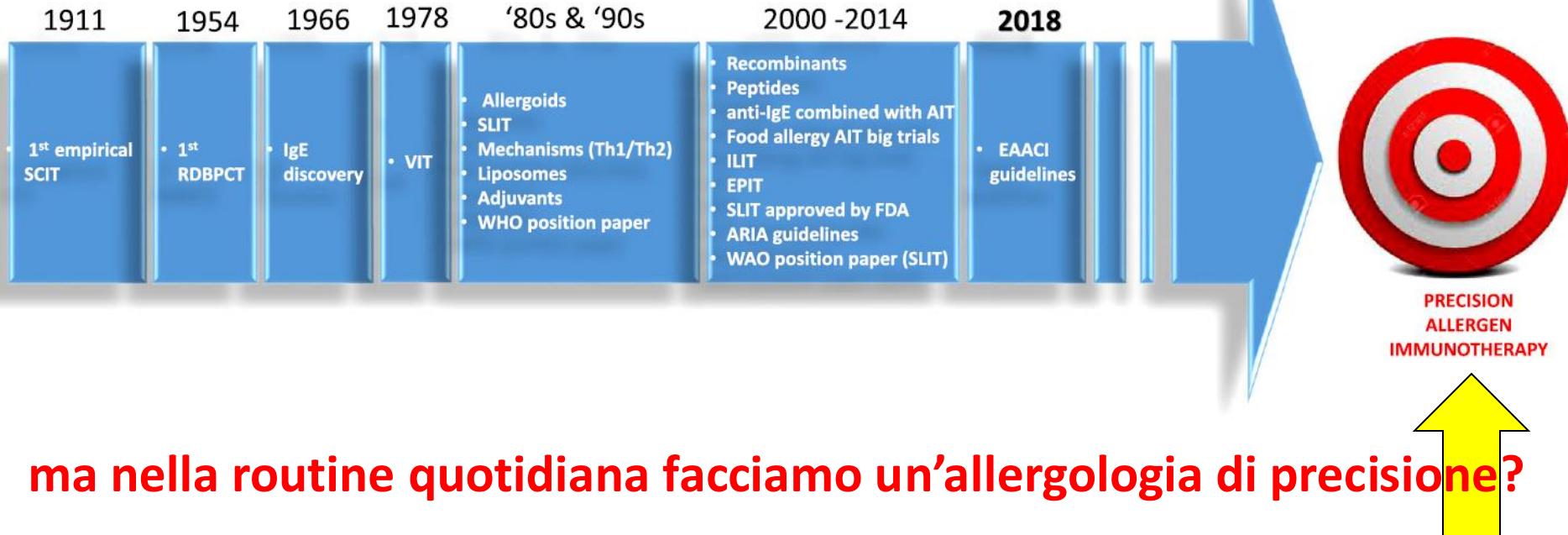
The screenshot shows a medical software interface. A central window titled 'Dati registrazioni del paziente' displays patient information: N.Cartella (6835), Cognome (G 25A, 8 M, 26 A), Nome (2022), and Età (25A, 8 M, 26 A). It also shows the first (14/04/2021) and last (26/09/2022) registration dates. Below this, a graph titled 'Rhinoconjunctivitis Total Symptom Score' (RTSS) is shown, with a secondary y-axis for 'Graminas'. The x-axis represents dates from 09/04/2022 to 08/06/2022. The graph shows two data series: a blue line for RTSS and a red line for Graminas. The RTSS line has several sharp peaks, notably around April 12, April 21, May 18, and June 1. The Graminas line is mostly flat near zero. Red arrows point to the 'RTSS' label on the graph and to the red line itself. The software interface includes a navigation bar with icons for BackOffice, Monitor, and various medical functions, as well as a sidebar with a list of patient IDs.



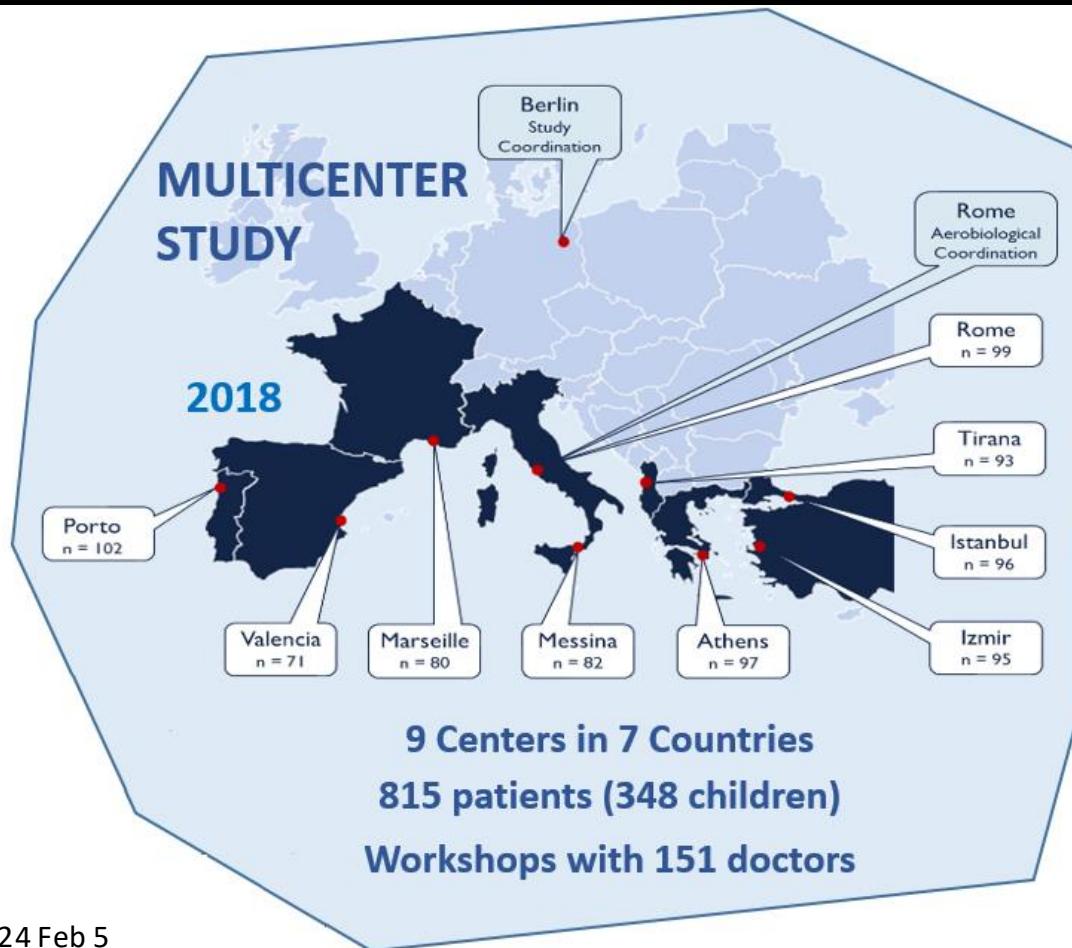
# Allergy Immunotherapy (AIT)

Unico strumento che può **modificare** la storia naturale della malattia allergica:

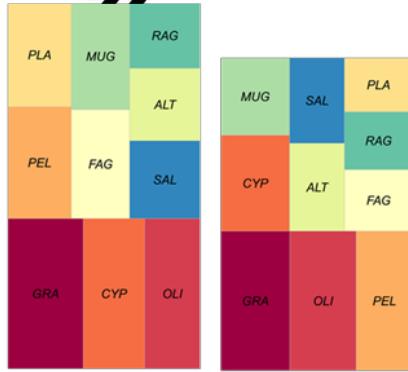
- Riducendo i sintomi della RCA anche dopo la sua fine
- Prevenendo lo sviluppo di asma bronchiale



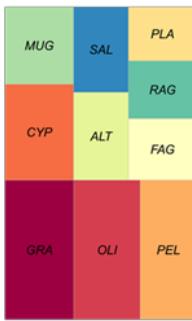
## @IT-2020 Project



Dramburg S. et al. Allergy. 2024 Feb 5



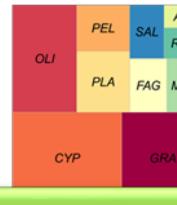
Rome n=99  
SPT+=565 (5.7/p)



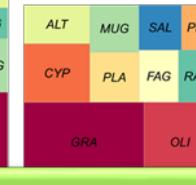
Athens n=97  
SPT+=473 (4.9/p)



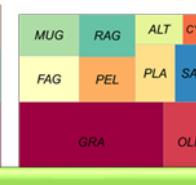
Tirana n=93  
MOL+=204 (2.2/p)



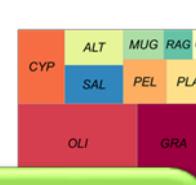
Izmir n=95  
MOL+=209 (2.2/p)



Marseille n=80  
MOL+=176 (2.2/p)



Valencia n=71  
MOL+=152 (2.1/p)



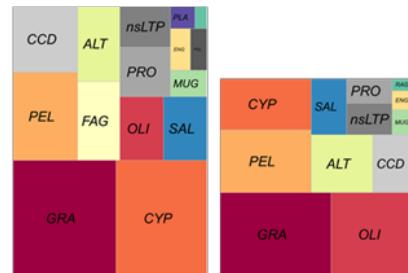
Porto n=102  
MOL+=211 (2.1/p)



Messina n=82  
SPT+=164 (2.0/p)



Istanbul n=96  
SPT+=173 (1.8/p)



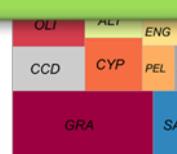
Rome n=99  
MOL+=378 (3.8/p)



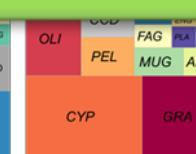
Athens n=97  
MOL+=270 (2.8/p)



Tirana n=93  
MOL+=204 (2.2/p)



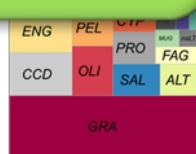
Izmir n=95  
MOL+=209 (2.2/p)



Marseille n=80  
MOL+=176 (2.2/p)



Valencia n=71  
MOL+=152 (2.1/p)



Porto n=102  
MOL+=211 (2.1/p)



Messina n=82  
MOL+=142 (1.7/p)



Istanbul n=96  
MOL+=141 (1.5/p)

## ROMA

numero SPT + = 5,7/paziente

numero Molecole Principali + = 3,8/paziente

In ogni mappa ad albero, l'area dei rettangoli corrisponde alla frequenza relativa dei risultati a partire dall'angolo in basso a sinistra (maggiore frequenza relativa) fino all'angolo in alto a destra (minore frequenza relativa). Le dimensioni di ciascuna mappa ad albero sono scalate in base alla frequenza media di SPT/IgE per paziente.

Dramburg S. et al. Allergy. 2024 Feb 5

## L'AIT funzionerà in questo paziente?

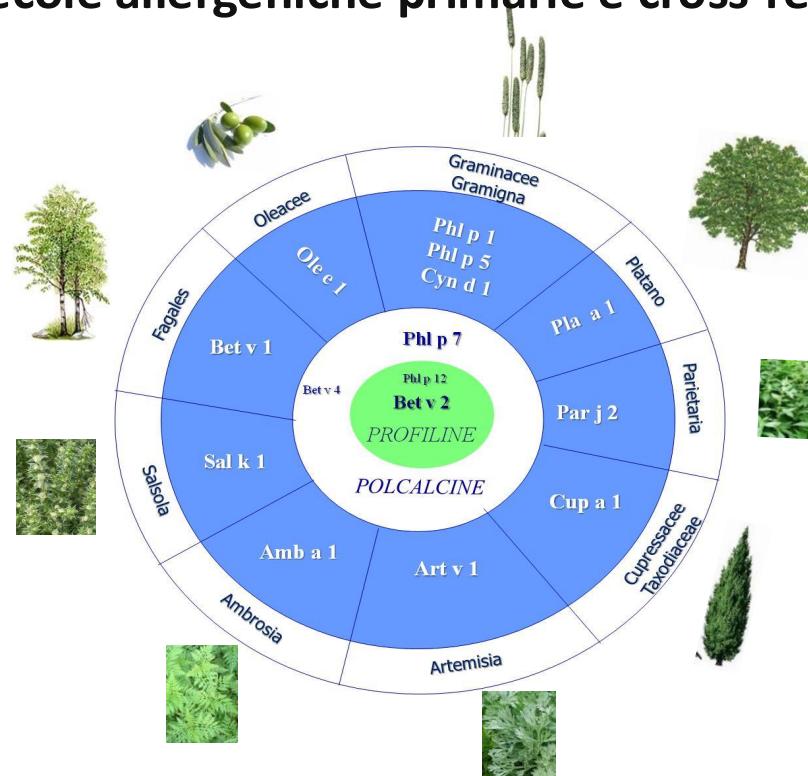
Per avere i migliori risultati dall'AIT è fondamentale:

una corretta «**predittività**»  
della/e sensibilizzazioni clinicamente rilevanti per il paziente

che può derivare solo da:

una corretta «**appropriatezza diagnostica**»

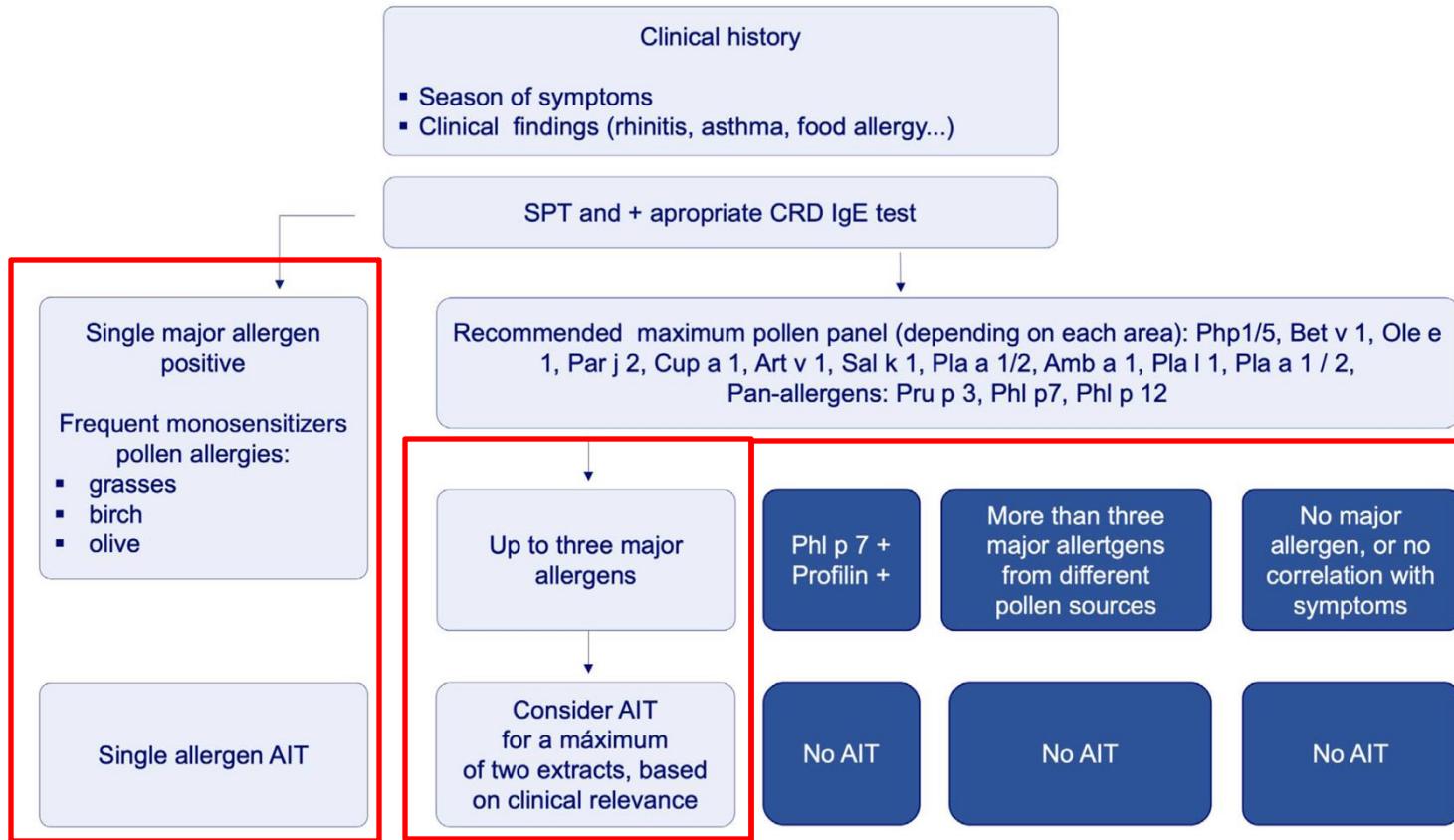
## Schema delle molecole allergeniche primarie e cross-reattive nei pollini



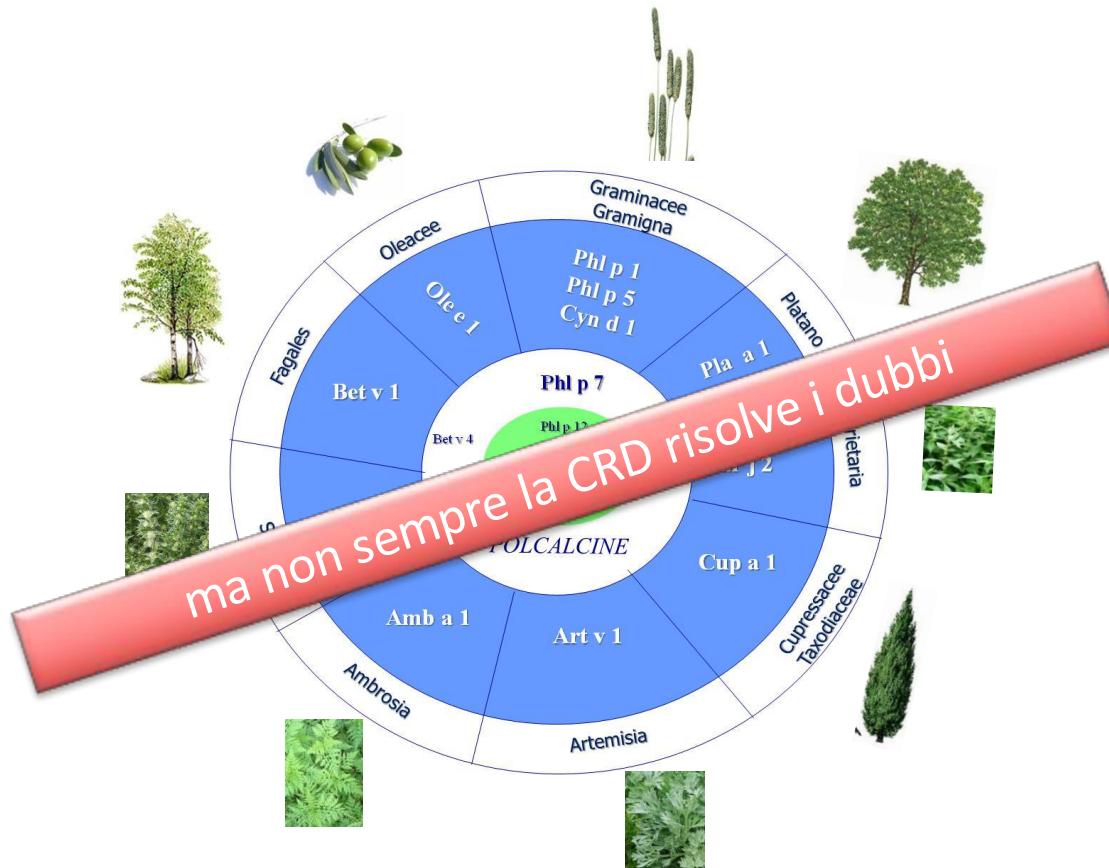
Diagnostica Molecolare (CRD)



## Diagnostic algorithm to support decision-making in the selection of AIT in multiple pollen allergies



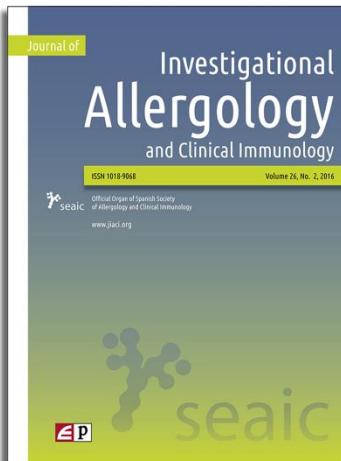
## Schema delle molecole allergeniche primarie e cross-reattive nei pollini



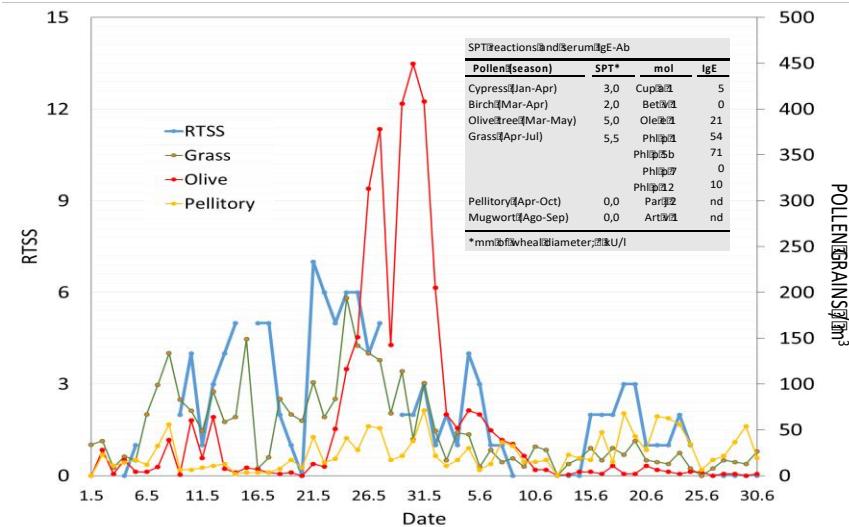
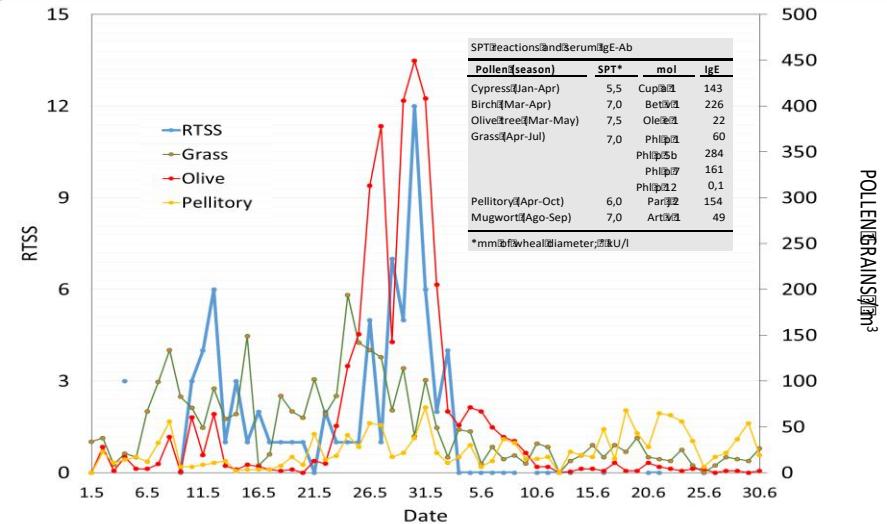


## The Smartphone: A Novel Diagnostic Tool in Pollen Allergy?

Bianchi A<sup>1</sup>, Tsilochristou O<sup>2</sup>, Gabrielli F<sup>3</sup>,  
Tripodi S<sup>4</sup>, Matricardi PM<sup>2</sup>

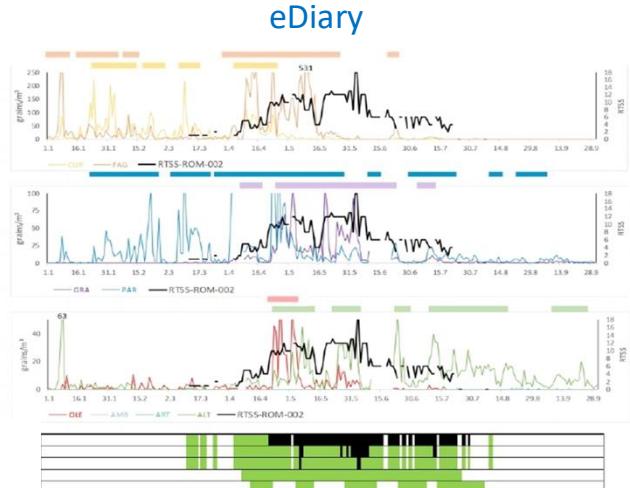
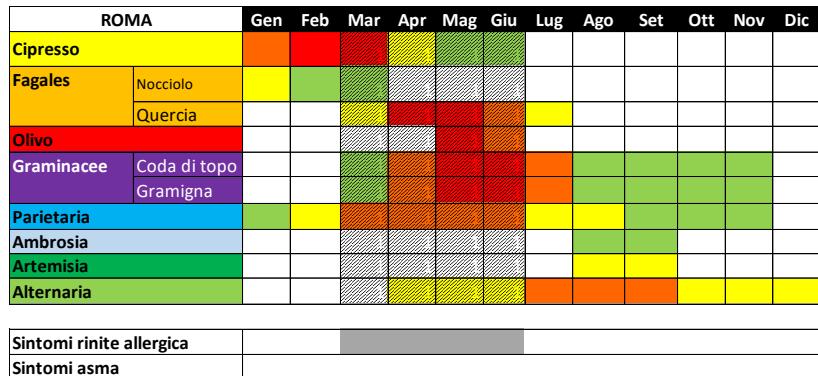


J Investig Allergol Clin Immunol 2016;  
Vol. 26(3): 204-207



## e-Diary: what information for the doctor and the patient ?

### Traditional approach



three STRONG points

- 1  pollen count
- 2  Real-time reporting (no bias)
- 3  prospective daily

Clinical History + eDiary in Pollen Allergy = Precision Allergology

## CDSS per la prescrizione Ottimale dell'AIT

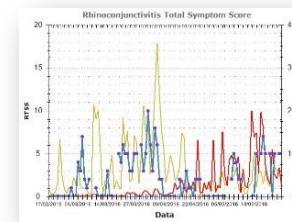
### 1. Diagnostica Tradizionale (anamnesi + SPT)



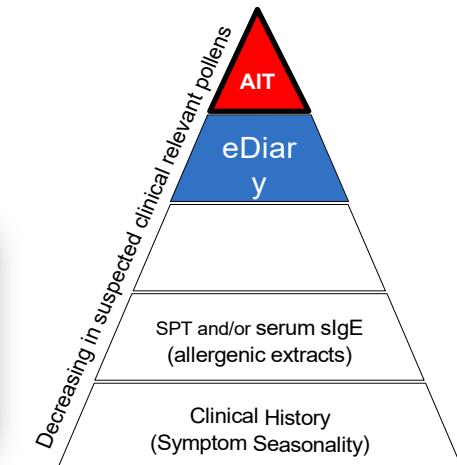
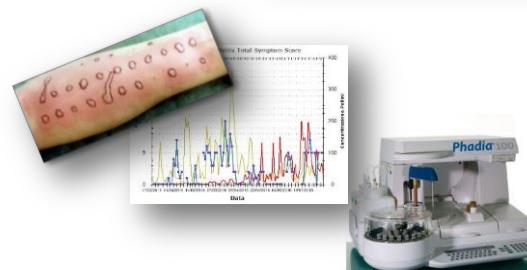
### 2. Diagnostica Molecolare (CRD)



### 3. AllergyMonitor e curve polliniche



### 4. Diagnostica Tradizionale + AllergyMonitor/curve polliniche + IgEs per estratti e IgE molecolari



Patient with clinical history of hay fever

Matricardi PM, Potapova E, Forchert L, Dramburg S, Tripodi S.

Digital allergology: towards a clinical decision support system for allergen immunotherapy. *Pediatric Allergy and Immunology*. 2020;31:61-64.

## @IT-2020 Project AllergyPlan

### Sviluppo di un Algoritmo di AI per la Diagnosi di Allergie ai Pollini

#### Obiettivo Principale:

- Creare un modello di machine learning in grado di supportare i medici nell'identificazione degli allergeni rilevanti (pollini e Alternaria) in diverse regioni/nazioni e periodi dell'anno.

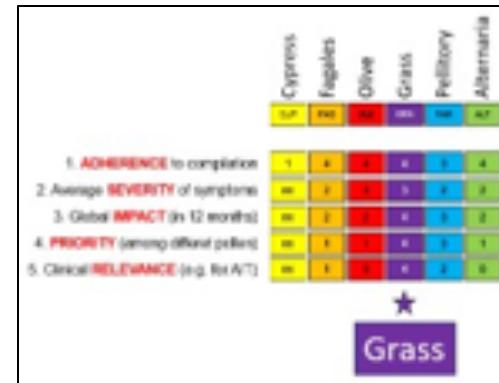
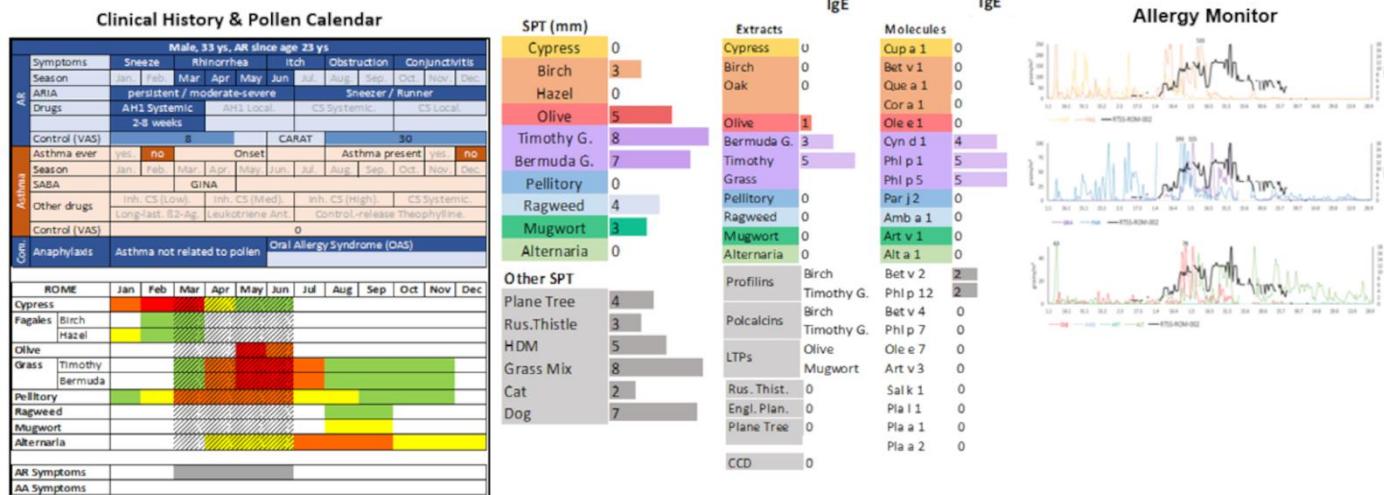
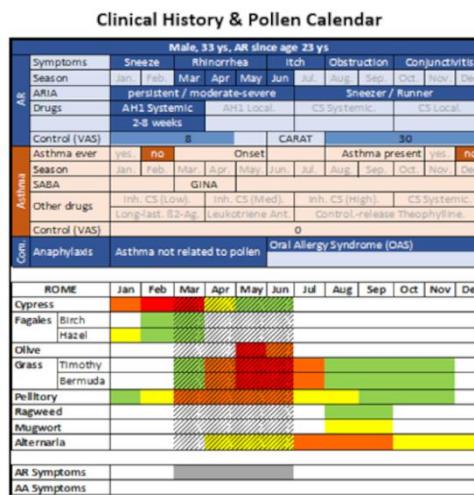
Etiologic diagnosis of seasonal allergic rhinitis by artificial intelligence. Monnati F, Palmieri L, et Al...Tripodi S, Matricardi PM  
(submitted)

## @IT-2020 Project AllergyPlan

### Dataset & Popolazione

- **192 pazienti totali:**
  - 100 di Roma
  - 92 di Tirana
- **Principali informazioni raccolte:**
  - **Clinical History (CH):** dati anamnestici, comorbidità, ecc.
  - **Skin Prick Test (SPT):** area della reazione, positività/negatività, ecc.
  - **Atopy (IgE):** test basati su estratti e molecole specifiche.
  - **Clinical Diary (CD) AllergyMonitor<sup>®</sup>:** diario giornaliero dei sintomi (CSMS, VAS, QoL).

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(submitted)



Valutazione del paziente da parte degli esperti, in base a:

- anamnesi clinica
- calendario pollinico
- valori SPT e IgE (estratti e molecole)
- dati longitudinali del diario clinico (curve polliniche e score clinici: RTSS-dCSMS-VAS).

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## @IT-2020 Project AllergyPlan

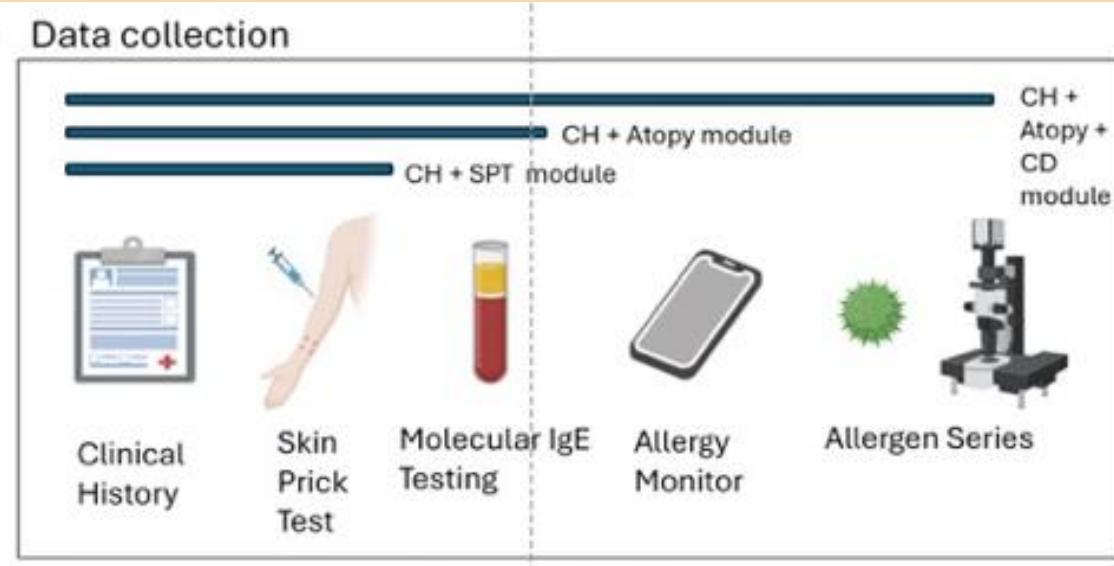
### Costruzione del Gold Standard

- **Tre medici specialisti** hanno valutato ogni paziente per ogni allergene, integrando dati di laboratorio, test cutanei e sintomi.
- **Finalità:** creare un riferimento “gold standard” su cui confrontare le previsioni dell’algoritmo.
- **Concordanza tra i medici** valutata con:
  - **Krippendorff's alpha**
  - **Intraclass Correlation Coefficient (ICC)**

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(submitted)

## Flusso dello studio

### a) Data collection

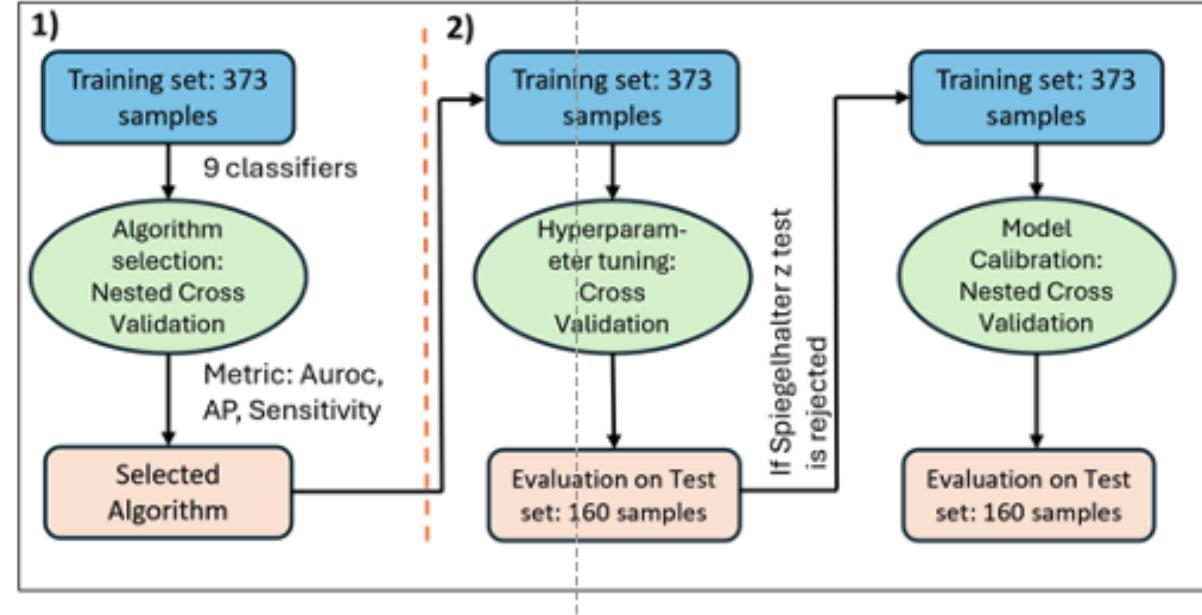


a) Sono stati raccolti dati attraverso questionari, test in vivo (sul paziente) e in vitro (in laboratorio), oltre a informazioni da un'app mobile. Questi dati sono stati confrontati con la concentrazione degli allergeni. Le barre in alto indicano i 3 passaggi diagnostici usati nel sistema di supporto decisionale (CDSS).

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(submitted)

## Flusso dello studio

### c) Training and evaluation scheme



#### In 2 anni di lavoro:

Sono stati sviluppati sei modelli di AI per rappresentare i tre passaggi diagnostici, con due obiettivi: identificare la causa dell'allergia (etiology) e supportare le decisioni per l'immunoterapia allergenica (AIT). I modelli per l'etiology si basavano sui passaggi 1 e 2, mentre quelli per l'AIT si basavano sul passaggio 2.

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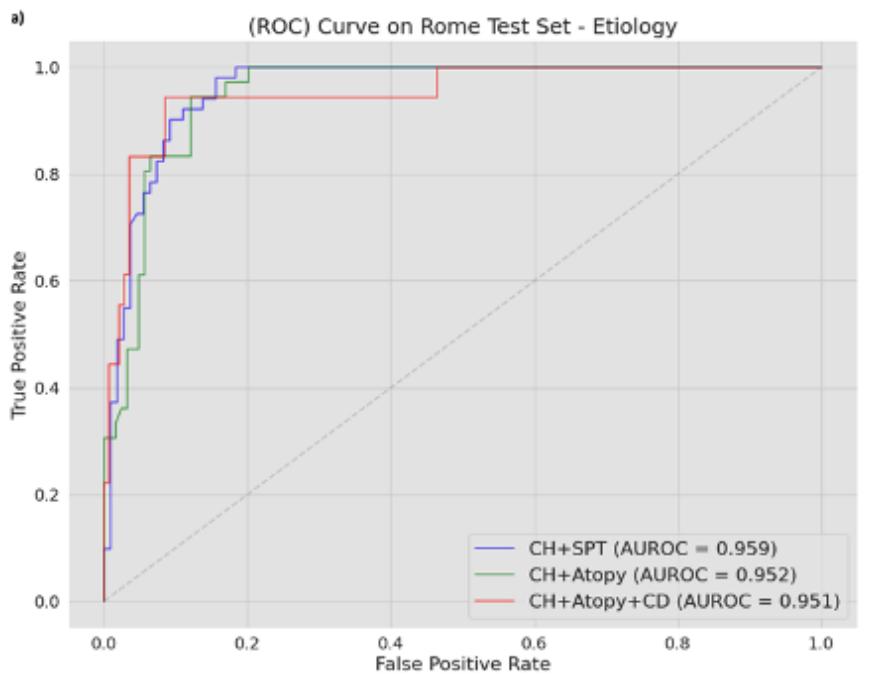
## @IT-2020 Project AllergyPlan

### Prestazioni & Metriche Chiave

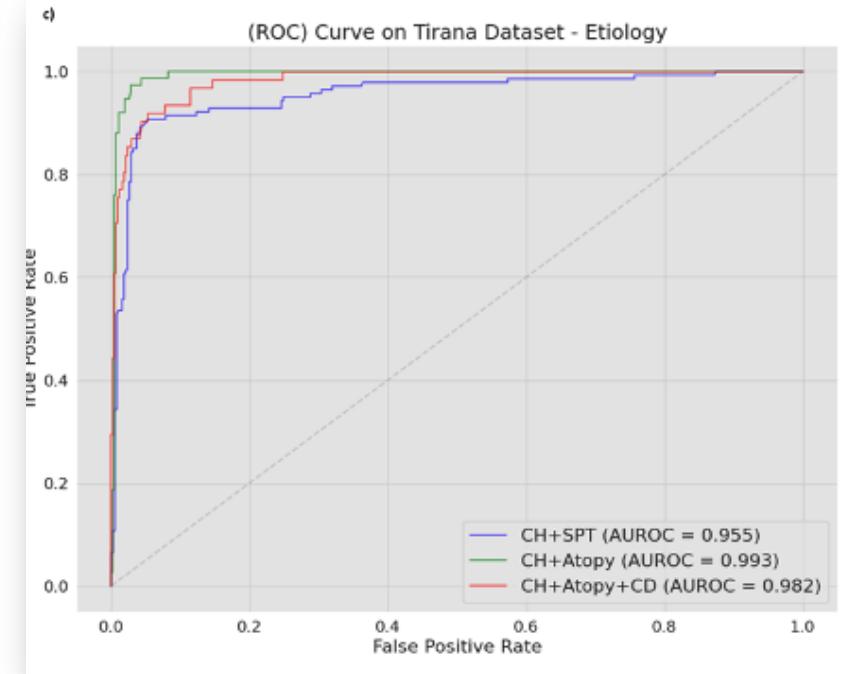
- **AUC (Area Under the ROC Curve):** ~0,95 o superiore in tutti i moduli.
- **Sensibilità (True Positive Rate):** 83% – 92% (etologia) e 91% – 100% (immunoterapia).
- **Specificità:** 88% – 94%.

**PPV** (Positive Predictive Value) più basso per classi poco rappresentate, ma in generale risultati soddisfacenti

Etiologic diagnosis of seasonal allergic rhinitis by artificial intelligence. Monnati F, Palmieri L, et Al...Tripodi S, Matricardi PM  
(submitted)



Roma

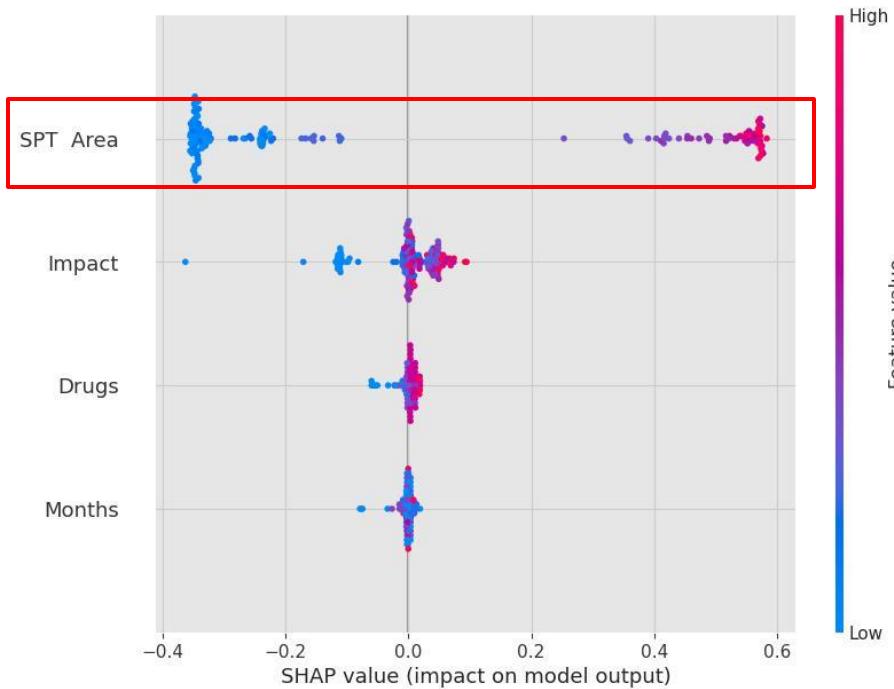


Tirana

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(submitted)

## Variabili Predizione vs Gold Standard

CH + SPT



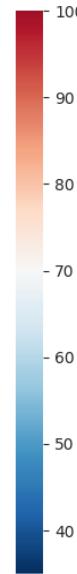
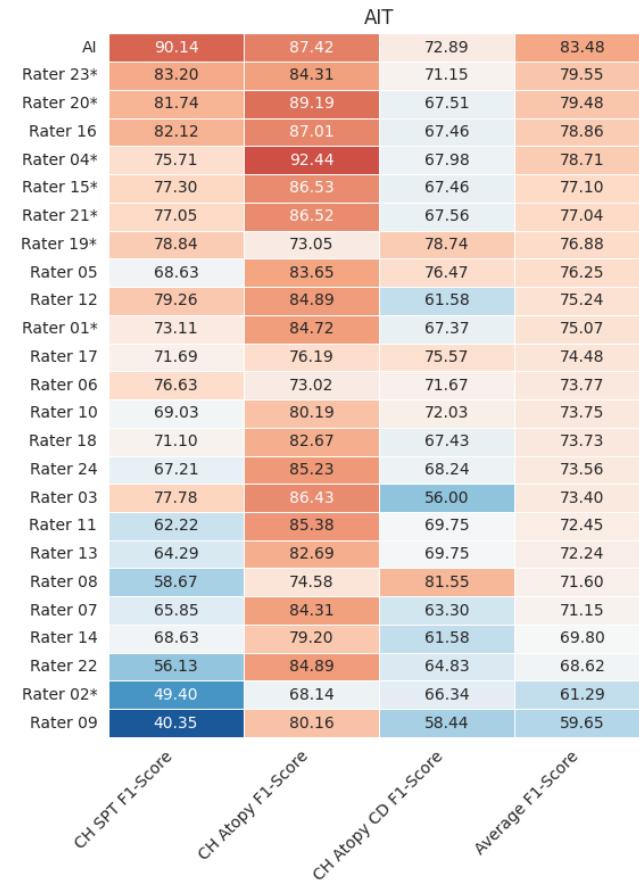
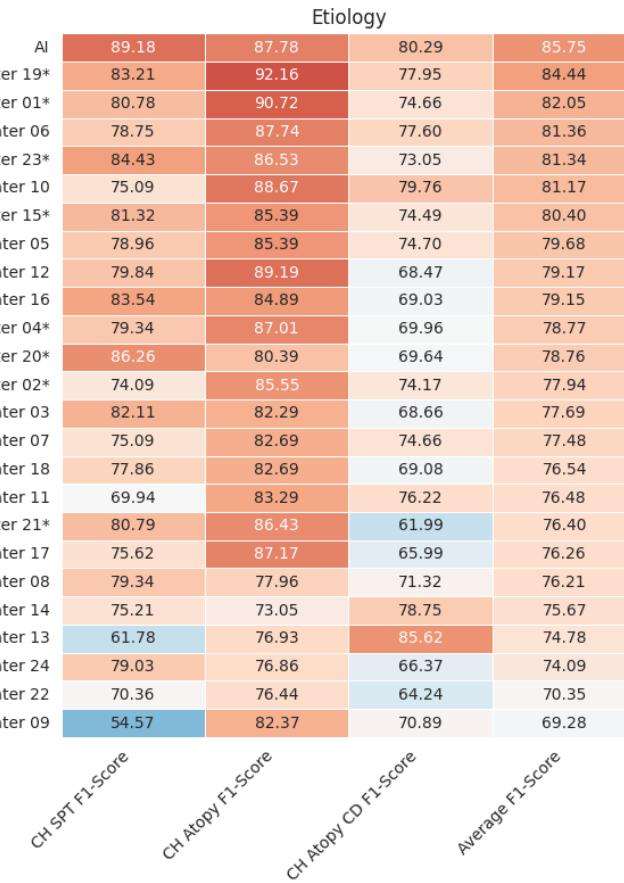
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(submitted)

## Medici vs AI

Un workshop si è svolto presso l’Ospedale Umberto I di Roma con **24 medici** per valutare 12 pazienti selezionati da un set di 29 utilizzati per testare modelli di intelligenza artificiale. I partecipanti comprendevano **8 specialisti in allergologia, 9 specializzandi in allergologia pediatrica e 7 studenti di master**. L’evento era diviso in due parti: formazione teorica e valutazione di casi clinici. Ogni medico ha esaminato il profilo complessivo dei pazienti e valutato 6 allergeni con un punteggio da 0 a 4 o indicato dati insufficienti. La valutazione, con 6 minuti per paziente, seguiva un metodo basato sul gold standard.



## Confronto predizione tra AI e Medici durante workshop



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(submitted)

## @IT-2020 Project AllergyPlan

### Confronto con Medici & Validazione Esterna

- **Confronto diretto** con 24 medici su un sottoinsieme di 68 coppie paziente-allergene:
  - Il modello AI si è posizionato **primo** in alcune combinazioni (CH + SPT) e comunque ai primi posti nelle altre.
- **Validazione su Tirana:**
  - L'algoritmo allenato sui dati di Roma ha mantenuto buone performance sul dataset di Tirana, dimostrando **robustezza**.

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(submitted)

## @IT-2020 Project AllergyPlan

### Conclusioni

- **Algoritmo affidabile:** elevate prestazioni e buona generalizzazione (Roma vs Tirana).
- **Supporto concreto** per i medici:
  - Identifica rapidamente l'allergene principale.
  - Aiuta a decidere sull'immunoterapia.
- **Prospettive:** estendere il modello ad altre regioni/allergeni e migliorare la calibrazione per ridurre l’"overconfidence" delle previsioni.

Etiologic diagnosis of seasonal allergic rhinitis by artificial intelligence. Monnati F, Palmieri L, et Al...Tripodi S, Matricardi PM  
(submitted)

## @IT-2025 Project AllergyPlan



2025-2026

Sarà validato nello studio policentrico real-world @IT-2025  
sull'appropriatezza diagnostica dell'AIT  
coordinato dal Dr. Mattia Giovannini  
Azienda Ospedaliera Universitaria Meyer IRCCS