PREDICTIVE MODELING TRANSITION TO PsA IN HIGH-RISK PsO PATIENTS TO ENABLE EARLY INTERVENTION

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SUMMARY

- Psoriasis (PsO) affects 125 million people worldwide, with ~30% developing Psoriatic Arthritis (PsA), which can cause severe joint damage if not detected early.
- Early identification of high-risk PsO patients is crucial for timely intervention and improved outcomes.
- Findings indicate that most PsA cases develop within 12 months of starting advanced PsO treatment.
- Comorbidities such as circulatory, musculoskeletal, and skin conditions increase PsA risk.
- High drug switching rates in the first two years, especially from PDE4 to Interleukin inhibitors, which improve survival probability.

INTRODUCTION & OBJECTIVES

- This study leverages analytical methodologies to identify patients at high risk of transitioning from Psoriasis (PsO) to Psoriatic Arthritis (PsA). We aim to improve early detection and intervention, enabling tailored treatment strategies and better resource allocation.

METHODS

Data Source and Cohort Selection

- The dataset was sourced from the MarketScan Commercial Claims and Encounters Database, spanning a period from January 2010 to December 2022. Patients were selected based on a confirmed diagnosis of Psoriasis and evidence of initiating advanced systemic treatments, such as biologics or disease-modifying antirheumatic drugs (DMARDs). To ensure reliable patient history, all included individuals had a minimum of 12 months of continuous enrollment before starting treatment.

Feature Engineering

- A robust feature set comprising over 3,500 variables was constructed to capture a comprehensive view of each patient's clinical profile. These features included:
  - **Demographic** information, such as age group, gender, and geographic region.
  - **Comorbidity** patterns, categorized into groups like musculoskeletal, dermatologic, and circulatory conditions.
  - **Treatment**-related variables, covering drug class exposure (e.g., Interleukin inhibitors, Anti-TNF agents, PDE4 inhibitors, NSAIDs, steroids, and topical therapies), frequency of brand switching, and duration on therapy.
  - **Procedural** and diagnostic code clusters (ICD, CPT, and NDC) to quantify healthcare utilization and complexity of clinical presentations.
  - **Time to Event** to assess the impact of each selected feature (e.g., Inflammatory conditions, Joint pain and disorders, etc.) on the outcome.

Figure 1 | Demographic distribution of PsO and PsA population

Demographic analysis reveals that women (56%) are more likely to transition to PsA than men. Age group 50-60 shows the highest risk, indicating a greater likelihood of PsA progression in this range.

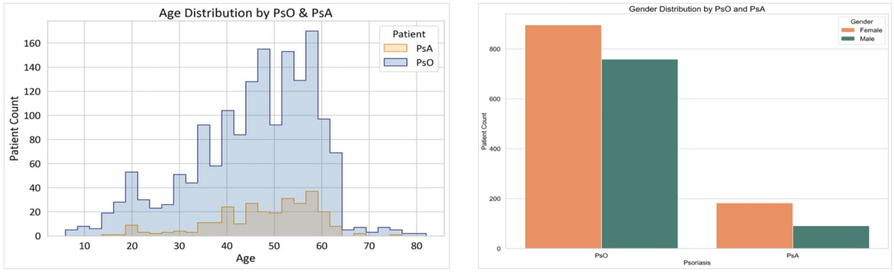

Figure 2 | Survival function of different drugs

The survival chart supports the result that Anti-TNF and Interleukin therapies are significant predictors, both show higher survival probabilities compared to traditional treatments. Their performance in delaying PSA onset highlights their importance in early-stage intervention and risk stratification.

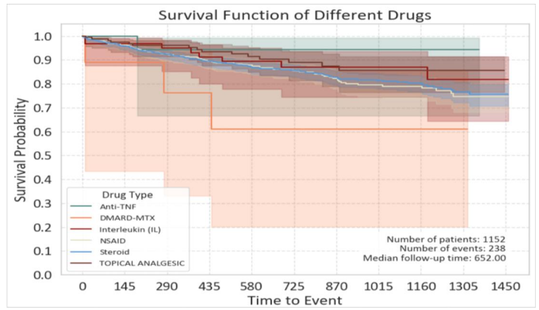

Figure 3 | Time to Event Analysis for Selected Features

The box plot for time to event shows that the median time to PSA is lower for those with inflammatory conditions and joint pain and disorders

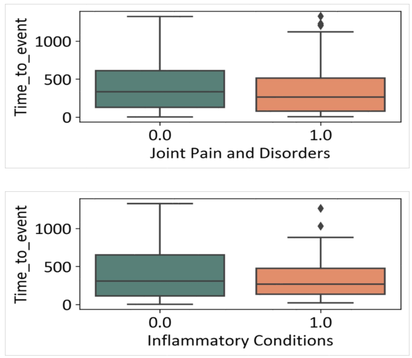

Figure 4 | Model Performance

Model Performance comparison showing RSF achieved 94% gain at 365 days and 92% at 730 days, with an F-score of 60% and Precision of 48% at 730 days, demonstrating robust predictive accuracy.

Method	Concordance Index	AUC Curve	Min 80% Recall		
			Specificity	Precision	F-Score
Cox Regression	0.73	ST - Strong LT - Decline in Accuracy	365 days - 15% 730 days - 12%	365 days - 15% 730 days - 34%	365 days - 18% 730 days - 34%
Cox Regression with PCA	0.76	ST - Improves Rapidly LT - Strong and Stable	365 days - 31% 730 days - 27%	365 days - 11% 730 days - 21%	365 days - 20% 730 days - 35%
Random Survival Forest	0.83	ST - Improves Rapidly LT - Strong and Stable	365 days - 71% 730 days - 76%	365 days - 22% 730 days - 48%	365 days - 38% 730 days - 60%
Random Survival Forest with PCA	0.78	ST - Improves Rapidly LT - Strong and Stable	365 days - 62% 730 days - 68%	365 days - 20% 730 days - 40%	365 days - 32% 730 days - 53%

Risk	Risk Score Range		Patient Set
Very High	156.7	21.2	20%
High	21.2	11.8	20%
Medium	11.8	6.5	20%
Low	6.5	3.5	20%
Very Low	3.5	0.3	20%

RESULT

- To forecast the likelihood of PsO patients progressing to PSA, we evaluated multiple machine learning approaches. Among these, the RSF model delivered superior performance in predicting time-to-event outcomes, with the highest concordance index (0.83) and strong short- and long-term classification metrics.

Performance Highlights:

- RSF showed 94% gain at 365 days and 92% at 730 days, indicating its strength in early and long-term prediction.
- Achieved F-score of 60% at 730 days and Precision of 48%, reflecting robust predictive accuracy.

CONCLUSIONS

- Findings revealed that most PsA cases emerge within the first year after advanced PsO treatment initiation, with significant predictors including Anti-TNF and Interleukin therapies. Brand switching peaked in the initial two years, underscoring critical early intervention opportunities. RSF outperformed other models, accurately stratifying patients by progression risk. Additionally, survival analysis findings underscored the influence of comorbidities, such as circulatory, musculoskeletal, and skin disorders in accelerating PsA development.
- This study demonstrates the value of predictive modeling in identifying patients at high-risk of transitioning from PsO to PsA. Such models can drive targeted drug development, optimize clinical trial design, and facilitate precision medicine approaches. Future work should integrate broader datasets to validate findings and explore cost-benefit analyses for early intervention strategies.

ABBREVIATIONS

PsO – Psoriasis **| PsA –** Psoriatic Arthritis**| DMARD –** Disease-Modifying Antirheumatic Drugs **| ICD –** International Classification of Diseases **| CPT –** Current Procedural Terminology **| NDC –** National Development Council **| NDC –** National Development Council **| TNF –** Tumor Necrosis Factor**| RSF –** Random Survival Forest

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