Psoriasis Treatment Patterns: A Retrospective Claims Study

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ABSTRACT

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BACKGROUND: Psoriasis (PsO) is a chronic, autoimmune, dermatologic disease affecting 7.5 million adults in the United States. Treatment options for psoriasis include topical therapy, phototherapy, oral systemic therapies, and biologics. Currently, there is a gap in the evidence in the evaluation of treatment patterns for psoriasis. With emerging options in managing psoriasis, it has become increasingly important to investigate current utilization patterns.

METHODS: This observational, retrospective cohort study utilized the MarketScan® Commercial Claims and Medicare Supplemental Databases from January 1st, 2014 to December 31st, 2016. The target population was psoriasis patients over 18 years old who were new users of oral or biologic psoriasis medications. Descriptive statistics including proportions of patients on each treatment type were presented. Outcomes of interest were persistence, switching, and restarting. We investigated within-class persistence, between-class switching and between-class restarting. Additionally, we compared orals and biologics with respect to persistence and switching. Lines of therapy and temporal patterns of switching and restarting after loss of persistence were also characterized. Furthermore, a Cox regression model was used to compare persistence on orals and biologics as overall classes.

RESULTS: A total of 5933 patients were identified. 2600 patients lost persistence on their index medication class. Patients whose index drug was a Vitamin A derivative or other biologic had highest proportions of loss of persistence. Treatment type (oral versus biologic) had no bearing on persistence (HR: 1.00, 95%CI: 0.93, 1.09). Of the 2600 patients who lost persistence, 546 switched classes at least once during the study period. The most common switch from an oral index therapy was to a TNF-α inhibitor. The most common switch from a biologic was to a PDE4 inhibitor. A second switch was fairly uncommon, with 93 of 546 patients undergoing a second switch. Of 2600 patients who lost persistence, 1853 patients restarted their index medication class. The most commonly restarted oral medication class was PDE4 inhibitors (27.5% of all restarts), followed by folic acid antagonists (19.9%). TNF-α inhibitors were more frequently restarted than other biologics (32.2% versus 18.1% of all restarts).

CONCLUSION: Approximately half of all patients lost persistence, after which the majority restarted their index drug. More switches from orals to biologics were made than vice versa, with larger proportions of biologics constituting 2nd line treatment compared to 1st line treatment. More studies are needed to identify characteristics of patients that differentiate patterns of treatment utilization in US adult psoriasis patients.

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BACKGROUND

Psoriasis is a chronic autoimmune disease characterized by raised, red, scaly patches on the skin.[1] Symptoms are most commonly seen on the scalp, elbows, knees, hands, and feet, but may affect areas such as nails and soft tissues of the genitals.[2] Approximately 7.5 million adults in the United States are affected by psoriasis. The disease is associated with poor health outcomes, with an increased incidence of comorbidities including Crohn's disease, ulcerative colitis, lymphoma, heart disease, obesity, depression, suicide, and substance use.[2-4]
2009 guidelines from the American Academy of Dermatology (AAD) tailor the treatment of psoriasis based on the presence or absence of psoriatic arthritis, and severity of disease.[2] Severity is commonly determined by the Psoriasis Area and Severity Index (PASI), which incorporates the percentage of body surface area (BSA) affected and involvement of certain areas, such as hands, feet, facial, or genital regions.[2,5] Anti-tumor necrosis factor (TNF) biologics with or without methotrexate are indicated in psoriasis patients with comorbid psoriatic arthritis (PsA). For patients with limited disease and no psoriatic arthritis, topicals and targeted phototherapy are recommended. Phototherapy, systemic therapies, or biologics are recommended for patients with extensive disease.[2] Goals of treatment identified by the National Psoriasis Foundation are BSA involvement less than or equal to 3%, or BSA improvement 75% or greater from baseline at 3 months after treatment initiation.[6]
We conducted a review to examine the current landscape of the literature pertaining to treatment patterns in psoriasis. Of fourteen studies included in our analysis, thirteen investigated only biologics. We found that in all but one study, etanercept was the most frequently used biologic, followed by adalimumab. When comparing etanercept to adalimumab, we found consistently lower persistence and more gaps in therapy with etanercept. There was significant heterogeneity across studies in measurements of discontinuation, persistence, switching, restarting, and duration of use.[7-11] Currently, there is a gap in the evidence to evaluate treatment patterns of topical therapies, oral systemic agents, and phototherapy used in the treatment of adults with plaque psoriasis in the US. With emerging options for managing psoriasis in the past decade, it has become increasingly important to investigate current utilization patterns and the extent of use of available treatments.

OBJECTIVE

The primary objective of this study was to characterize psoriasis treatment patterns of oral systemic and biologic therapies in real-life settings. Specifically, we were interested in persistence, switching, and restarting, to psoriasis treatments. These patterns were then used to characterize first- and second-line treatment.

METHODS

Data Source

Study data were garnered from Truven Health MarketScan® Commercial Claims and Medicare Supplemental and Coordination of Benefits (COB) Databases during the period from January 1st, 2014 to December 31st, 2016. These databases provide person-specific utilization information across inpatient, outpatient, and prescription medication services. The commercial claims and encounters database includes data on active employees and dependents, non-Medicare retirees and dependents, and Consolidated Omnibus Budget Reconciliation Act (COBRA) continues. The Medicare Supplemental and COB includes coverage information on Medicare-eligible active and retired employees plus their Medicare-eligible dependents from employer-sponsored supplemental plans. Our analysis utilized inpatient and outpatient service tables as well as outpatient pharmaceutical claims tables to describe the treatment patterns of newly diagnosed psoriasis patients. Demographic characteristics were detailed in Enrollment Tables from a separate file. The inpatient and outpatient service databases contained claims information using both International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes, as well as its 10th revision (ICD-10-CM), Current Procedural Terminology (CPT) codes, dates of services rendered, and billing information. The relevant variables from the outpatient pharmaceutical claims were the National Drug Code (NDC) for psoriasis-related medications, days' supply, and date of service.

All data were de-identified to protect patient privacy in compliance with the Health Insurance Portability and Accountability Act of 1996 (HIPAA). The current study did not require IRB review and approval, as the University of Washington Human Subjects Division Institutional Review Board (IRB) determined that the study protocol did not meet the federal definition of "human subjects research."

Sample Selection

Our population of interest is adult psoriasis patients over 18 years old who are new users of oral and biologic systemic therapy. Inclusion and exclusion criteria were based on existing literature. To be included in our data set, subjects must be 18 years or older, have at least two diagnostic claims for psoriasis during a 12-month period on or before the date of the first psoriasis treatment, and at least 12 months of continuous medical and pharmacy benefit coverage prior to the first psoriasis treatment claim. We set the index date as the first oral or biologic psoriasis treatment claim in our study period. To identify new users, we imposed a washout period (pre-index duration of 12 months pre-index with no treatment) before the first-observed psoriasis oral or biologic treatment claim. We included patients with inflammatory comorbidities that may require similar biologic treatment (e.g. psoriatic arthritis, rheumatoid arthritis, Crohn's disease, ulcerative colitis, and ankylosing spondylitis) using ICD codes (Appendix 2). If the prevalence of the inflammatory comorbidity was greater than 10%, patients with that comorbidity were not excluded from the analysis. The Charlson Comorbidity Index (CCI) was also calculated for each individual using Quan's enhanced algorithm.[12] Evidence of receipt of therapeutic interventions administered to patients following psoriasis diagnosis were garnered from identifying relevant NDC's (Appendix 3). With the exceptions of infliximab and most phototherapy sessions, which were identified from inpatient claims, therapeutic interventions were identified from outpatient medical services and outpatient pharmaceutical claims. Treatments were categorized in classes as "PDE4 Inhibitors," "Vitamin A Derivatives," "Folic Acid Antagonists," "Calcineurin Inhibitors," "Fumaric Acid Esters," "TNF-α Inhibitors," and "Other Biologics." The two overall types were orals and biologics.

Persistence

Persistence to each medication was defined as continuous use from initiation to a >30-day gap between claims) for each class of treatment. We calculated time to loss of persistence as the 31st day since the start of the gap (Appendix 6). The 31st day was used as the date in which loss of persistence was observed because until they lose persistence, we include all prior gaps (<30) in our calculation of time, and the patient should not be penalized for the 30-day grace period that is a part of the definition of persistence. As long as the individual remained persistent on medications with the same class, we deemed them as persistent.

Switching

The first switch of a medication was defined as the initiation of a different class of treatment following index. To avoid misclassification as "adjunct" therapy, we assessed switching only in those who lost persistence to their index treatment. We identified the number of first switches from index, and what class of medication each individual switched to. The same was calculated for a second switch, only using a subset of those who experienced a first switch. The time in which a switch occurred was defined as the time since the date of loss of persistence.

Restarting

Restarting was defined as re-initiating index treatment following discontinuation of the same treatment. The first restart of a medication was characterized for all those who lost persistence.

Lines of Treatment

Lines of treatment were categorized as "first" and "second" line, where index drug class was considered first-line, and the drug class corresponding to a unique first switch was equivalent to second-line.

First Action Following Loss of Persistence

The above definitions of switching and restarting take all switches and restarts from index into account, but do not specify order after loss of persistence. Additionally, identifying lines of treatment does not take restarts into account. To provide more information on temporality and chronicle the most common actions taken after losing persistence on index, we identified the first occurrence of either a restart or a switch and calculated the numbers of patients undergoing each action by type and class.

Statistical Analyses

Descriptive statistics were used to characterize our outcomes of interest (i.e., persistence, switching, restarting). We presented the proportions of patients on each treatment type, and demographic variables were summarized using means and standard deviations.

We calculated proportions of those persistent on index by treatment class. In order to account for censoring due end of study period and disenrollment, survival analysis was conducted to examine time to loss of persistence at the within-class level. Kaplan-Meier estimates of survival probabilities including cumulative incidence of loss of persistence at 12 months, and median time-to-loss of persistence in days with corresponding 95% confidence intervals (CI) were calculated to illustrate persistence. We characterized persistence both at the within-class-level and type-level. We fit unadjusted and adjusted Cox proportional hazards regression models with censored time to loss of persistence as the response and overall treatment class (orals versus biologics) as the predictor of interest. The adjusted model included CCI score, age, region of residence, and employment status as covariates of interest. The covariates were tested for collinearity using the variance inflation factor (VIF) test. Statistical inference on the hazard ratio for loss of persistence was based on a Wald statistic. P-values and confidence intervals were assessed at a significance level of 0.05.

We reported proportions of patients who underwent switching for each drug class and identified the two most common switches and lines of treatment. Median survival and 25th percentiles with 95% CI were characterized for the first switch. Similarly, we calculated the proportion of patients who underwent one restart and the median time to restart with a 95% CI. All analyses accounted for censoring by end of study period, death, and patient-specific end of continuous enrollment.

RESULTS

A total of 5933 patients were identified to be at least 18 years old, were new initiators of oral or biologic treatment, and had at least two psoriasis diagnostic claims as well as 12 months of continuous medical and pharmacy benefit coverage before their index date. Of the 5933 that were identified, 2216 (37.3%) had comorbid psoriatic arthritis. Rheumatoid arthritis had the second highest prevalence in this population at 8.8%. Crohn's disease, ulcerative colitis, and ankylosing spondylitis were prevalent in 1.2% or 1% of our population. After excluding those with all inflammatory comorbidities except psoriatic arthritis, 5281 patients were included in the analysis.

Population Characteristics

Our total population consisted of 2692 (51%) females, with most patients (47.3%) residing in the Southern geographic region. 66.8% were employed. The mean CCI was 0.71 (standard deviation = 1.44). 53.7% of all patients were on concomitant topical therapy, while 5.5% were on concomitant phototherapy. Of 5281 patients, 3335 (63.2%) of patients initiated oral systemic therapy during our study period, while 2226 (42.2%) and 1055 (20.0%) initiated TNF-α and other biologics, respectively. Concomitant topical therapy use was a little over half of the population, ranging from 53.0% to 58.0% for the three categories of index medication. Table 1a illustrates the breakdown of characteristics by index treatment type. Table 2a shows demographic characteristics by comorbidity.

Persistence

Of the total 5281 patients in our sample, 2600 lost persistence on index. Patients whose index medication was a non-TNF-α biologic experienced the most loss of persistence, in which 394, or 71.4% of these patients lost persistence (Table 2a). The "other biologics" class also had the highest cumulative incidence of loss of persistence (69.4%, 95% CI: 65.2%, 73.1%) at 12 months. The class with the second-highest loss of persistence was Vitamin A derivatives, with 63.5% of patients experiencing a loss of persistence. Longest duration of use, as indicated by the longest mean and median times until loss of persistence, were for PDE4 inhibitors for oral drugs (143.0±118.7 and 85 days, respectively), and TNF-α inhibitors for biologics (164.4±121.9 and 115 days, respectively). When comparing orals to biologics in general, proportions of those that lost persistence on index were similar: 47.8% of those on orals and 51.2% on biologics lost persistence (Table 2b). The mean time-to-persistence loss was lower in orals than in biologics (129.3±110.4 and 153.3±116.8, respectively). Median time to lose persistence was 61 days for orals and 115 days for biologics. By twelve months, the majority of those who had lost persistence for the first time on index during the study period had lost persistence.

Survival analyses showed folic acid antagonists as exhibiting the highest median persistence at 654 days (95% CI: 405 to infinity). TNF-α inhibitors had a similar median survival at 601 days (95% CI: 460 days, infinity). In contrast, the shortest median persistence was for Vitamin A derivatives, at 61 days (95% CI: 61 days, 167 days). Kaplan-Meier curves with loss of persistence as the event of interest are shown in Figure 1. The curves show sharp drop-offs in persistence at approximately 90 days for all classes, regardless of type.

Results from the regressions are presented in Table 2c. The likelihood of losing persistence as evidenced by the hazard ratio did not differ between oral and biologic classes after adjusting for covariates (adjusted HR: 1.00; 95% CI: 0.93, 1.09; *p*-value=0.92). The VIF test to assess multicollinearity between covariates in the Cox regression model indicated no major collinearity. Adjustment for covariates did not alter the hazard for loss of persistence based on treatment type.

Switching

546 of 2600 patients who lost persistence to index underwent at least one switch during the study period (Table 3a). Patients on folic acid antagonists as index constituted the largest proportion of switches, accounting for 38.8% of all first switches. The vast majority of those who began treatment on a folic acid antagonist switched to a TNF-α inhibitor (158 of 212). Those with TNF-α inhibitors as index had the second highest proportion of switches (25.5%), with switches to other biologics, PDE4 inhibitors, and folic acid antagonists. PDE4 inhibitors accounted for 20.9% of all first switches. For those whose index was an oral therapy, the highest number of switches were to TNF-α inhibitors, constituting 228 of 357 total switches (Table 3b, Figure 2a). For those who initiated treatment on biologics, the highest proportion of switches were to oral PDE4 inhibitors (71 of 189 switches), then to other biologics (64 of 189 switches) (Table 3b, Figure 2b). Regardless of how we defined the time in which the switch occurred (time since index versus time since loss of persistence), mean and median times to switch were similar and highest among PDE4 inhibitors and the two biologics classes.

Median non-switching represents the time in which 50% of subjects were expected to survive, or not undergo a switch. However, some drug classes had never gone below 50% survival by the end of the study period, making median survival a less meaningful measure in evaluating times to switch. Therefore, we reported the 25th percentile alongside the median. The longest lower quartile survival after losing persistence on index for orals was in the PDE4 inhibitor class, with 342 days (95% CI: 252 days, 396 days) in the 25th percentile. For biologics, other biologics had longer survival, with 516 days (95% CI: 408 days, infinity) in the 25th percentile. When comparing orals to biologics, biologics had longer non-switching days, with median non-switching at 630 days (95% CI: 630, infinity) and 25th percentile at 375 days (95% CI: 356 days, 419 days). Kaplan-Meier curves show similar overall patterns in which PDE4 inhibitors and both biologics classes had less instances of switching and more gradual times to switch (Figures 4, 5).

Restarting

The total number of patients who restarted their index medication class after losing persistence was 1853. The most common restarted oral therapy was the PDE4 inhibitor class, with 510 restarts (27.5% of all restarts). The most common biologic restart was the TNF-α inhibitor class (596, 32.2%). Mean and median times to restart followed similar patterns. The longest median time to restart since start of index was the folic acid antagonist class for orals (237.0±131.8 days), and TNF-α inhibitors for biologics (242.3±139.1 days). Median time to restart since loss of persistence for all classes fell under 34-days.

Median non-restarting represents the time in which half of the population is estimated to have not restarted. Estimates and the associated Kaplan-Meier curve showed longest median survival with folic acid antagonists (219, 95%CI: 199, 239 days) for orals and TNF-α inhibitors (231, 95%CI: 216, 250 days) for biologics.

Lines of Treatment

TNF-α inhibitors were proportionally the most common first- and second-line treatment options overall, accounting for 31.2% and 51.2% of treatment in each line, respectively (Table 5, Figure 6). The most common first-line oral systemic therapy was folic acid antagonists (27.8%), followed closely by PDE4 inhibitors (27.0%). PDE4 inhibitors followed TNF-α inhibitors as common second-line treatment (22.6%). Fumaric acid esters, vitamin A derivatives, and calcineurin inhibitors were the least common types of treatment in either line. Other biologics accounted for 10.5% of first-line and 16.8% of second-line treatment.

First Action Following Loss of Persistence

For both types and all classes of index treatment, the most common action to occur after loss of persistence was a restart (Figures 7-9). Of those who restarted as a first occurrence, nearly half lost persistence after initiating the restart. Those whose index was an oral medication most commonly switched to TNF-α inhibitors, while those whose index was a biologic most commonly switched to PDE4 inhibitors.

DISCUSSION

Our results showed that PDE4 inhibitors and TNF-α inhibitors accounted for the highest fraction of all first- and second-line treatments, exhibited the longest persistence, and were among the most common classes that individuals switched to or restarted after loss of persistence. Folic acid antagonists followed similar patterns to PDE4 inhibitors for persistence and as a common first-line agent. Approximately half of our patients discontinued their index class, with the majority of persistence loss occurring by 12 months. The sharp drops in persistence at approximately 90 days is consistent with established induction periods of 12 to 16 weeks for various systemic psoriasis treatments. Despite average time-to-lose persistence being higher in biologics than in orals, suggesting better persistence on biologics, our regression results indicate that treatment type has negligible effect on persistence. This null finding could be due to a variety of patient-specific factors we were unable to adjust for, including severity of disease, reasons for discontinuation, and duration of disease.

Our findings of switching patterns between orals and biologics are supported by a previous study conducted in Italy, demonstrating more switches occurring from orals to biologics than vice versa.[13] Regardless of our definition of time in calculating time-to-switch, individuals whose index was PDE4 inhibitors, TNF-α inhibitors, or other biologics, experienced the longest average times-to-switch. The index medication class exhibiting the earliest mean restart after losing persistence was PDE4 inhibitors (43.8±70.0 days) for orals and TNF-α inhibitors for biologics (57.7±87.2 days).

To date, one study has investigated treatment patterns of orals and biologics in US adult psoriasis patients.[14] The analyses were conducted at the active-ingredient level for topical therapies, phototherapy, orals, and biologics, in systemic-naïve, moderate-to-severe psoriasis patients from 2007 to 2012. However, persistence was calculated only for biologics. Similar to our results, this study found longer persistence with TNF-α inhibitors, particularly infliximab and adalimumab, compared to other biologics. The authors also found the most common oral index treatment to be methotrexate, a folic acid antagonist. Our study indicated PDE4

inhibitors and folic acid antagonists as nearly equally distributed as first-line treatment. This difference in finding is likely due to the study period precluding the 2014 FDA-approval of PDE4 inhibitors for psoriasis. Authors observed higher proportions of biologic use in later lines of therapy, which was also seen in our analysis. Major differences in characterizing treatment patterns were the study's use of a longer grace period in defining loss of persistence (61 days), and its capture of treatment by month. Treatment was assessed on a monthly basis, assuming standard durations by medication class, instead of actual days' supply.

Strengths and Limitations

Current literature investigating treatment patterns in psoriasis compares TNF-α inhibitors within the same class (i.e., etanercept, adalimumab, infliximab), or with ustekinumab. Our study offers insight to the dynamics of psoriasis treatments through time and for a broader range of treatment options. It is the first to evaluate persistence, switching, restarting, and lines of treatment between classes of oral and biologic therapies, inclusive of PDE4 inhibitors and a variety of non-TNF-α inhibitor biologics. The use of real-world claims and days' supply, evaluation of various outcomes across oral and biologic classes, combined with more recent data, updates the current limited understanding of treatment patterns in psoriasis. Another strength of this study is the use of all available data. Rather than estimating persistence and survival with fixed periods of observation, we took advantage of three years' worth of patient information.

We shared the same limitations common to most retrospective claims studies, in which we were unable to confirm true uptake by patients nor assess the effect of disease severity on our outcomes. Additionally, because MarketScan databases do not include information on death, the censored individuals in our study could have either been lost to follow-up, or died. Reasons to discontinue or lose persistence, switch, or restart are also left for speculation. One study investigated commonly reported reasons for discontinuation of select medications used in moderate-to-severe psoriasis.[15] Reported reasons for discontinuation included lack of efficacy as well as improvement, further complicating the clinical interpretation of persistence. The most frequently reported reasons differed by treatment class. While less than 6% of patients on etanercept or adalimumab reported discontinuation due to clinical improvement, 12% to 18% of patients on the oral therapies in the study (methotrexate, acitretin, and cyclosporine) reported improvement as the primary reason for discontinuation. Conflicting reasons and the lack of understanding why patients discontinue or change therapies cloud the clinical applicability of treatment pattern results. However, patterns of utilization can provide insight on what treatments patients tend to tolerate. Additionally, switching patterns are likely more indicative of failed therapy, while short times to restarting suggest poor compliance.

Future Directions

Future steps include characterizing persistence on second-line treatment, evaluating adherence, patterns in the active-ingredient level, and identifying the most common third-line therapies. Subgroup analyses comparing those who do and do not have psoriatic arthritis should be conducted to evaluate the effect of compelling indications for biologics. Finally, use of more comprehensive data sources with linked clinical information or survey data to elucidate patient characteristics who differ in utilization can better inform decision-making.

CONCLUSION

This retrospective claims study found approximately half of patients lose persistence on index treatment on an oral or biologic, with highest persistence found in PDE4 inhibitors, TNF-α inhibitors, and folic acid antagonists. Treatment type did not seem to dictate persistence. Most individuals restarted their index medication after losing persistence, within a short amount of time. Oral therapy to TNF-α inhibitors was the most frequently observed switch. Further studies must be conducted to identify characteristics for better clinical outcomes and compliance.

TABLES AND FIGURES

Table 1a. Demographic Characteristics

Characteristic	Patients with Psoriasis and/or Psoriatic Arthritis (n=5281, 89.0% of 5933 total)	Patients on Oral Systemic Therapy (n=3335, 63.2% of 5281)	Patients on TNF Biologics (n=2226, 42.2% of 5281)	Patients on Other Biologics (n=1055, 20.0% of 5281)
Age, Mean ± SD	48.6±13.5	50.2±13.4	46.4±12.7	47.3±12.3
Female Sex, N (%)	2692 (51.0%)	1835 (55.0%)	1042 (46.8%)	519 (49.2%)
Geographic Residence, N (%)				
Northeast	1017 (19.3%)	709 (21.3%)	319 (14.3%)	198 (18.8%)
North Central	1040 (19.7%)	711 (21.3%)	408 (18.3%)	176 (16.7%)
South	2500 (47.3%)	1481 (44.4%)	1189 (53.4%)	530 (50.2%)
West	714 (13.5%)	426 (12.8%)	307 (13.8%)	149 (14.1%)
Unknown	10 (0.2%)	8 (0.2%)	3 (0.1%)	2 (0.2%)
Employment Status, N (%)				
Employed	3526 (66.8%)	2152 (64.5%)	1577 (70.8%)	765 (72.5%)
Other	1755 (33.2%)	1183 (35.5%)	649 (29.2%)	290 (27.5%)
CCI, Mean ± SD	0.71±1.44	0.79±1.53	0.59±1.26	0.61±1.26
Patients on concomitant topical therapy, N (%)	2836 (53.7%)	1934 (58.0%)	1179 (53.0%)	595 (56.4%)
Patients on concomitant phototherapy, N (%)	290 (5.5%)	225 (6.7%)	92 (4.1%)	50 (4.7%)

Table 1b. Demographic Characteristics by Comorbidity

Characteristic	All Patients (n= 5933)	Patients with No Inflammatory Comorbidity (n=3527, 59.5% of total)	Patients with Comorbid Psoriatic Arthritis (n= 2216, 37.3% of total)	Patients with Comorbid Rheumatoid Arthritis (n= 519, 8.8% of total)	Patients with Comorbid Crohn's Disease (n=68, 1.2% of total)	Patients with Comorbid Ulcerative Colitis (n=72, 1.2% of total)	Patients with Comorbid Ankylosing Spondylitis (n=60, 1.0% of total)
Age, Mean ± SD	48.89±13.45	48.2±13.9	49.9±12.4	52.3±12.6	45.0±13.7	48.6±13.7	48.4±12.2
Female Sex, N (%)	3109 (52.4%)	1725 (48.9%)	1254 (56.6%)	346 (66.7%)	43 (63.2%)	43 (59.7%)	31 (51.7%)
Geographic Residence, N (%)							
Northeast	1157 (19.5%)	701 (19.9%)	421 (19.0%)	115 (22.2%)	12 (17.7%)	15 (20.8%)	9 (15.0%)
North Central	1142 (19.3%)	698 (19.8%)	409 (18.5%)	87 (16.8%)	6 (8.8%)	12 (16.7%)	8 (13.3%)
South	2826 (47.6%)	1664 (47.2%)	1069 (48.2%)	254 (49.0%)	41 (60.3%)	36 (50.0%)	32 (53.3%)
West	796 (13.4%)	455 (12.9%)	315 (14.2%)	61 (11.8%)	9 (13.2%)	9 (12.5%)	11 (18.3%)
Unknown	12 (0.2%)	9 (0.3%)	2 (0.1%)	2 (0.4%)	0	0	0
Employment Status, N (%)							
Employed	3927 (66.2%)	2374 (67.3%)	1434 (64.7%)	306 (59.0%)	48 (70.6%)	49 (68.1%)	40 (66.7%)
Other	2006 (33.8%)	1153(32.7%)	782 (35.3%)	213 (41.0%)	20 (29.4%)	23 (31.9%)	2 (33.3%)
CCI, Mean ± SD	0.80±1.50	0.67±1.39	0.95±1.60	1.66±1.79	0.69±1.00	1.01±1.95	0.82±0.97
Patients on topical therapy, N (%)	3119 (52.6%)	1975 (56.0%)	1062 (47.9%)	217 (41.8%)	33 (48.5%)	36 (50.0%)	20 (33.3%)
Patients on phototherapy, N (%)	316 (5.3%)	221 (6.3%)	88 (4.0%)	22 (4.2%)	2 (2.9%)	3 (4.2%)	1 (1.7%)
Patients on oral therapy, N (%)	3775 (63.6%)	2173 (61.6%)	1488 (67.2%)	376 (72.5%)	29 (42.7%)	35 (48.6%)	33 (55.0%)
Patients on TNF biologics, N (%)	2524 (42.5%)	1339 (38.0%)	1099 (49.6%)	216 (41.6%)	41 (60.3%)	44 (61.1%)	35 (58.3%)
Patients on other biologics, N (%)	1147 (19.3%)	765 (21.7%)	359 (16.2%)	66 (12.7%)	16 (23.5%)	12 (16.7%)	12 (20.0%)

Table 2a. Within-Class Persistence

Drug	Lost Persistence on Index N (%)	Cumulative Incidence of Loss of Persistence at 12 months N (probability of lost persistence) [95% CI]	Time-to-Loss of Persistence (days)		Median Survival (days): Loss of Persistence [95% CI]	Lower quartile (25th percentile) Survival (days): Loss of Persistence [95% CI]	Median Survival (days): Switch 1 (Time: Since loss of persistence) [95% CI]	Lower quartile (25th percentile) Survival (days): Switch 1 (Time: Since loss of persistence) [95% CI]
			Mean ± SD	Median				
Oral Systemic Therapy								
PDE4 Inhibitor (n=1424)	691 (48.5%)	637 (47.0%) [44.3%, 50.0%]	143.0±118.7	85	441 [374, 571]	88 [69, 103]	614 [589, NA]	342 [252, 396]
Vitamin A Derivative (n=104)	66 (63.5%)	66 (65.1%) [54.3%, 73.3%]	78.6±38.0	61	61 [61, 167]	61 [61, 61]	336 [145, NA]	52 [32, 274]
Folic Acid Antagonist (n=1470)	673 (45.8%)	640 (46.0%) [43.3%, 48.6%]	122.6±105.6	61	654 [405, NA]	66 [61, 91]	379 [247, 465]	52 [34, 95]
Calcineurin Inhibitor (n=77)	40 (51.9%)	39 (52.1%) [39.1%, 62.4%]	90.6±76.4	61	308 [91, NA]	61 [61, 88]	149 [86, NA]	28 [-26, 208]
Fumaric Acid Ester (n=5)	2 (40.0%)	2 (40%) [0%, 70.7%]	61±0	61	NA [61, NA]	61 [61, NA]	171 [NA, NA]	171 [NA, NA]
Biologics								
TNF-α Inhibitor (n=1649)	734 (44.5%)	670 (43.9%) [41.3%, 46.3%]	164.4±121.9	115	601 [460, NA]	130 [115, 147]	630 [544, NA]	356 [289, 385]
Other Biologics (n=552)	394 (71.4%)	371 (69.4%) [65.2%, 73.1%]	132.7±103.6	92	121 [115, 146]	66 [61, 84]	NA [NA, NA]	516 [408, NA]

Table 2b. Persistence on Orals and Biologics

Drug	**Lost Persistence on Index** N (%)	**Cumulative Incidence of Loss of Persistence at 12 months** N (%) [95% CI]	**Time-to-Loss of Persistence (days)**		**Median Survival (days):** Loss of Persistence [95% CI]	**Lower quartile (25th percentile) Survival (days):** Loss of Persistence [95% CI]	**Median Survival (days): Switch 1** (Time: Since loss of persistence) [95% CI]	**Lower quartile (25th percentile) Survival (days): Switch 1** (Time: Since loss of persistence) [95% CI]
			Mean ± SD	Median				
Orals **(n=3080)**	1472 (47.8%)	1380 (47.3%) [45.4%, 49.1%]	129.3±110.4	61	456 [384, 574]	66 [61, 85]	509 [465, 589]	151 [122, 179]
Biologics **(n=2201)**	1128 (51.2%)	1040 (50.4%) [48.2%, 52.6%]	153.3±116.8	115	347 [303, 406]	110 [95, 115]	630 [630, NA]	375 [356, 419]

Table 2c. Cox Regression Results on Persistence

Drug Class	Unadjusted model			Adjusted model[a]		
	Hazard Ratio	95% CI	*p*-value	Hazard Ratio	95% CI	*p*-value
Biologics	1.05	0.98, 1.14	0.19	1.00	0.93, 1.09	0.92

[a]Adjusted for baseline demographic variables: CCI score, age, region of residence, employment status

Table 3a. Between-Class Switching

Drug	Switch 1 (n=546) N (% *all* switch 1's, 546) (% index-specific switches)	Switch 2 (n=93) N (% *all* switch 2's, 93) (% index-specific switches)	Time-to-Switch 1 (days) Since start of index (Since loss of persistence)		Median Survival (days): Switch 1 (Time: Since start of index) [95% CI]	Lower quartile (25th percentile) Survival (days): Switch 1 (Time: Since start of index) [95% CI]
			Mean ± SD	Median		
Index Oral Systemic Therapy						
PDE4 Inhibitor	114 (20.9%) (16.5% of 691 who lost persistence to PDE4) Switched to: N Vitamin A Derivative 1 Folic Acid Antagonist 11 Calcineurin Inhibitor 1 Fumaric Acid Ester 0 TNF-α Inhibitor 55 Other Biologics 46	17 (18.3%) (14.9% of 114 who had one switch from PDE4) Switched to: N Vitamin A Derivative 1 Folic Acid Antagonist 3 Calcineurin Inhibitor 0 Fumaric Acid Ester 0 TNF-α Inhibitor 2 Other Biologics 11	256.3±163.6 (145.5±145.9)	239 (123)	NA [NA, NA]	500 [434, 659]
Vitamin A Derivative	17 (3.1%) (25.8% of 66 who lost persistence to Vitamin A) Switched to: N PDE4 Inhibitor 8 Folic Acid Antagonist 1 Calcineurin Inhibitor 1 Fumaric Acid Ester 0 TNF-α Inhibitor 7 Other Biologics 0	5 (5.4%) (29.4% of 17 who had one switch from Vitamin A) Switched to: N PDE4 Inhibitor 1 Folic Acid Antagonist 1 Calcineurin Inhibitor 0 Fumaric Acid Ester 0 TNF-α Inhibitor 1 Other Biologics 2	205.5±143.3 (114.4±121.5)	168 (52)	397 [249, NA]	168 [105, 335]
Folic Acid Antagonist	212 (38.8%) (31.5% of 673 who lost persistence to FAA) Switched to: N PDE4 Inhibitor 39 Vitamin A Derivative 0 Calcineurin Inhibitor 1 Fumaric Acid Ester 1 TNF-α Inhibitor 158	43 (46.2%) (20.3% of 212 who had one switch from FAA) Switched to: N PDE4 Inhibitor 8 Vitamin A Derivative 0 Calcineurin Inhibitor 1 Fumaric Acid Ester 0 TNF-α Inhibitor 5	204.0±162.6 (94.9±139.1)	159 (44.5)	524 [464, NA]	189 [154, 234]

<table>
<tr><td></td><td><table><tr><td>Other Biologics</td><td>13</td></tr></table></td><td><table><tr><td>Other Biologics</td><td>29</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Calcineurin Inhibitor</td><td>13 (2.4%)
(32.5% of 40 who lost persistence to Calc)<table><tr><td>Switched to:</td><td>N</td></tr><tr><td>PDE4 Inhibitor</td><td>3</td></tr><tr><td>Vitamin A Derivative</td><td>0</td></tr><tr><td>Folic acid Antagonist</td><td>1</td></tr><tr><td>Fumaric Acid Ester</td><td>0</td></tr><tr><td>TNF-α Inhibitor</td><td>7</td></tr><tr><td>Other Biologics</td><td>2</td></tr></table></td><td>3 (3.2%)
(23.1% of 13 who had one switch from Calc)<table><tr><td>Switched to:</td><td>N</td></tr><tr><td>PDE4 Inhibitor</td><td>1</td></tr><tr><td>Vitamin A Derivative</td><td>0</td></tr><tr><td>Folic acid Antagonist</td><td>0</td></tr><tr><td>Fumaric Acid Ester</td><td>0</td></tr><tr><td>TNF-α Inhibitor</td><td>1</td></tr><tr><td>Other Biologics</td><td>1</td></tr></table></td><td>163±144.1
(74±120.1)</td><td>119
(58)</td><td>286 [147, NA]</td><td>104 [22, 286]</td></tr>
<tr><td>Fumaric Acid Ester</td><td>1 (0.2%)
(50% of 2 who lost persistence to Fum Acid)<table><tr><td>Switched to:</td><td>N</td></tr><tr><td>PDE4 Inhibitor</td><td>0</td></tr><tr><td>Vitamin A Derivative</td><td>0</td></tr><tr><td>Folic Acid Antagonist</td><td>0</td></tr><tr><td>Calcineurin Inhibitor</td><td>0</td></tr><tr><td>TNF-α Inhibitor</td><td>1</td></tr><tr><td>Other Biologics</td><td>0</td></tr></table></td><td>0</td><td>NA</td><td>NA</td><td>232 [NA, NA]</td><td>232 [NA, NA]</td></tr>
<tr><td colspan="7">Index Biologic Therapy</td></tr>
<tr><td>TNF-α Inhibitor</td><td>139 (25.5%)
(18.9% of 734 who lost persistence to TNF)<table><tr><td>Switched to:</td><td>N</td></tr><tr><td>PDE4 Inhibitor</td><td>51</td></tr><tr><td>Vitamin A Derivative</td><td>0</td></tr><tr><td>Folic Acid Antagonist</td><td>22</td></tr><tr><td>Calcineurin Inhibitor</td><td>1</td></tr><tr><td>Fumaric Acid Ester</td><td>1</td></tr><tr><td>Other Biologics</td><td>64</td></tr></table></td><td>21 (22.6%)
(15.8% of 139 who had one switch from TNF)<table><tr><td>Switched to:</td><td>N</td></tr><tr><td>PDE4 Inhibitor</td><td>2</td></tr><tr><td>Vitamin A Derivative</td><td>1</td></tr><tr><td>Folic Acid Antagonist</td><td>7</td></tr><tr><td>Calcineurin Inhibitor</td><td>1</td></tr><tr><td>Fumaric Acid Ester</td><td>0</td></tr><tr><td>Other Biologics</td><td>10</td></tr></table></td><td>298.5±176.6
(166.5±157.7)</td><td>283
(111)</td><td>NA [696, NA]</td><td>499 [454, 606]</td></tr>
<tr><td>Other biologics</td><td>50 (9.2%)
(12.7% of 394 who lost persistence to Other Biologics)<table><tr><td>Switched to:</td><td>N</td></tr><tr><td>PDE4 Inhibitor</td><td>20</td></tr><tr><td>Vitamin A Derivative</td><td>1</td></tr><tr><td>Folic Acid Antagonist</td><td>13</td></tr><tr><td>Calcineurin Inhibitor</td><td>1</td></tr></table></td><td>4 (4.3%)
(8.0% of 50 who had one switch from Other Biologics)<table><tr><td>Switched to:</td><td>N</td></tr><tr><td>PDE4 Inhibitor</td><td>0</td></tr><tr><td>Vitamin A Derivative</td><td>0</td></tr><tr><td>Folic Acid Antagonist</td><td>1</td></tr><tr><td>Calcineurin Inhibitor</td><td>0</td></tr></table></td><td>293.8±144.8
(172.6±146.4)</td><td>296
(162.5)</td><td>NA [NA, NA]</td><td>631 [559, NA]</td></tr>
</table>

	Fumaric Acid Ester	0		Fumaric Acid Ester	0				
	TNF-α Inhibitor	15		TNF-α Inhibitor	3				

Table 3b. Switching on Index Orals and Biologics

Drug	**Switch 1 (n=546)** N (% of *all* switch 1's, 546)	**Switch 2 (n=93)** N (% of *all* switch 2's, 93)	**Time-to-Switch 1 (days)** Since start of index (Since loss of persistence)		**Median Survival (days): Switch 1** (Time: Since start of index) [95% CI]	**Lower quartile (25th percentile) Survival (days): Switch 1** (Time: Since start of index) [95% CI]
			Mean ± SD	Median		
Orals	357 (65.4%) Switched to: N PDE4 Inhibitor 50 Vitamin A Derivative 1 Folic acid Antagonist 13 Calcineurin Inhibitor 3 Fumaric Acid Ester 1 TNF-α Inhibitor 228 Other Biologics 61	68 (73.1%) Switched to: N PDE4 Inhibitor 10 Vitamin A Derivative 1 Folic acid Antagonist 4 Calcineurin Inhibitor 1 Fumaric Acid Ester 0 TNF-α Inhibitor 9 Other Biologics 43	219.4±162.8 (111.5±141.3)	182 (58)	674 [636, NA]	295 [258, 351]
Biologics	189 (34.6%) Switched to: N PDE4 Inhibitor 71 Vitamin A Derivative 1 Folic acid antagonist 35 Calcineurin Inhibitor 2 Fumaric Acid Ester 1 TNF-α Inhibitor 15 Other Biologics 64	25 (26.9%) Switched to: N PDE4 Inhibitor 2 Vitamin A Derivative 1 Folic acid antagonist 8 Calcineurin Inhibitor 1 Fumaric Acid Ester 0 TNF-α Inhibitor 3 Other Biologics 10	297.3±168.4 (168.1±154.5)	292 (116)	NA [698, NA]	Switch 1: 566 [499, 637]

Table 4. Between-Class Restarting (first restart)

Drug	**Total number of patients who restarted after losing persistence (n= 1853)** N (%)	**Time-to-Restart 1 (days)** Since start of index (Since loss of persistence)		**Median Survival (days): Restart 1** (Time: Since loss of persistence) [95% CI]
		Mean ± SD	Median	
Oral Systemic Therapy				
PDE4 Inhibitor	510 (27.5%)	212.5±131.3 (43.8±70.0)	176 (21)	180 [166, 198]
Vitamin A Derivative	25 (1.3%)	160.7±89.7 (60.4±76.2)	127 (24)	127 [107, 214]
Folic Acid Antagonist	369 (19.9%)	237.0±131.8 (64.1±83.4)	219 (29)	219 [199, 239]
Calcineurin Inhibitor	17 (0.9%)	175.8±106.8 (52.8±63.2)	134 (27)	136 [105, 312]
Fumaric Acid Ester	0 (0%)	NA	NA	NA
Biologics				
TNF-α Inhibitor	596 (32.2%)	242.3±139.1 (57.7±87.2)	217.5 (23)	231 [216, 250]
Other biologics	336 (18.1%)	201.9±123.1 (61.3±73.6)	149 (33.5)	173 [144, 192]

Table 5. Lines of Treatment

Drug	**First-Line (n=5281)** N (%)	**Second-Line (n= 208)** N (%)
Oral Systemic Therapy		
PDE4 Inhibitor	1424 (27.0%)	47 (22.6%)
Vitamin A Derivative	104 (2.0%)	1 (0.5%)
Folic Acid Antagonist	1470 (27.8%)	16 (7.7%)
Calcineurin Inhibitor	77 (1.5%)	2 (1.0%)
Fumaric Acid Ester	5 (0.1%)	0 (0%)
Biologics		
TNF-α Inhibitor	1649 (31.2%)	107 (51.4%)
Other biologics	552 (10.5%)	35 (16.8%)

Figure 1. Kaplan-Meier Curves for Persistence on Index

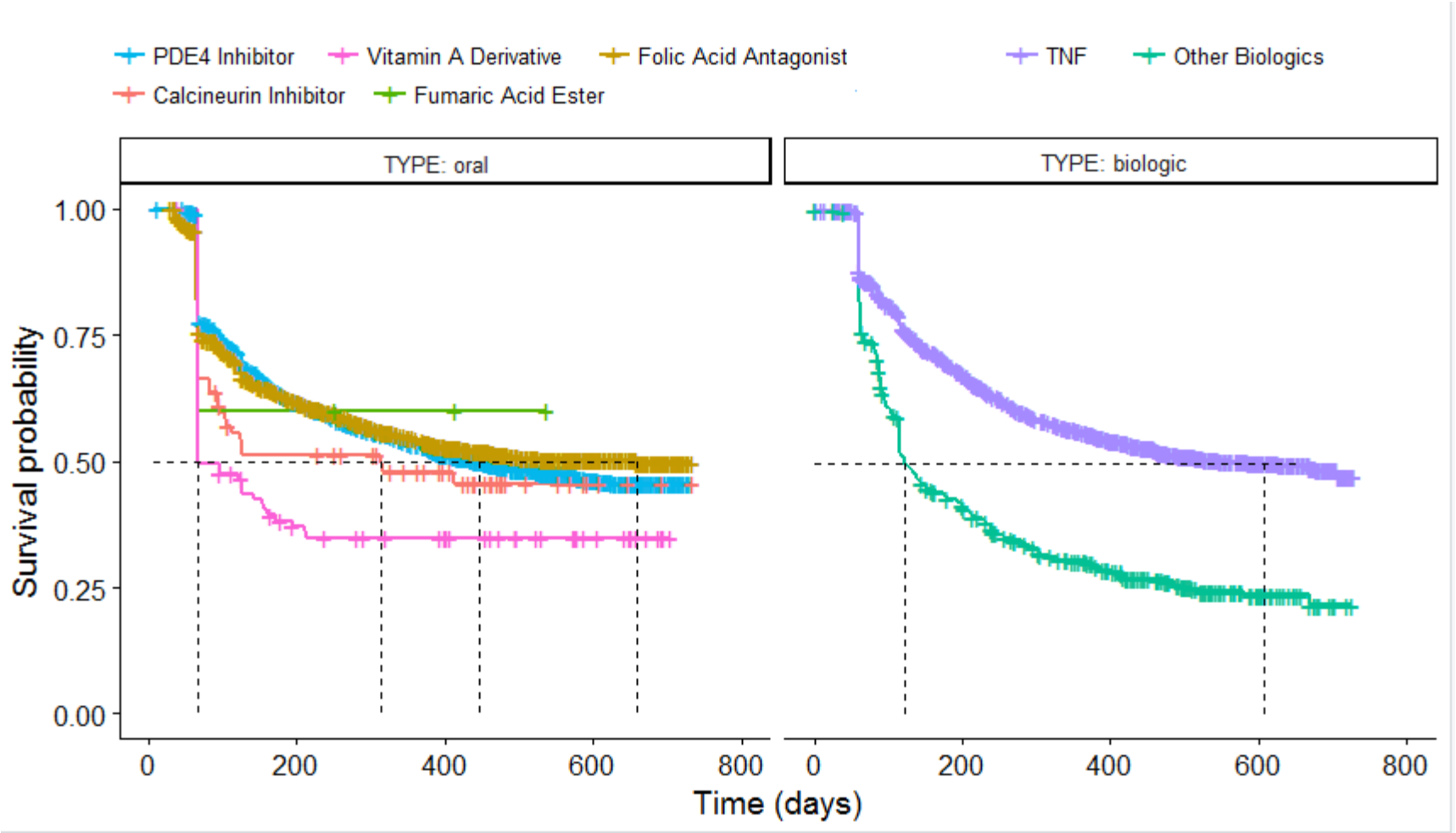


Figure 2a. Oral Index: Drug Types of First Switch

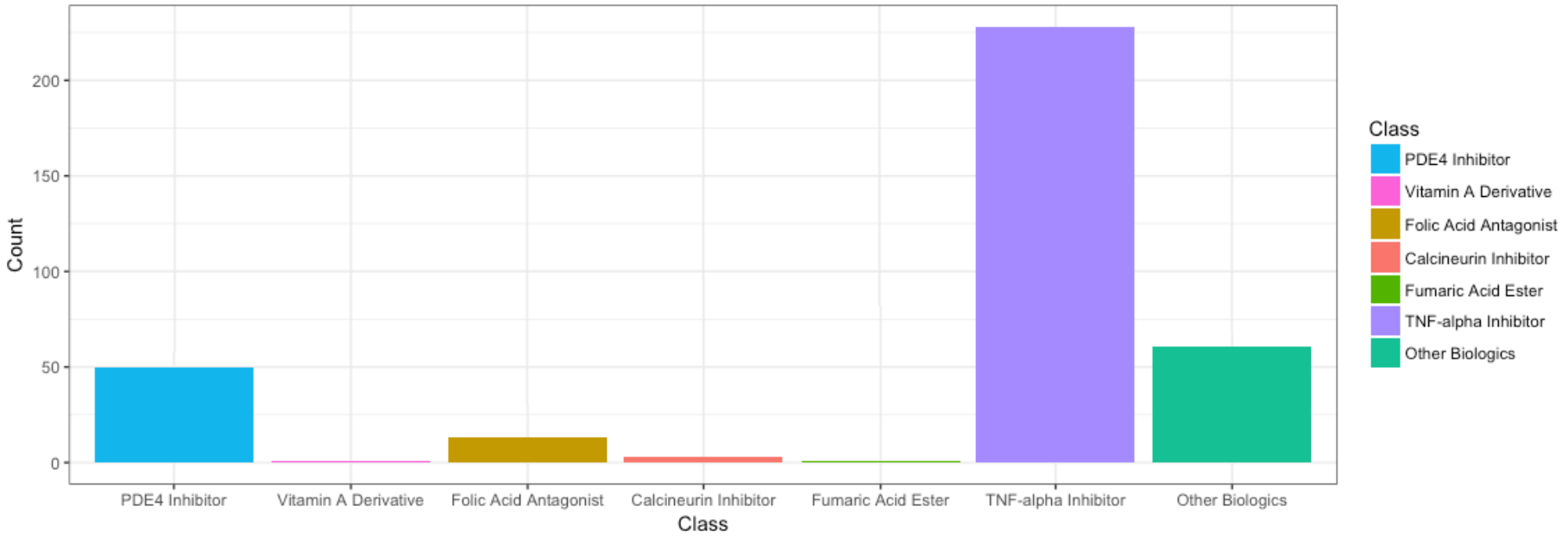


Figure 2b. Biologic Index: Drug Types of First Switch

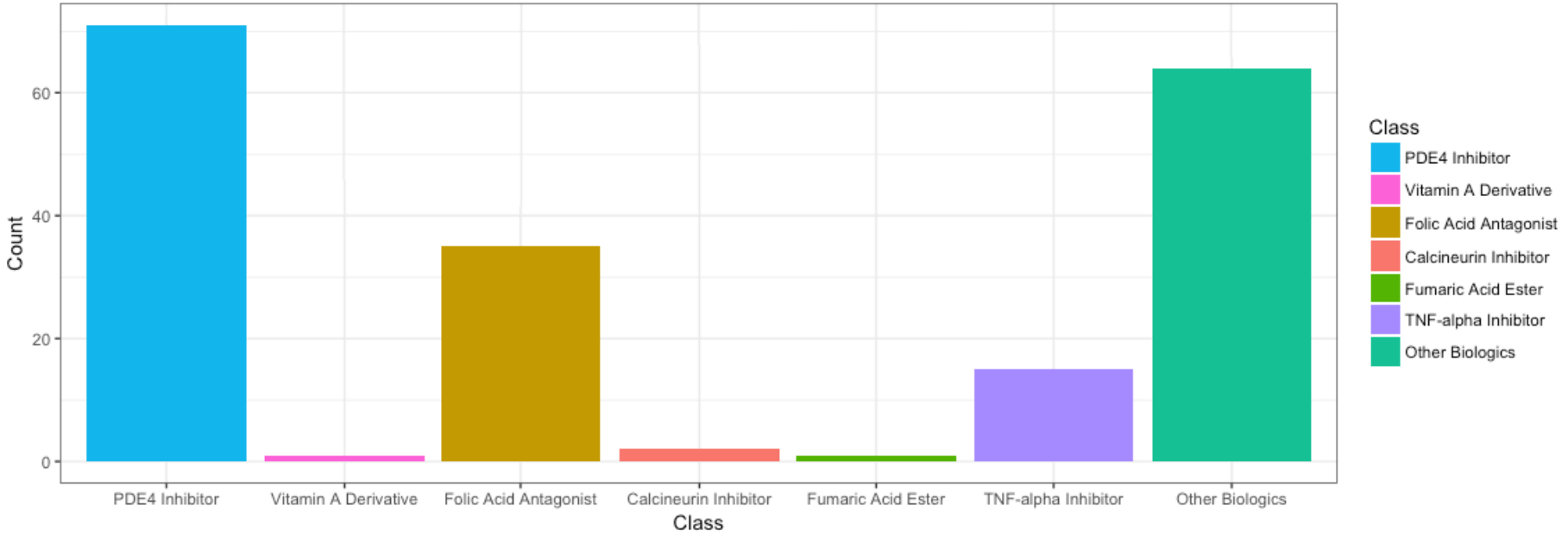


Figure 3. Kaplan-Meier Curves for First Switch (Time Since Loss of Persistence)

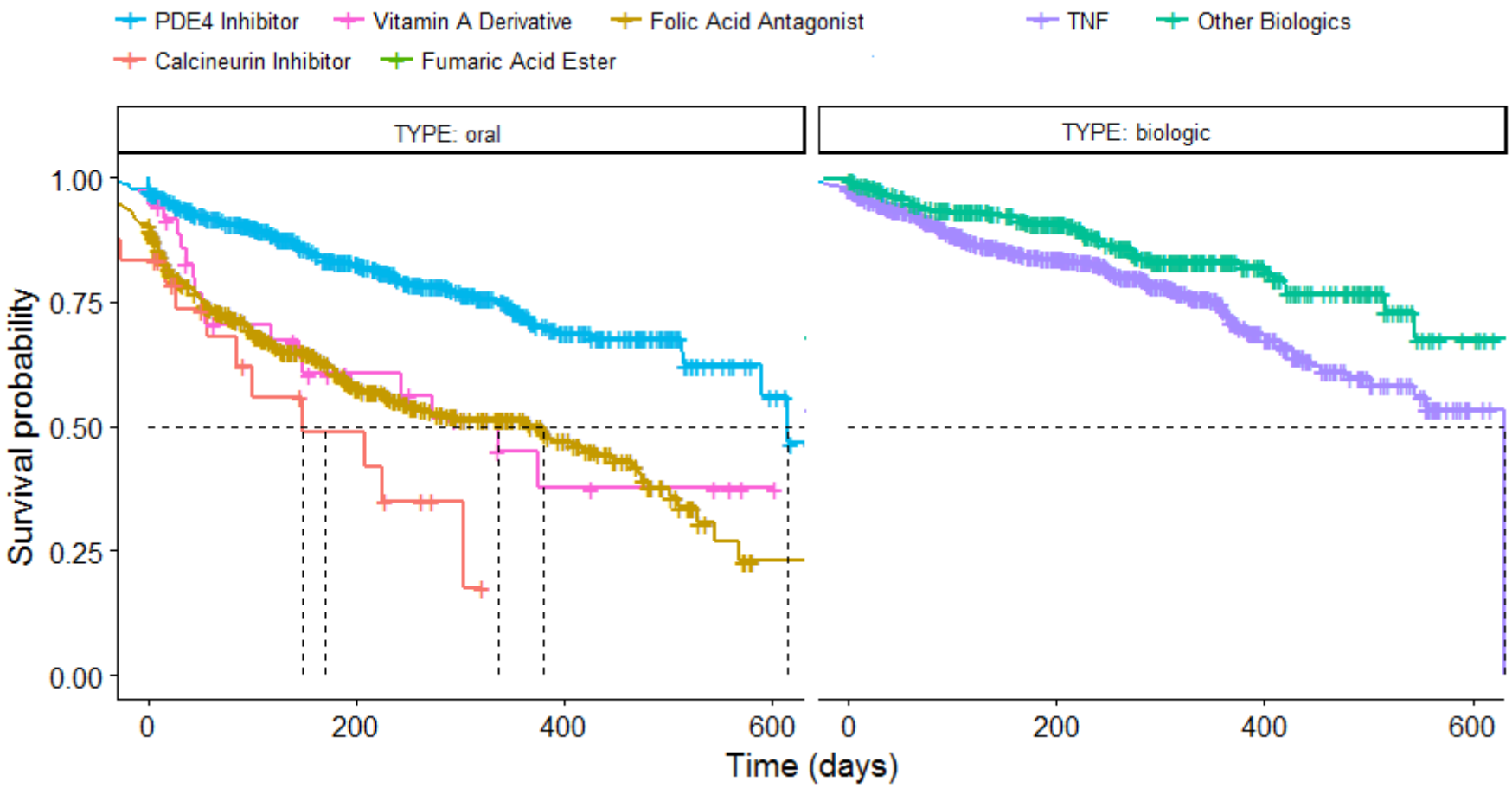


Figure 4. Kaplan-Meier Curves for First Switch (Time Since Index)

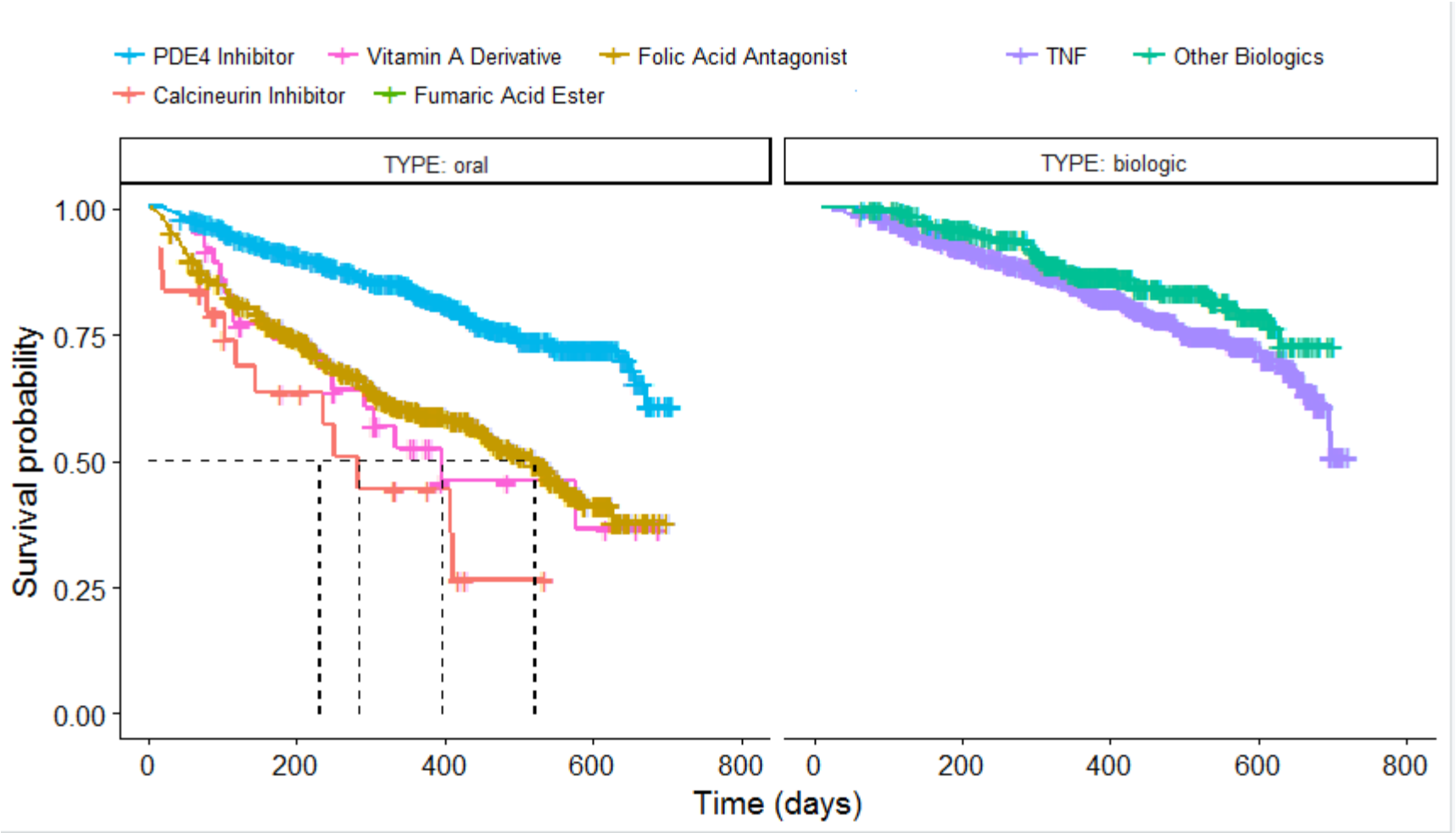


Figure 5. Kaplan-Meier Curves for First Restart

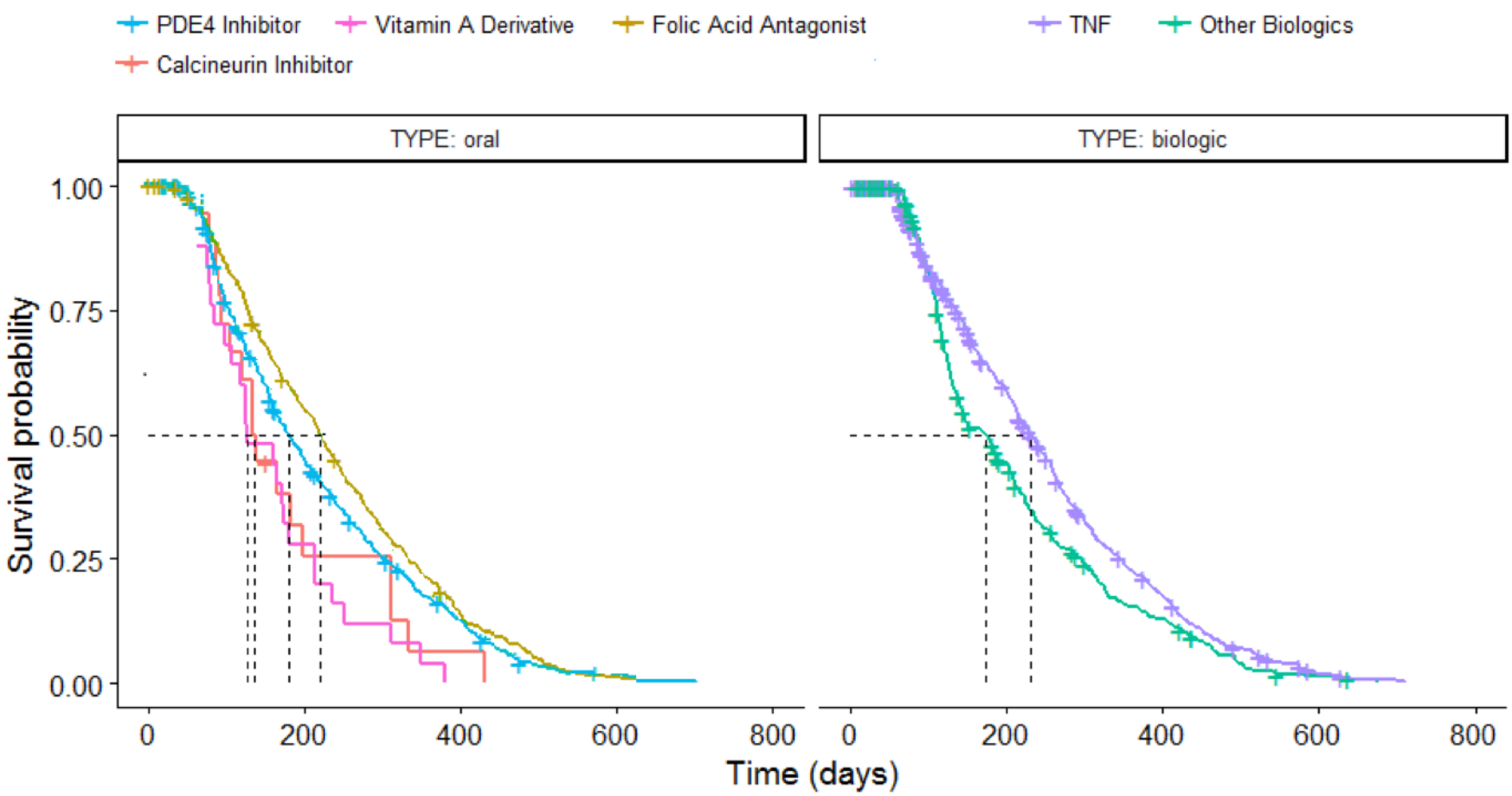


Figure 6. Lines of Treatment

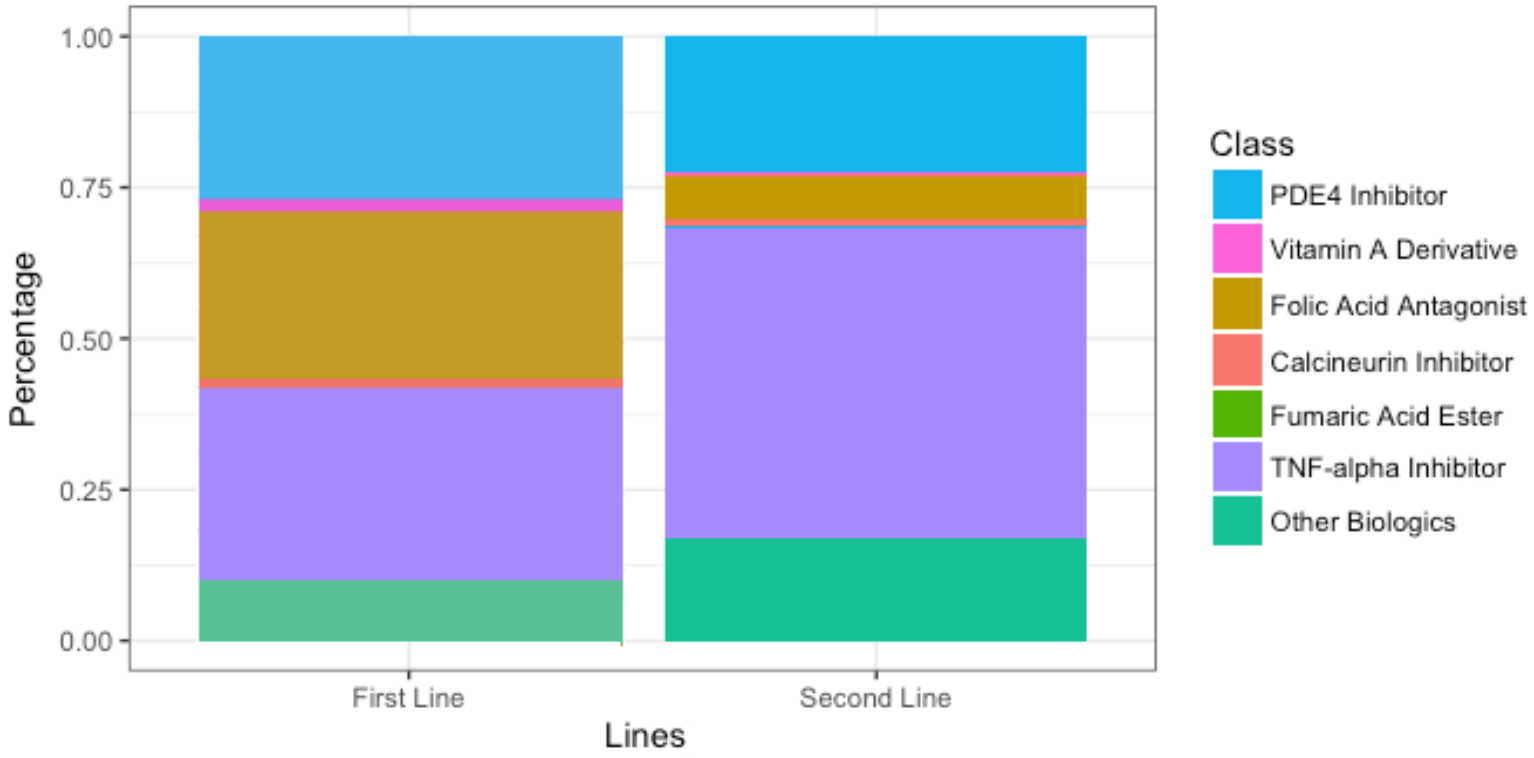


Figure 7. First Action Following Loss of Persistence, Orals

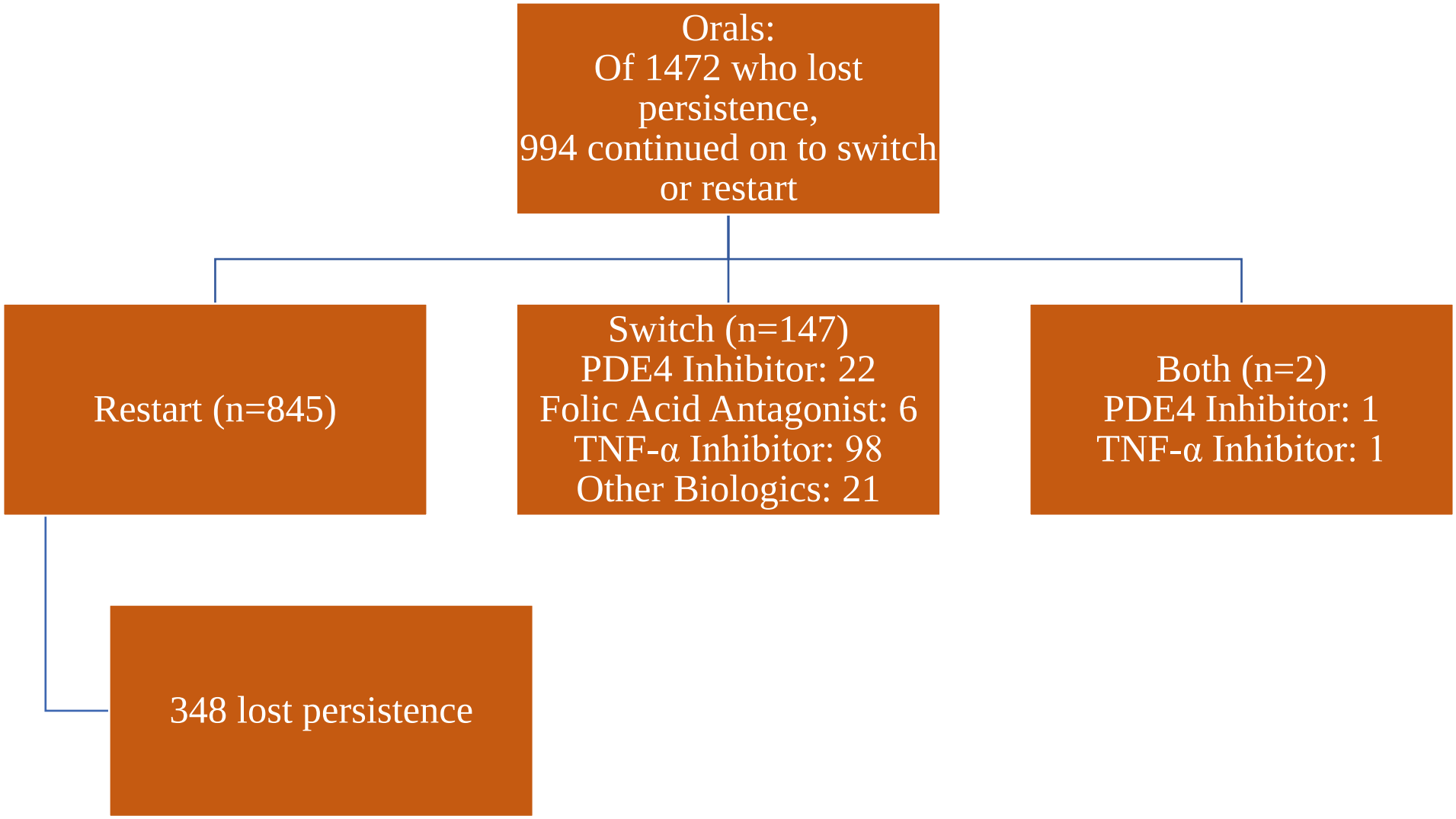


Figure 8. First Action Following Loss of Persistence, Biologics

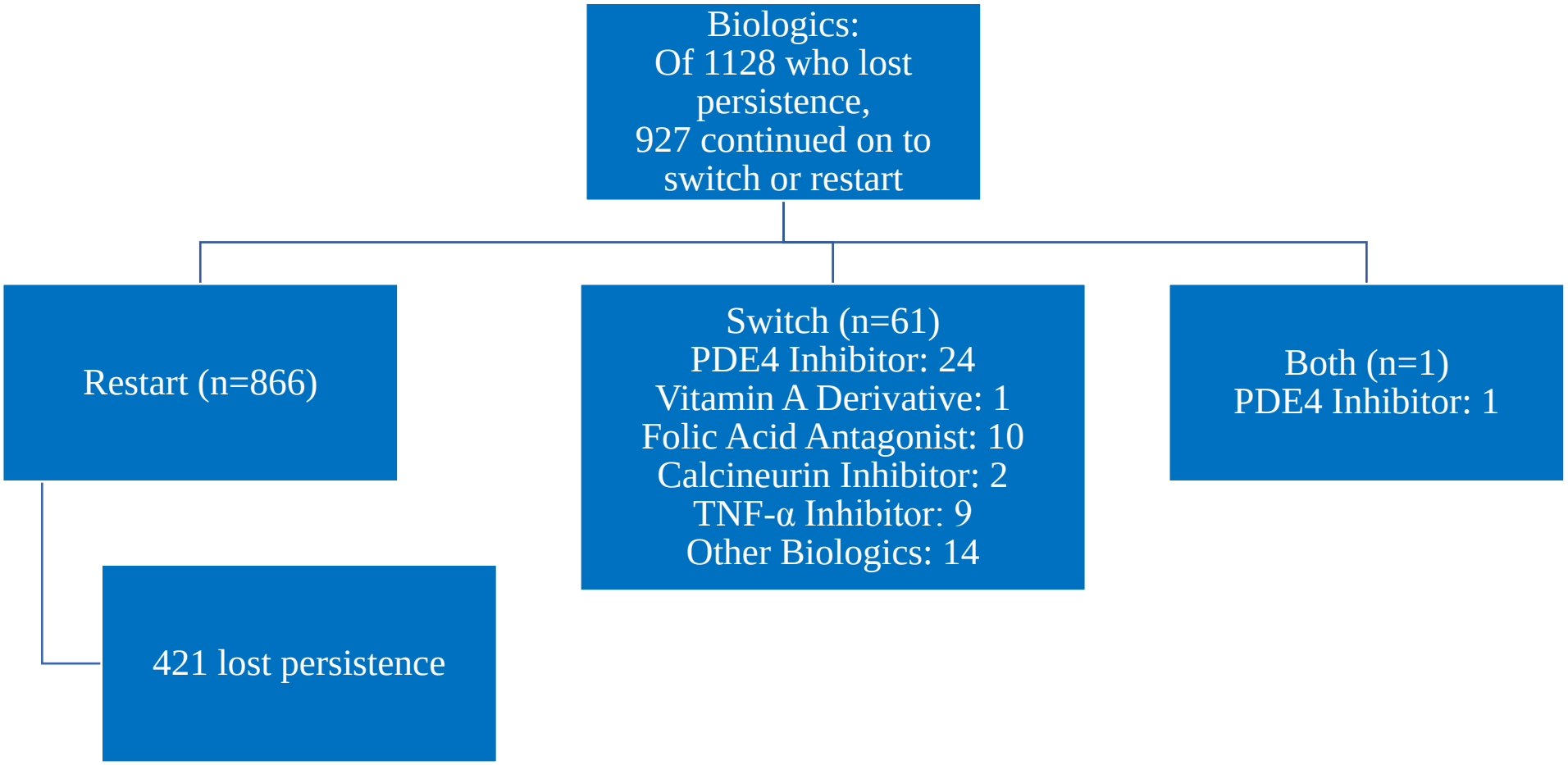
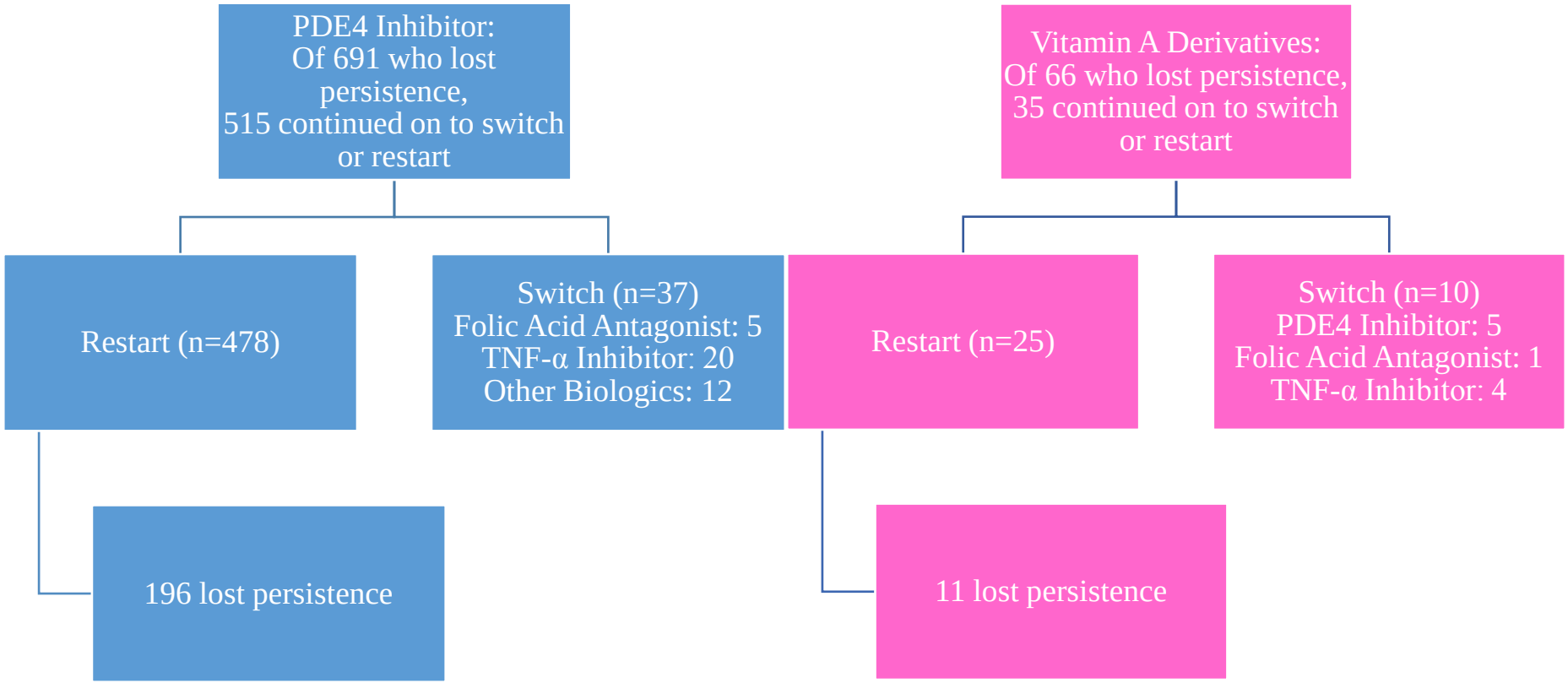
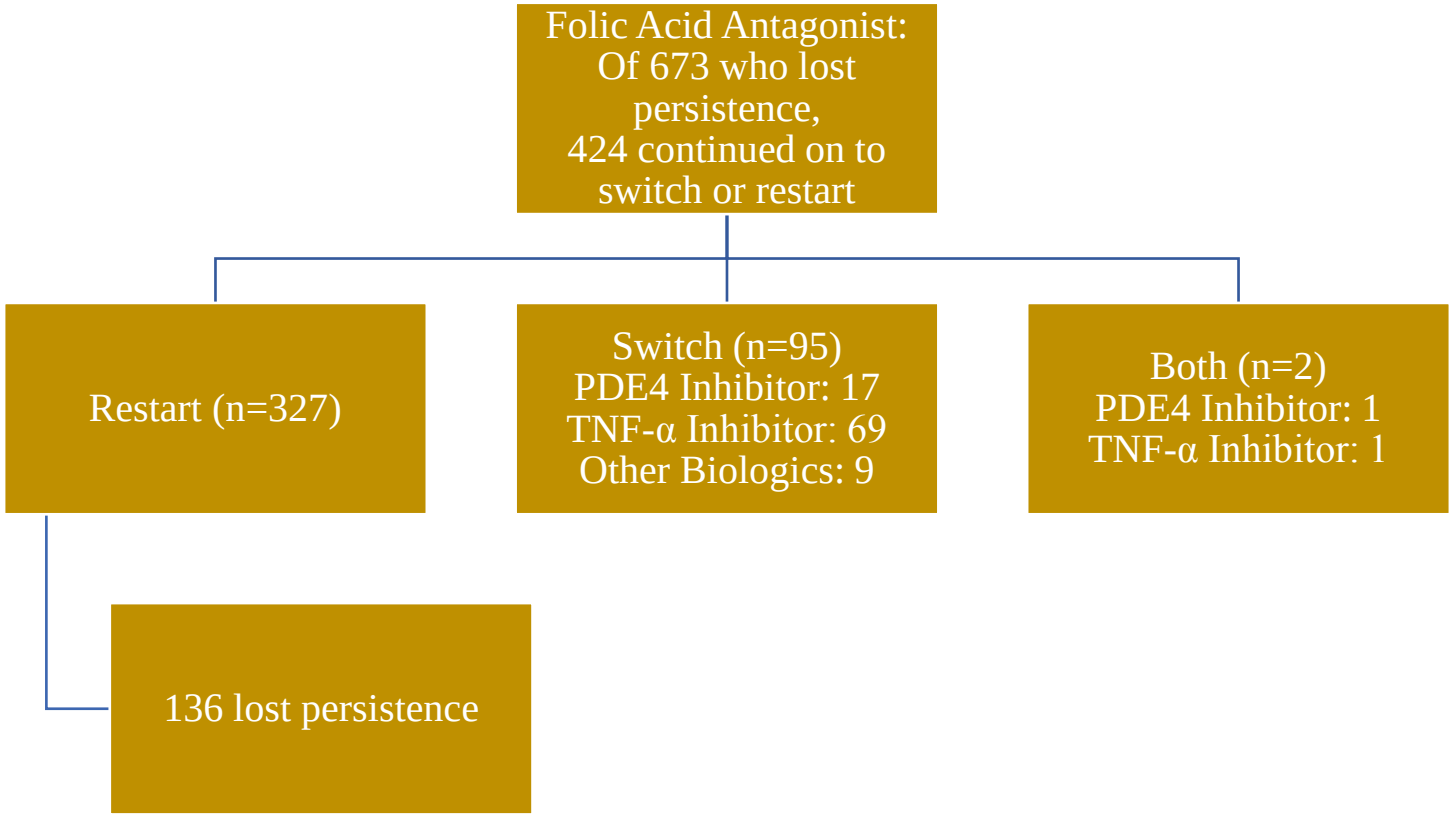
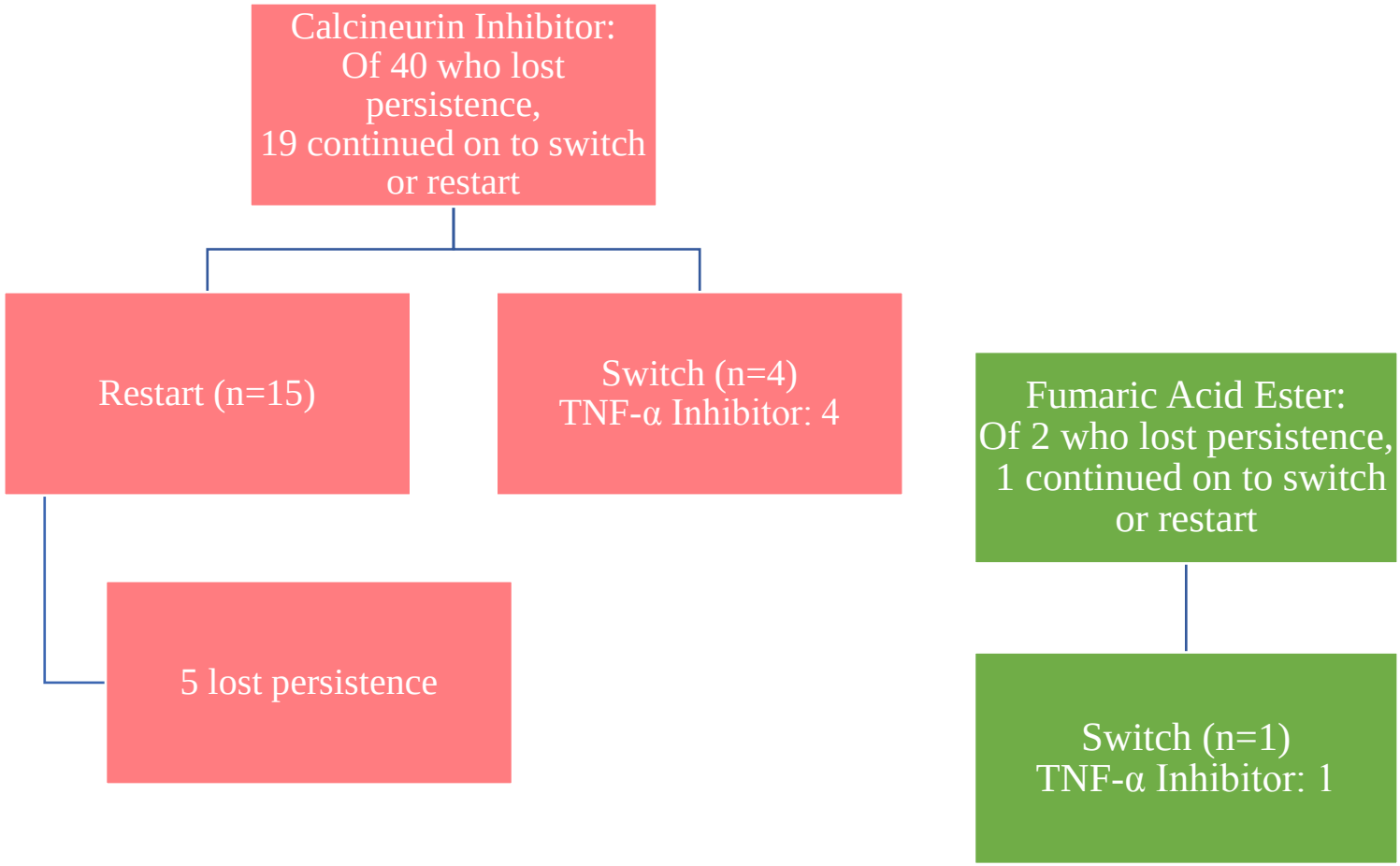
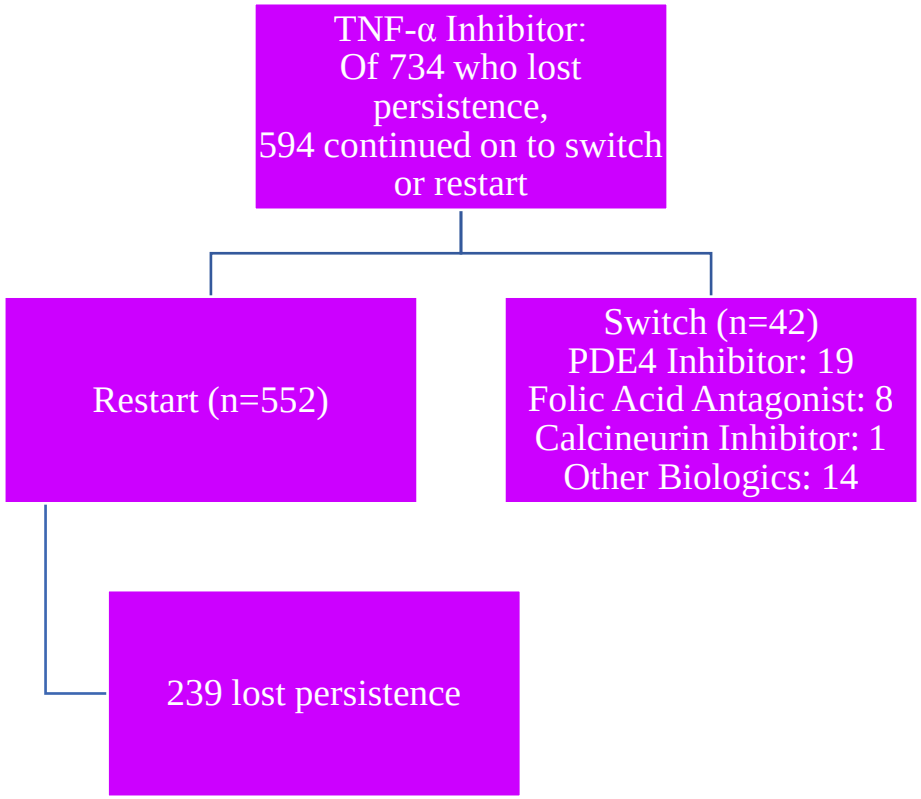


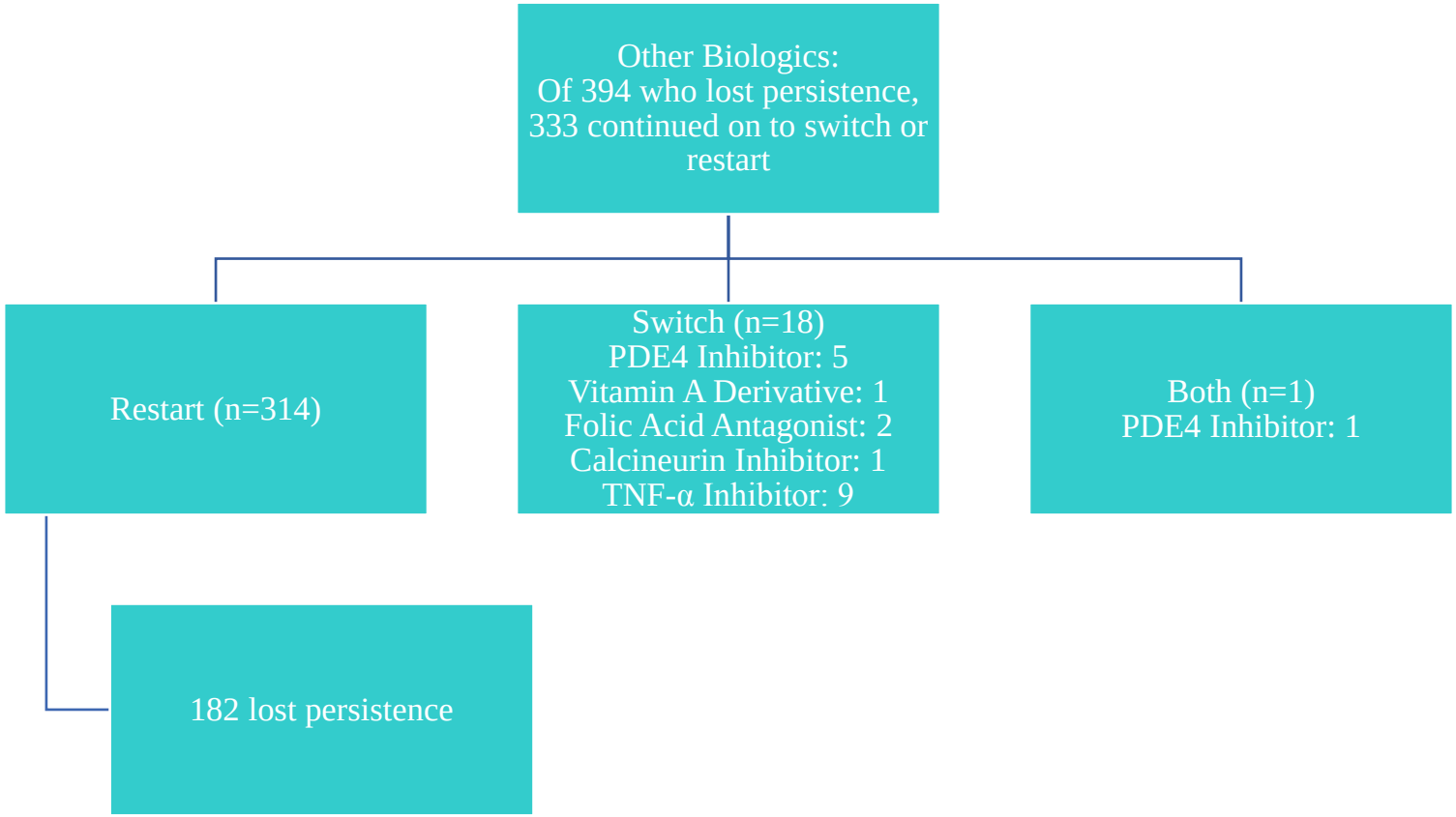
Figure 9. First Action Following Loss of Persistence, by Index Class




Folic Acid Antagonist:
Of 673 who lost persistence,
424 continued on to switch or restart
Restart (n=327)
Switch (n=95)
PDE4 Inhibitor: 17
TNF-α Inhibitor: 69
Other Biologics: 9
Both (n=2)
PDE4 Inhibitor: 1
TNF-α Inhibitor: 1
136 lost persistence


Calcineurin Inhibitor:
Of 40 who lost persistence,
19 continued on to switch or restart
Restart (n=15)
Switch (n=4)
TNF-α Inhibitor: 4
5 lost persistence
Fumaric Acid Ester:
Of 2 who lost persistence,
1 continued on to switch or restart
Switch (n=1)
TNF-α Inhibitor: 1


TNF-α Inhibitor:
Of 734 who lost persistence,
594 continued on to switch or restart
Restart (n=552)
Switch (n=42)
PDE4 Inhibitor: 19
Folic Acid Antagonist: 8
Calcineurin Inhibitor: 1
Other Biologics: 14
239 lost persistence


Other Biologics:
Of 394 who lost persistence, 333 continued on to switch or restart
Restart (n=314)
182 lost persistence
Switch (n=18)
PDE4 Inhibitor: 5
Vitamin A Derivative: 1
Folic Acid Antagonist: 2
Calcineurin Inhibitor: 1
TNF-α Inhibitor: 9
Both (n=1)
PDE4 Inhibitor: 1

REFERENCES

1. About psoriasis. National Psoriasis Foundation website. https://www.psoriasis.org/document.doc?id=793. Published 2012. Accessed August 16th, 2017.
2. Menter A, Gottlieb A, Feldman SR, Van Voorhees AS et al. Guidelines of care for the management of psoriasis and psoriatic arthritis: Section 1. Overview of psoriasis and guidelines of care for the treatment of psoriasis with biologics. J Am Acad Dermatol. 2008 May;58(5):826-50.
3. Rachakonda TD, Schupp CW, Armstrong AW. Psoriasis prevalence among adults in the United States. J Am Acad Dermatol. 2014 Mar; 70(3): 512–516.
4. Psoriasis. American Academy of Dermatology. https://www.aad.org/media/stats/conditions/psoriasis
5. Jochen Schmitt and Gottfried Wozel. The Psoriasis Area and Severity Index Is the Adequate Criterion to Define Severity in Chronic Plaque-Type Psoriasis. Dermatology. 2005;210:194–199.
6. Armstrong, AW. et al. From the Medical Board of the National Psoriasis Foundation: Treatment targets for plaque psoriasis. J Am Acad Dermatol. 2017 Feb;76(2):290 – 298.
7. Khalid JM, Fox KM, Globe G, et al. Treatment patterns and therapy effectiveness in psoriasis patients initiating biologic therapy in England. Journal of Dermatological Treatment. 2014; 25(1):67-72.
8. Horn E, Patel V, Fox K, Dann F. Treatment patterns and utilization of systemic and biologic therapy among psoriasis patients. Journal of the American Academy of Dermatology. 56(2): AB180.
9. Merola JF, et al. Switching biologics in the treatment of psoriatic arthritis. Seminars in Arthritis and Rheumatism. 2017 Aug; 47(1):29-37.
10. Svedbom A, Dalen J, Mamolo C, Cappelleri JC, Petersson IF, Stahle M. Treatment patterns with topicals, traditional systemics and biologics in psoriasis—a Swedish database analysis. J Eur Acad Dermatol Venereol. 2015;29(2):215-223.
11. Gulliver W, Gregory V, Khalil S, Mallya U. Biologic switching and discontinuation patterns in patients with moderate to severe plaque psoriasis. Poster presented at: 23rd EADV Congress; October 8-12, 2014; Amsterdam, the Netherlands.
12. Quan H, et al. Coding Algorithms for Defining Comorbidities in ICD-9-CM and ICD-1 0 Administrative Data. Medical Care, Vol. 43, No. 11 (Nov., 2005), pp. 1130-1139.
13. Tabolli S, Giannantoni P, Paradisi A, Abeni D. The 'switcher' patient profile in psoriasis treatment: from traditional to biological from biological to traditional systemic drugs. Br J Dermatol.2015;173:256–8.
14. Armstrong AW, Koning JW, Rowse S, et al. Initiation, switching, and cessation of psoriasis treatments among patients with moderate to severe psoriasis in the United States. Clin Drug Investig 2017; 37: 493–501.
15. Yeung H, Wan J, Van Voorhees AS, et al. Patient-reported reasons for the discontinuation of commonly used treatments for moderate to severe psoriasis. J Am Acad Dermatol. 2013 Jan;68(1):64-72.

APPENDICES

Appendix 1. Psoriasis Diagnostic Codes

Obs	Dx Code	ICD version	Description
1	6961	9	Other Psoriasis
2	6968	9	Psoriasis Related Dis NEC (Other psoriasis and similar disorders)
3	L400	10	Psoriasis vulgaris
4	L401	10	Generalized pustular psoriasis
5	L402	10	Acrodermatitis continua (uncommon variant of pustular psoriasis)
6	L403	10	Pustulosis palmaris et plantaris (pustular psoriasis of the extremities)
7	L404	10	Guttate psoriasis
8	L408	10	Other psoriasis
9	L409	10	Psoriasis, unspecified

Appendix 2a. Inflammatory Comorbidity Diagnostic Codes: Psoriatic Arthritis

Obs	Dx Code	ICD version	Description
1	6960	9	Psoriatic Arthropathy
2	L4050	10	Arthropathic psoriasis, unspecified
3	L4051	10	Distal interphalangeal psoriatic arthropathy
4	L4052	10	Psoriatic arthritis mutilans
5	L4053	10	Psoriatic spondylitis (PsA + spinal involvement)
6	L4054	10	Psoriatic juvenile arthropathy
7	L4059	10	Other psoriatic arthropathy

Appendix 2b. Inflammatory Comorbidity Diagnostic Codes: Rheumatoid Arthritis

Obs	Dx Code	ICD version	Description
1	7140	9	Rheumatoid arthritis
2	7142	9	Other rheumatoid arthritis
3	71430	9	Polyarticular juvenile rheumatoid arthritis, chronic or unspecified
4	71431	9	Polyarticular juvenile rheumatoid arthritis, acute
5	71432	9	Pauciarticular juvenile rheumatoid arthritis, vertebrae
6	M050	10	Felty's syndrome (Rheumatoid arthritis with splenoadenomegaly and leukopenia)
7	M056	10	Rheumatoid arthritis with involvement of other organs and systems
8	M0560	10	Rheumatoid arthritis of unspecified site with involvement of other organs and systems
9	M0561	10	Rheumatoid arthritis of shoulder with involvement of other organs and systems
10	M05611	10	Rheumatoid arthritis of right shoulder with involvement of other organs and systems
11	M05612	10	Rheumatoid arthritis of left shoulder with involvement of other organs and systems
12	M0562	10	Rheumatoid arthritis of elbow with involvement of other organs and systems
13	M05621	10	Rheumatoid arthritis of right elbow with involvement of other organs and systems
14	M05622	10	Rheumatoid arthritis of left elbow with involvement of other organs and systems
15	M05629	10	Rheumatoid arthritis of unspecified elbow with involvement of other organs and systems
16	M0563	10	Rheumatoid arthritis of wrist with involvement of other organs and systems
17	M05631	10	Rheumatoid arthritis of right wrist with involvement of other organs and systems
18	M05632	10	Rheumatoid arthritis of left wrist with involvement of other organs and systems
19	M05639	10	Rheumatoid arthritis of unspecified wrist with involvement of other organs and systems
20	M0564	10	Rheumatoid arthritis of hand with involvement of other organs and systems
21	M05641	10	Rheumatoid arthritis of right hand with involvement of other organs and systems
22	M05642	10	Rheumatoid arthritis of left hand with involvement of other organs and systems
23	M05649	10	Rheumatoid arthritis of unspecified hand with involvement of other organs and systems

24	M0565	10	Rheumatoid arthritis of hip with involvement of other organs and systems
25	M05651	10	Rheumatoid arthritis of right hip with involvement of other organs and systems
26	M05652	10	Rheumatoid arthritis of left hip with involvement of other organs and systems
27	M05659	10	Rheumatoid arthritis of unspecified hip with involvement of other organs and systems
28	M0566	10	Rheumatoid arthritis of knee with involvement of other organs and systems
29	M05661	10	Rheumatoid arthritis of right knee with involvement of other organs and systems
30	M05662	10	Rheumatoid arthritis of left knee with involvement of other organs and systems
31	M05669	10	Rheumatoid arthritis of unspecified knee with involvement of other organs and systems
32	M0567	10	Rheumatoid arthritis of ankle and foot with involvement of other organs and systems
33	M05672	10	Rheumatoid arthritis of left ankle and foot with involvement of other organs and systems
34	M05679	10	Rheumatoid arthritis of unspecified ankle and foot with involvement of other organs and systems
35	M0569	10	Rheumatoid arthritis of multiple sites with involvement of other organs and systems
36	M057	10	Rheumatoid arthritis with rheumatoid factor without organ or systems involvement
37	M0570	10	Rheumatoid arthritis with rheumatoid factor of unspecified site without organ or systems involvement
38	M0571	10	Rheumatoid arthritis with rheumatoid factor of shoulder without organ or systems involvement
39	M05711	10	Rheumatoid arthritis with rheumatoid factor of right shoulder without organ or systems involvement
40	M05712	10	Rheumatoid arthritis with rheumatoid factor of left shoulder without organ or systems involvement
41	M05719	10	Rheumatoid arthritis with rheumatoid factor of unspecified shoulder without organ or systems involvement
42	M0572	10	Rheumatoid arthritis with rheumatoid factor of elbow without organ or systems involvement
43	M05721	10	Rheumatoid arthritis with rheumatoid factor of right elbow without organ or systems involvement
44	M05722	10	Rheumatoid arthritis with rheumatoid factor of left elbow without organ or systems involvement
45	M05729	10	Rheumatoid arthritis with rheumatoid factor of unspecified elbow without organ or systems involvement
46	M0573	10	Rheumatoid arthritis with rheumatoid factor of wrist without organ or systems involvement
47	M05731	10	Rheumatoid arthritis with rheumatoid factor of right wrist without organ or systems involvement

48	M05732	10	Rheumatoid arthritis with rheumatoid factor of left wrist without organ or systems involvement
49	M05739	10	Rheumatoid arthritis with rheumatoid factor of unspecified wrist without organ or systems involvement
50	M0574	10	Rheumatoid arthritis with rheumatoid factor of hand without organ or systems involvement
51	M05741	10	Rheumatoid arthritis with rheumatoid factor of right hand without organ or systems involvement
52	M05742	10	Rheumatoid arthritis with rheumatoid factor of left hand without organ or systems involvement
53	M05749	10	Rheumatoid arthritis with rheumatoid factor of unspecified hand without organ or systems involvement
54	M0575	10	Rheumatoid arthritis with rheumatoid factor of hip without organ or systems involvement
55	M05751	10	Rheumatoid arthritis with rheumatoid factor of right hip without organ or systems involvement
56	M05752	10	Rheumatoid arthritis with rheumatoid factor of left hip without organ or systems involvement
57	M05759	10	Rheumatoid arthritis with rheumatoid factor of unspecified hip without organ or systems involvement
58	M0576	10	Rheumatoid arthritis with rheumatoid factor of knee without organ or systems involvement
59	M05761	10	Rheumatoid arthritis with rheumatoid factor of right knee without organ or systems involvement
60	M05762	10	Rheumatoid arthritis with rheumatoid factor of left knee without organ or systems involvement
61	M05769	10	Rheumatoid arthritis with rheumatoid factor of unspecified knee without organ or systems involvement
62	M0577	10	Rheumatoid arthritis with rheumatoid factor of ankle and foot without organ or systems involvement
63	M05771	10	Rheumatoid arthritis with rheumatoid factor of right ankle and foot without organ or systems involvement
64	M05772	10	Rheumatoid arthritis with rheumatoid factor of left ankle and foot without organ or systems involvement
65	M05779	10	Rheumatoid arthritis with rheumatoid factor of unspecified ankle and foot without organ or systems involvement
66	M0579	10	Rheumatoid arthritis with rheumatoid factor of multiple sites without organ or systems involvement
67	M058	10	Other rheumatoid arthritis with rheumatoid factor
68	M0580	10	Other rheumatoid arthritis with rheumatoid factor of unspecified site
69	M0581	10	Other rheumatoid arthritis with rheumatoid factor of shoulder
70	M05811	10	Other rheumatoid arthritis with rheumatoid factor of right shoulder
71	M05812	10	Other rheumatoid arthritis with rheumatoid factor of left shoulder

72	M05819	10	Other rheumatoid arthritis with rheumatoid factor of unspecified shoulder
73	M0582	10	Other rheumatoid arthritis with rheumatoid factor of elbow
74	M05821	10	Other rheumatoid arthritis with rheumatoid factor of right elbow
75	M05822	10	Other rheumatoid arthritis with rheumatoid factor of left elbow
76	M05829	10	Other rheumatoid arthritis with rheumatoid factor of unspecified elbow
77	M0583	10	Other rheumatoid arthritis with rheumatoid factor of wrist
78	M05831	10	Other rheumatoid arthritis with rheumatoid factor of right wrist
79	M05832	10	Other rheumatoid arthritis with rheumatoid factor of left wrist
80	M05839	10	Other rheumatoid arthritis with rheumatoid factor of unspecified wrist
81	M0584	10	Other rheumatoid arthritis with rheumatoid factor of hand
82	M05841	10	Other rheumatoid arthritis with rheumatoid factor of right hand
83	M05842	10	Other rheumatoid arthritis with rheumatoid factor of left hand
84	M05849	10	Other rheumatoid arthritis with rheumatoid factor of unspecified hand
85	M0585	10	Other rheumatoid arthritis with rheumatoid factor of hip
86	M05851	10	Other rheumatoid arthritis with rheumatoid factor of right hip
87	M05852	10	Other rheumatoid arthritis with rheumatoid factor of left hip
88	M05859	10	Other rheumatoid arthritis with rheumatoid factor of unspecified hip
89	M0586	10	Other rheumatoid arthritis with rheumatoid factor of knee
90	M05861	10	Other rheumatoid arthritis with rheumatoid factor of right knee
91	M05862	10	Other rheumatoid arthritis with rheumatoid factor of left knee
92	M05869	10	Other rheumatoid arthritis with rheumatoid factor of unspecified knee
93	M0587	10	Other rheumatoid arthritis with rheumatoid factor of ankle and foot
94	M05871	10	Other rheumatoid arthritis with rheumatoid factor of right ankle and foot
95	M05872	10	Other rheumatoid arthritis with rheumatoid factor of left ankle and foot

96	M05879	10	Other rheumatoid arthritis with rheumatoid factor of unspecified ankle and foot
97	M0589	10	Other rheumatoid arthritis with rheumatoid factor of multiple sites
98	M059	10	Rheumatoid arthritis with rheumatoid factor, unspecified
99	M06	10	Other rheumatoid arthritis
100	M060	10	Rheumatoid arthritis without rheumatoid factor
101	M0600	10	Rheumatoid arthritis without rheumatoid factor, unspecified site
102	M0601	10	Rheumatoid arthritis without rheumatoid factor, shoulder
103	M06011	10	Rheumatoid arthritis without rheumatoid factor, right shoulder
104	M06012	10	Rheumatoid arthritis without rheumatoid factor, left shoulder
105	M06019	10	Rheumatoid arthritis without rheumatoid factor, unspecified shoulder
106	M0602	10	Rheumatoid arthritis without rheumatoid factor, elbow
107	M06021	10	Rheumatoid arthritis without rheumatoid factor, right elbow
108	M06022	10	Rheumatoid arthritis without rheumatoid factor, left elbow
109	M06029	10	Rheumatoid arthritis without rheumatoid factor, unspecified elbow
110	M0603	10	Rheumatoid arthritis without rheumatoid factor, wrist
111	M06031	10	Rheumatoid arthritis without rheumatoid factor, right wrist
112	M06039	10	Rheumatoid arthritis without rheumatoid factor, unspecified wrist
113	M0604	10	Rheumatoid arthritis without rheumatoid factor, hand
114	M06041	10	Rheumatoid arthritis without rheumatoid factor, right hand
115	M06042	10	Rheumatoid arthritis without rheumatoid factor, left hand
116	M06049	10	Rheumatoid arthritis without rheumatoid factor, unspecified hand
117	M0605	10	Rheumatoid arthritis without rheumatoid factor, hip
118	M06051	10	Rheumatoid arthritis without rheumatoid factor, right hip
119	M06052	10	Rheumatoid arthritis without rheumatoid factor, left hip

120	M06059	10	Rheumatoid arthritis without rheumatoid factor, unspecified hip
121	M0606	10	Rheumatoid arthritis without rheumatoid factor, knee
122	M06061	10	Rheumatoid arthritis without rheumatoid factor, right knee
123	M06062	10	Rheumatoid arthritis without rheumatoid factor, left knee
124	M06069	10	Rheumatoid arthritis without rheumatoid factor, unspecified knee
125	M0607	10	Rheumatoid arthritis without rheumatoid factor, ankle and foot
126	M06071	10	Rheumatoid arthritis without rheumatoid factor, right ankle and foot
127	M06072	10	Rheumatoid arthritis without rheumatoid factor, left ankle and foot
128	M06079	10	Rheumatoid arthritis without rheumatoid factor, unspecified ankle and foot
129	M0608	10	Rheumatoid arthritis without rheumatoid factor, vertebrae
130	M0609	10	Rheumatoid arthritis without rheumatoid factor, multiple sites
131	M0681	10	Other specified rheumatoid arthritis, shoulder
132	M06819	10	Other specified rheumatoid arthritis, unspecified shoulder
133	M0682	10	Other specified rheumatoid arthritis, elbow
134	M06829	10	Other specified rheumatoid arthritis, unspecified elbow
135	M06839	10	Other specified rheumatoid arthritis, unspecified wrist
136	M06849	10	Other specified rheumatoid arthritis, unspecified hand
137	M06869	10	Other specified rheumatoid arthritis, unspecified knee
138	M06879	10	Other specified rheumatoid arthritis, unspecified ankle and foot
139	M068	10	Other specified rheumatoid arthritis
140	M069	10	Rheumatoid arthritis, unspecified
141	M080	10	Unspecified juvenile rheumatoid arthritis
142	M0800	10	Unspecified juvenile rheumatoid arthritis of unspecified site
143	M08011	10	Unspecified juvenile rheumatoid arthritis, right shoulder

144	M08012	10	Unspecified juvenile rheumatoid arthritis, left shoulder
145	M08019	10	Unspecified juvenile rheumatoid arthritis, unspecified shoulder
146	M08021	10	Unspecified juvenile rheumatoid arthritis, right elbow
147	M08022	10	Unspecified juvenile rheumatoid arthritis, left elbow
148	M08031	10	Unspecified juvenile rheumatoid arthritis, right wrist
149	M08032	10	Unspecified juvenile rheumatoid arthritis, left wrist
150	M08041	10	Unspecified juvenile rheumatoid arthritis, right hand
151	M08042	10	Unspecified juvenile rheumatoid arthritis, left hand
152	M08051	10	Unspecified juvenile rheumatoid arthritis, right hip
153	M08052	10	Unspecified juvenile rheumatoid arthritis, left hip
154	M08061	10	Unspecified juvenile rheumatoid arthritis, right knee
155	M08062	10	Unspecified juvenile rheumatoid arthritis, left knee
156	M08071	10	Unspecified juvenile rheumatoid arthritis, right ankle and foot
157	M08072	10	Unspecified juvenile rheumatoid arthritis, left ankle and foot
158	M08079	10	Unspecified juvenile rheumatoid arthritis, unspecified ankle and foot
159	M0808	10	Unspecified juvenile rheumatoid arthritis, vertebrae
160	M0809	10	Unspecified juvenile rheumatoid arthritis, multiple sites
161	M0820	10	Juvenile rheumatoid arthritis with systemic onset, unspecified site
162	M08211	10	Juvenile rheumatoid arthritis with systemic onset, right shoulder
163	M08212	10	Juvenile rheumatoid arthritis with systemic onset, left shoulder
164	M08219	10	Juvenile rheumatoid arthritis with systemic onset, unspecified shoulder
165	M08221	10	Juvenile rheumatoid arthritis with systemic onset, right elbow
166	M08222	10	Juvenile rheumatoid arthritis with systemic onset, left elbow
167	M08229	10	Juvenile rheumatoid arthritis with systemic onset, unspecified elbow

168	M08231	10	Juvenile rheumatoid arthritis with systemic onset, right wrist
169	M08232	10	Juvenile rheumatoid arthritis with systemic onset, left wrist
170	M08241	10	Juvenile rheumatoid arthritis with systemic onset, right hand
171	M08239	10	Juvenile rheumatoid arthritis with systemic onset, unspecified wrist
172	M08242	10	Juvenile rheumatoid arthritis with systemic onset, left hand
173	M08249	10	Juvenile rheumatoid arthritis with systemic onset, unspecified hand
174	M08251	10	Juvenile rheumatoid arthritis with systemic onset, right hip
175	M08252	10	Juvenile rheumatoid arthritis with systemic onset, left hip
176	M08259	10	Juvenile rheumatoid arthritis with systemic onset, unspecified hip
177	M08261	10	Juvenile rheumatoid arthritis with systemic onset, right knee
178	M08262	10	Juvenile rheumatoid arthritis with systemic onset, left knee
179	M08269	10	Juvenile rheumatoid arthritis with systemic onset, unspecified knee
180	M0827	10	Juvenile rheumatoid arthritis with systemic onset, ankle and foot
181	M08271	10	Juvenile rheumatoid arthritis with systemic onset, right ankle and foot
182	M08272	10	Juvenile rheumatoid arthritis with systemic onset, left ankle and foot
183	M08279	10	Juvenile rheumatoid arthritis with systemic onset, unspecified ankle and foot
184	M0828	10	Juvenile rheumatoid arthritis with systemic onset, vertebrae
185	M0829	10	Juvenile rheumatoid arthritis with systemic onset, multiple sites
186	M083	10	Juvenile rheumatoid polyarthritis (seronegative)
187	M084	10	Pauciarticular juvenile rheumatoid arthritis
188	M0840	10	Pauciarticular juvenile rheumatoid arthritis, unspecified site
189	M08411	10	Pauciarticular juvenile rheumatoid arthritis, right shoulder
190	M08412	10	Pauciarticular juvenile rheumatoid arthritis, left shoulder
191	M08419	10	Pauciarticular juvenile rheumatoid arthritis, unspecified shoulder

192	M08421	10	Pauciarticular juvenile rheumatoid arthritis, right elbow
193	M08422	10	Pauciarticular juvenile rheumatoid arthritis, left elbow
194	M08429	10	Pauciarticular juvenile rheumatoid arthritis, unspecified elbow
195	M08431	10	Pauciarticular juvenile rheumatoid arthritis, right wrist
196	M08432	10	Pauciarticular juvenile rheumatoid arthritis, left wrist
197	M08439	10	Pauciarticular juvenile rheumatoid arthritis, unspecified wrist
198	M08441	10	Pauciarticular juvenile rheumatoid arthritis, right hand
199	M08442	10	Pauciarticular juvenile rheumatoid arthritis, left hand
200	M08449	10	Pauciarticular juvenile rheumatoid arthritis, unspecified hand
201	M08451	10	Pauciarticular juvenile rheumatoid arthritis, right hip
202	M08452	10	Pauciarticular juvenile rheumatoid arthritis, left hip
203	M08459	10	Pauciarticular juvenile rheumatoid arthritis, unspecified hip
204	M08461	10	Pauciarticular juvenile rheumatoid arthritis, right knee
205	M08462	10	Pauciarticular juvenile rheumatoid arthritis, left knee
206	M08469	10	Pauciarticular juvenile rheumatoid arthritis, unspecified knee
207	M08471	10	Pauciarticular juvenile rheumatoid arthritis, right ankle and foot
208	M08472	10	Pauciarticular juvenile rheumatoid arthritis, left ankle and foot
209	M08479	10	Pauciarticular juvenile rheumatoid arthritis, unspecified ankle and foot
210	M0848	10	Pauciarticular juvenile rheumatoid arthritis, vertebrae

Appendix 2c. Inflammatory Comorbidity Diagnostic Codes: Crohn's Disease

Obs	Dx Code	ICD version	Description
1	5550	9	Regional enteritis of small intestine (Equivalent to K5000, K50011, K50018, K50019)
2	5550 with 5609	9	Regional enteritis of small intestine + Unspecified intestinal obstruction (Equivalent to K50012)
3	5550 with 5695	9	Regional enteritis of small intestine + Abscess of intestine (Equivalent to K50014)

4	5550 with 56981	9	Regional enteritis of small intestine + Fistula of intestine, excluding rectum and anus (Equivalent to K50013)
5	5551	9	Regional enteritis of large intestine (Equivalent to K5010, K50111, K50118, K50119)
6	5551 with 5609	9	Regional enteritis of large intestine + Unspecified intestinal obstruction (Equivalent to K50112)
7	5551 with 5695	9	Regional enteritis of large intestine + Abscess of intestine (Equivalent to K50114)
8	5551 with 56981	9	Regional enteritis of large intestine + Fistula of intestine, excluding rectum and anus (Equivalent to K50113)
9	5552	9	Regional enteritis of small intestine with large intestine (Equivalent to K5080, K50811, K50818, K50819)
10	5552 with 5609	9	Regional enteritis of small intestine with large intestine + Unspecified intestinal obstruction (Equivalent to K50812)
11	5552 with 5695	9	Regional enteritis of small intestine with large intestine + Abscess of intestine (Equivalent to K50814)
12	5552 with 56981	9	Regional enteritis of small intestine with large intestine + Fistula of intestine, excluding rectum and anus (Equivalent to K50813)
13	5559	9	Regional enteritis of unspecified site (Equivalent to K5090, K50911, K50918, K50919)
14	5559 with 5609	9	Regional enteritis of unspecified site + nspecified intestinal obstruction (Equivalent to K50912)
15	5559 with 5695	9	Regional enteritis of unspecified site Abscess of intestine (Equivalent to K50914)
16	5559 with 56981	9	Regional enteritis of unspecified site + Fistula of intestine, excluding rectum and anus (Equivalent to K50913)
17	K50	10	Crohn's disease [regional enteritis]
18	K500	10	Crohn's disease of small intestine
19	K5000	10	Crohn's disease of small intestine without complications
20	K5001	10	Crohn's disease of small intestine with complications
21	K50011	10	Crohn's disease of small intestine with rectal bleeding
22	K50012	10	Crohn's disease of small intestine with intestinal obstruction
23	K50013	10	Crohn's disease of small intestine with fistula
24	K50014	10	Crohn's disease of small intestine with abscess
25	K50018	10	Crohn's disease of small intestine with other complication
26	K50019	10	Crohn's disease of small intestine with unspecified complications
27	K501	10	Crohn's disease of large intestine

28	K5010	10	Crohn's disease of large intestine without complications
29	K5011	10	Crohn's disease of large intestine with complications
30	K50111	10	Crohn's disease of large intestine with rectal bleeding
31	K50112	10	Crohn's disease of large intestine with intestinal obstruction
32	K50113	10	Crohn's disease of large intestine with fistula
33	K50114	10	Crohn's disease of large intestine with abscess
34	K50118	10	Crohn's disease of large intestine with other complication
35	K50119	10	Crohn's disease of large intestine with unspecified complications
36	K508	10	Crohn's disease of both small and large intestine
37	K5080	10	Crohn's disease of both small and large intestine without complications
38	K5081	10	Crohn's disease of both small and large intestine with complications
39	K50811	10	Crohn's disease of both small and large intestine with rectal bleeding
40	K50812	10	Crohn's disease of both small and large intestine with intestinal obstruction
41	K50813	10	Crohn's disease of both small and large intestine with fistula
42	K50814	10	Crohn's disease of both small and large intestine with abscess
43	K50818	10	Crohn's disease of both small and large intestine with other complication
44	K50819	10	Crohn's disease of both small and large intestine with unspecified complications
45	K509	10	Crohn's disease, unspecified
46	K5090	10	Crohn's disease, unspecified, without complications
47	K5091	10	Crohn's disease, unspecified, with complications
48	K50911	10	Crohn's disease, unspecified, with rectal bleeding
49	K50912	10	Crohn's disease, unspecified, with intestinal obstruction
50	K50913	10	Crohn's disease, unspecified, with fistula
51	K50914	10	Crohn's disease, unspecified, with abscess

52	K50918	10	Crohn's disease, unspecified, with other complication
53	K50919	10	Crohn's disease, unspecified, with unspecified complications

Appendix 2d. Inflammatory Comorbidity Diagnostic Codes: Ulcerative Colitis

Obs	Dx Code	ICD version	Description
1	5568	9	Other ulcerative colitis (Equivalent to K5180, K51811, K51818, K51819)
2	5568 with 56089	9	Other ulcerative colitis + Other specified intestinal obstruction (Equivalent to K51812)
3	5568 with 5695	9	Other ulcerative colitis + Abscess of intestine (Equivalent to K51814)
4	5568 with 56981	9	Other ulcerative colitis + Fistula of intestine, excluding rectum and anus (Equivalent to K51813)
5	5569	9	Ulcerative colitis, unspecified (Equivalent to K5190, K51911, K51918, K51919)
6	5569 with 56089	9	Ulcerative colitis, unspecified + Other specified intestinal obstruction (Equivalent to K51912)
7	5569 with 5695	9	Ulcerative colitis, unspecified + Abscess of intestine (Equivalent to K51914)
8	5569 with 56981	9	Ulcerative colitis, unspecified + Fistula of intestine, excluding rectum and anus (Equivalent to K51913)
9	K51	10	Ulcerative colitis
10	K5150	10	Left sided colitis without complications (Chronic left-sided ulcerative colitis; Ulcerative colitis, left sided, chronic; Left sided colitis NOS)
11	K518	10	Other ulcerative colitis
12	K5180	10	Other ulcerative colitis without complications
13	K5181	10	Other ulcerative colitis with complications
14	K51811	10	Other ulcerative colitis with rectal bleeding
15	K51812	10	Other ulcerative colitis with intestinal obstruction
16	K51813	10	Other ulcerative colitis with fistula
17	K51814	10	Other ulcerative colitis with abscess
18	K51818	10	Other ulcerative colitis with other complication
19	K51819	10	Other ulcerative colitis with unspecified complications
20	K519	10	Ulcerative colitis, unspecified

21	K5190	10	Ulcerative colitis, unspecified, without complications
22	K5191	10	Ulcerative colitis, unspecified, with complications
23	K51911	10	Ulcerative colitis, unspecified with rectal bleeding
24	K51912	10	Ulcerative colitis, unspecified with intestinal obstruction
25	K51913	10	Ulcerative colitis, unspecified with fistula
26	K51914	10	Ulcerative colitis, unspecified with abscess
27	K51918	10	Ulcerative colitis, unspecified with other complication
28	K51919	10	Ulcerative colitis, unspecified with unspecified complications

Appendix 2e. Inflammatory Comorbidity Diagnostic Codes: Ankylosing spondylitis

Obs	Dx Code	ICD version	Description
1	7200	9	Ankylosing spondylitis
2	M081	10	Juvenile ankylosing spondylitis
3	M45	10	Ankylosing spondylitis
4	M450	10	Ankylosing spondylitis of multiple sites in spine
5	M451	10	Ankylosing spondylitis of occipito-atlanto-axial region
6	M452	10	Ankylosing spondylitis of cervical region
7	M453	10	Ankylosing spondylitis of cervicothoracic region
8	M454	10	Ankylosing spondylitis of thoracic region
9	M455	10	Ankylosing spondylitis of thoracolumbar region
10	M456	10	Ankylosing spondylitis lumbar region
11	M457	10	Ankylosing spondylitis of lumbosacral region
12	M458	10	Ankylosing spondylitis sacral and sacrococcygeal region
13	M459	10	Ankylosing spondylitis of unspecified sites in spine

Appendix 3a. Psoriasis Medications of Interest (Orals and Biologics)

Drug	CPT or NDC Codes for Coding and Inclusion

Orals	
PDE4 Inhibitor	
Apremilast	59572063027, 59572063106, 59572063128, 59572063255
Vitamin A Derivative	
Acitretin	00093113556, 00115166708, 00378702093, 42794008008, 66993089430
Folic Acid Antagonist	
Methotrexate	67253032010, 67253032036, 52959024400, 51079067001, 51079067005, 42291059401, 68382077501, 51285036601, 51285036701, 51285036801, 51285036901, 00378001401, 54868382603, 54868382604, 54868382605, 54868382608, 54868382609, 00054455015, 00054455025, 00054855025, 00555057202, 00555057235, 43063043930, 63629147201, 63629147202, 54569181809, 55289092430, 67253058042, 67253058043, 67253058044, 67253058045, 67253058046
Calcineurin Inhibitors	
Cyclosporine	00093574019, 00093574065, 00093574119, 00093574165, 00093574219, 00093574265, 51862045801, 51862045847, 51862046001, 51862046047, 68084087925, 68084087995, 54868552200, 60505013300, 60505013400, 00185093230, 00185093287, 00185093330, 00185093386, 00185093387
Tacrolimus	68084044901, 68084044911, 68084045001, 68084045011, 68084045101, 68084045111, 00781930201, 00781930301, 00781930401, 51079002801, 51079002820, 60429037701, 60429037801, 60429037901, 00378204501, 00378204505, 00378204601, 00378204605, 00378204701, 00378204705, 51079081701, 51079081720, 51079081801, 51079081820, 64380072006, 64380072106, 64380072206, 16729004101, 16729004201, 16729004301, 00904642561, 00904662361, 00904662461, 55111052501, 55111052601, 55111052701, 00781210201, 00781210301, 00781210401, 62175038037, 62175038137, 62175038237, 69452015320, 69452015420, 69452015520
Fumaric Acid Ester	
Dimethyl fumarate	64406000501, 64406000602, 64406000703
Biologics	
TNF-α	
Etanercept	54868544400, 58406042534, 58406042541, 58406043501, 58406043504, 58406044501, 58406044504, 58406045501, 58406045504
Infliximab	00006430501, 00006430502, 00069080901, 57894003001
Adalimumab	00074379902, 00074433902, 00074433907, 00074634702, 00074937402
Other Biologics	
Ustekinumab	57894005427, 57894006002, 57894006003, 57894006103
Guselkumab	57894064001
Secukinumab	00078063941, 00078063968, 00078063997, 00078063998
Ixekizumab	00002144501, 00002144509, 00002144511, 00002144527, 00002772401, 00002772409, 00002772411, 00002772427
Brodalumab	00187000400, 00187000402

Appendix 3b. Psoriasis Medications of Interest (Topicals)

Drug	CPT or NDC Codes for Coding and Inclusion

Clobetasol propionate	54569455000, 54569606500, 50436998501, 60429090215, 60429090230, 60429090245, 60429090260, 00168016315, 00168016330, 00168016346, 00168016360, 71085000760, 00472040015, 00472040030, 00472040045, 00472040060, 50383026715, 50383026730, 50383026745, 50383026760, 54868358400, 54868358401, 54868358402, 51672125801, 51672125802, 51672125803, 51672125806, 40085088800, 40085088850, 54868629100, 45802043732, 45802043733, 66993088849, 66993088865, 00168029315, 00168029330, 00168029360, 45802092514, 45802092594, 45802092596, 50383026915, 50383026930, 50383026960, 52565008215, 52565008230, 52565008260, 51672129401, 51672129402, 51672129403, 00472040492, 00472040494, 52565005502, 52565005504, 00574210302, 00574210304, 51672135004, 51672135008, 60429090115, 60429090130, 60429090145, 60429090160, 00168016215, 00168016230, 00168016246, 00168016260, 68462053017, 68462053035, 00713065615, 00713065631, 00713065637, 00713065660, 50383026815, 50383026830, 50383026845, 50383026860, 54569606600, 54868369800, 54868369801, 54868369803, 51672125901, 51672125902, 51672125903, 51672125906, 00472040394 45802096126, 00781713704, 54569606700, 60432013325, 60432013350, 00168026950, 50383026625, 50383026650, 54868529200, 63646050025, 63646050050, 00472040225, 00472040250, 51672129302, 51672129303, 43386002860, 00574206302, 00574206304, 00591403946, 00591403974
Flurandrenolide	24470091912, 51672530104, 45802092803, 24470092112, 51672529808, 52565001760
Betamethasone dipropionate	51672131001, 51672131003, 49999022215, 49999022245, 54569111300, 54569255600, 00781707427, 00781707450, 00168005515, 00168005546, 00168026515, 00168026550, 00472038015, 00472038045, 52959072115, 52959072145, 68462029017, 68462029052, 54868629200, 54868629201, 54868097301, 54868097302, 45802037632, 45802037635, 51672127401, 51672127406, 51672130901, 51672130903, 51672134003, 51672134004, 45802002146, 54569155600, 00713080753, 00168026730, 00168026760, 54868628800, 00168005760, 54868328000, 00168026815, 00168026850, 00472038115, 00472038145, 00472038215, 00472038245, 66993089715, 66993089749, 51672131701, 51672131703, 00168005615, 00168005646, 54569111400
Diflorasone diacetate	51672129601, 51672129602, 51672129603, 51672129501, 51672129502, 51672129503
Desoximetasone	68180094902, 68180094904, 68180095001, 68180095002, 68180095004, 00472047815, 00472047860, 45802049535, 45802049537, 54868304101, 51672127001, 51672127003, 51672127007, 51672127009, 51672127101, 51672127103, 51672127107, 51672127108, 61748020515, 61748020560, 51672126101, 51672126103, 54868282900, 51672126201, 51672126203, 51672126207, 61748020615, 61748020660, 68462053117, 68462053165, 00472047915, 00472047960, 54868589100, 00168015115, 00168015160, 51672135203, 51672135207, 68180094601, 68180094604, 68180094804, 52565003015, 52565003060, 52565003099, 45802049614, 45802049696
Halobetasol propionate	51672132101, 51672132103, 54868490700, 00168035515, 00168035550, 00713064015, 00713064086, 45802012932, 45802012935, 45802013132, 45802013135, 00713063915, 00713063986, 54868548200, 54868548201, 42192012750, 51672132201, 51672132203

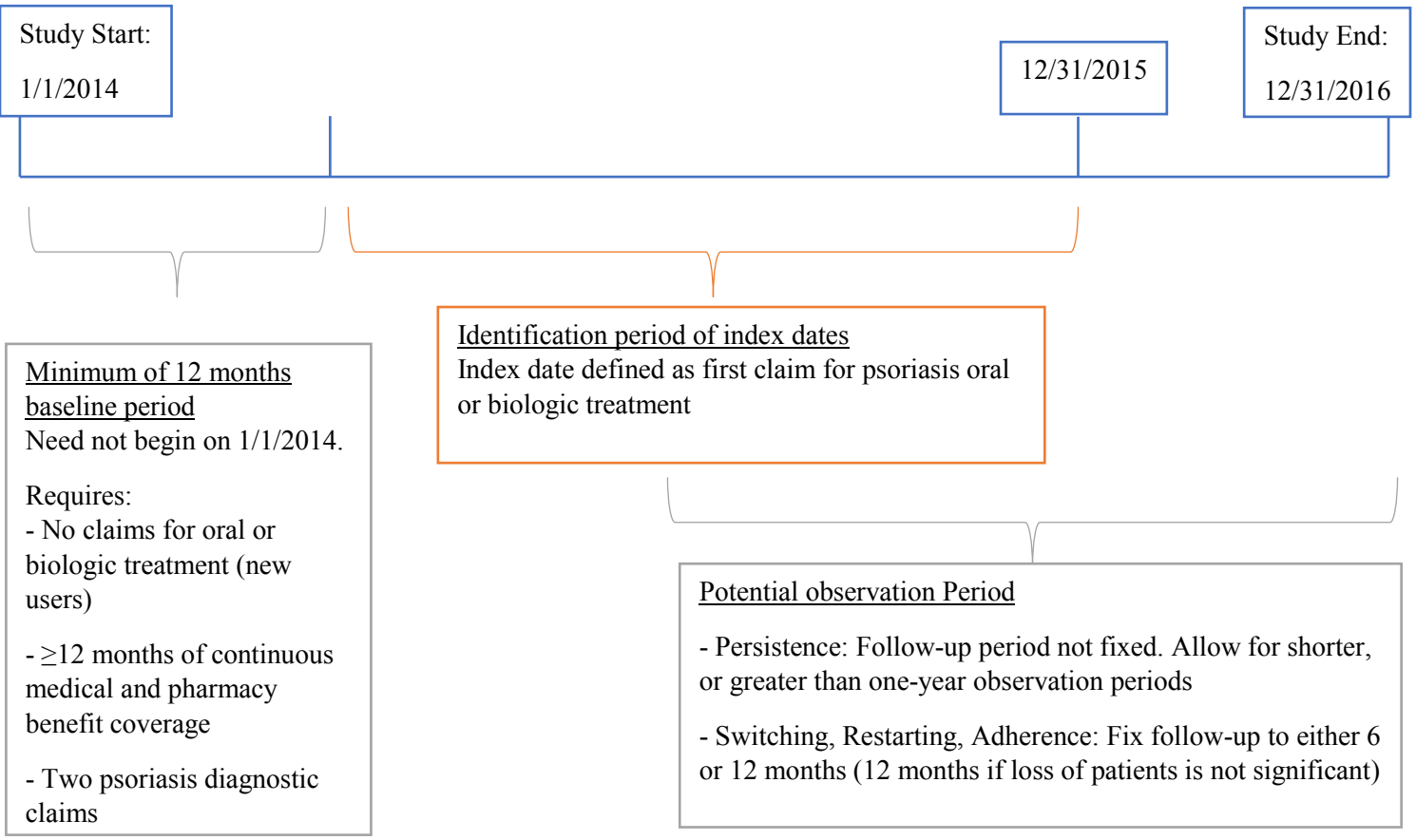
Fluocinonide	51672135302, 51672135303, 51672135304, 51672138601, 51672138602, 51672138603, 51672138604, 49999017215, 54569217700, 54569227500, 51862049415, 51862049430, 51862049460, 54569388700, 52959009301, 52959009302, 52959009303, 47781053226, 47781053272, 47781053273, 60429090415, 60429090430, 60429090460, 66267097315, 52959029915, 52959029930, 52959029960, 00168045704, 00168045730, 00168045760, 00093026215, 00093026230, 00093026292, 00093026315, 00093026330, 00093026392, 71085000401, 71085000560, 00472390115, 00472390130, 00472390160, 68462050535, 68462050565, 68462050566, 53002092068, 54868620400, 54868043101, 54868043102, 54868043103, 99207052510, 99207052530, 99207052560, 68682099210, 68682099230, 68682099260, 45802015153, 45802015194, 45802015196, 45861006401, 54868340800, 54868340801, 00115170552, 00115170645, 00115170758, 51672125301, 51672125302, 51672125303, 51672125304, 51672125401, 51672125402, 51672125403, 54569619300, 54868302300, 51672127901, 51672127902, 51672127903, 00713080360, 52959065260, 00093026592, 00168013515, 00168013560, 47781053326, 47781053372, 47781053373, 60429090715, 60429090730, 60429090760, 54569421000, 43199002915, 43199002930, 43199002960, 00168014015, 00168014030, 00168014060, 52959031501, 52959031503, 00093026415, 00093026430, 00093026492, 51672126401, 51672126402, 51672126403, 54868343501, 54868343502, 16714050201, 16714050202, 16714050203, 62991286501, 62991286502, 62991286503, 62991286504, 51552005601, 51552005602, 51927161600, 60429090860, 00168013460, 43199003120, 43199003160, 00472082902, 71085000660, 54868245101, 51672127302, 51672127304
Mometasone furoate	00781706627, 00085056701, 00085056702, 67405010045, 67405030045, 68462038502, 68462038537, 00085085401, 00085085402, 67405027560
Halcinonide	10631009420, 10631009430, 10631009476, 10631009620, 10631009630
Fluticasone propionate	00115147345, 00115147352, 00115147358, 45802022211, 45802022235, 45802022237, 10337033230, 10337033260, 54868533700, 00168033215, 00168033230, 00168033260, 54569619400, 00713063115, 00713063131, 00713063160, 00168043404, 00168043460, 68462042702, 10337043404, 45802044102, 45802022111, 45802022135, 45802022137, 00713063215, 00713063231, 00713063260, 54868545800
Betamethasone valerate	49999021815, 54569111500, 54569187301, 66267098415, 00472037015, 00472037045, 54868052000, 54868052001, 00168004015, 00168004046, 51672126901, 51672126906, 45802005301, 45802005302, 40076002100, 40076002150, 00378818050, 00378818099, 54868542400, 50742031501, 50742031550, 51672418803, 51672418807, 52959024303, 54569187401, 54879000460, 00168004160, 54868299402, 00713032715, 00713032737, 54569079300, 00168003315, 00168003346, 00472037115, 00472037145
Triamcinolone acetonide	49999015080, 49999028515, 61748021960, 00168033660, 00168033760, 00245013617, 00245013685
Hydrocortisone valerate	35356026615
Fluocinolone acetonide	00168005815, 00168005860, 00168006015, 00168006060
Prednicarbate	66993088061, 66993088060, 00168041015, 00168041060
Desonide	54868328400, 54868328401, 51672128001, 51672128003, 63187074715, 00472080415,

	00472080460, 00713066115, 00713066160, 69007077060, 45802042235, 45802042237, 69007076504, 51672407904, 51672407908, 54868505000, 00168031002, 00168031004, 00472080302, 00472080304, 45802042335, 45802042337, 54868445300, 54868445301, 00168030915, 00168030960, 51672128101, 51672128103
Hydrocortisone	63187030301, 63868020212, 68016001406, 68016001936, 68016002411, 68016010201, 49614040410, 49808038445, 49808038460, 49999016220, 49999016228, 49999041301, 51672201309, 50428167114, 59390002217, 00462015346, 00462015380, 00536510895, 00603053550, 00603778178, 01875052005, 10939008211, 10939052101, 10956067301, 11383018553, 12547023852, 35515094648, 40986001406, 40986001936, 40986002411, 41163025149, 41163026371, 41163040884, 41163047558, 61269010130, 83926011300, 51879011010, 60258004843, 41167003330, 43234018502, 00536510597, 00603778552, 10939052201, 10939052211, 10939027101, 41163026372, 35356022915, 40986002216, 46287000301, 46287000304, 46287000316, 68016000901, 68016002216
Alclometasone dipropionate	00168026315, 00168026345, 00168026360, 51672130601, 51672130603, 51672130606, 68462030017, 68462030047, 68462030065, 54868286100, 54868286101, 51672131601, 51672131603, 51672131606, 00168026415, 00168026445, 00168026460, 68462029917, 68462029947, 68462029965
Calcipotriene	00115147555, 00168040060, 00713031853, 00781711735, 00781711783, 00781716535, 00781716595, 45802098901, 45802098996, 50383073202, 51672415403, 51672415404, 66993087761, 66993087778, 66993087861, 66993087878, 68462050165, 68462050166
Calcitriol	00299201210, 45802060801
Tar	38779058505, 38779058508, 51927117000
Tazarotene	51672137302, 51672137303, 60758056130, 60758056160
Pimecrolimus	00187510001, 00187510002, 00187510003, 54868487800, 54868487801
Tacrolimus	45802039000, 45802039001, 45802039002, 45802070000, 45802070001, 45802070002, 00168041630, 00168041660, 00168041699, 00168041730, 00168041760, 00168041799
Anthralin	51552137902, 51552137904, 51927386900

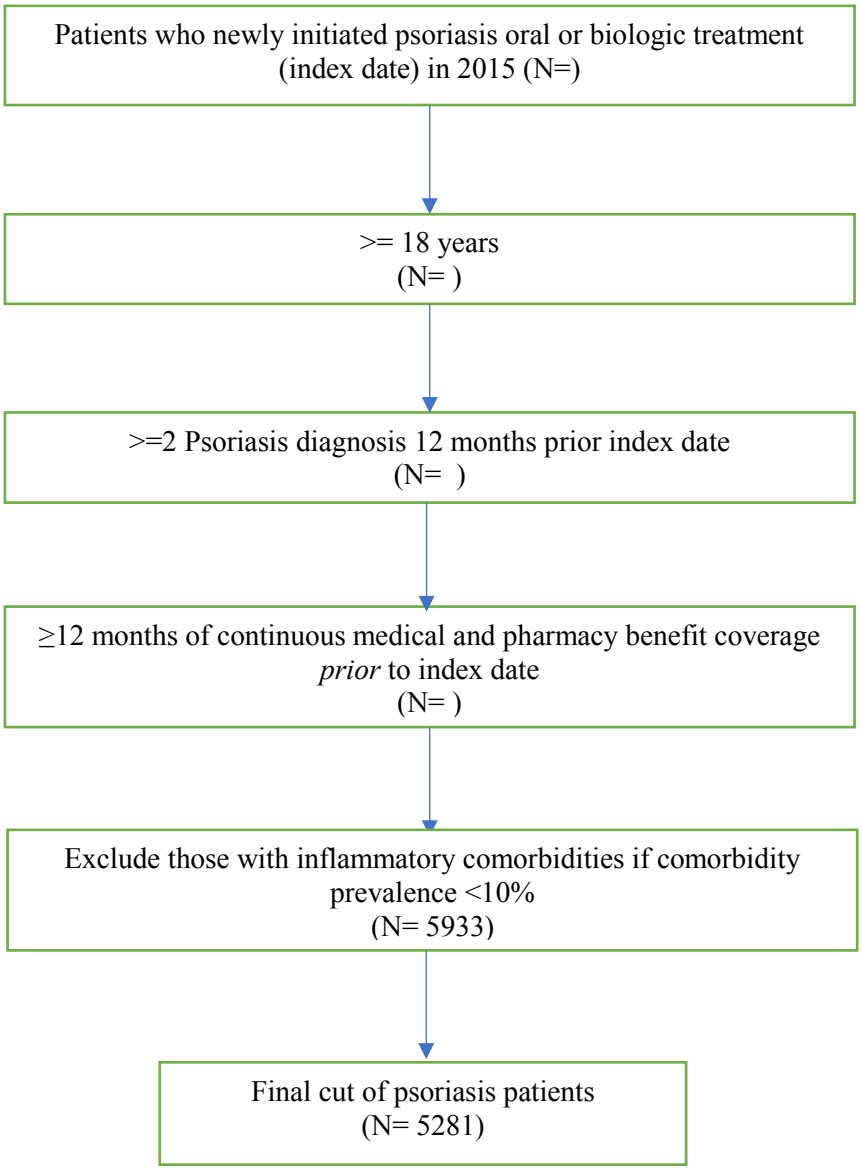
Appendix 3c. Psoriasis Procedures of Interest (Phototherapy, Laser)

Procedure	CPT	Description
Phototherapy		
PUVA	96912	Photochemotherapy; Psoralens and ultraviolet A (PUVA)
	96913	Photochemotherapy (Goeckerman and/or PUVA) for severe photoresponsive dermatoses requiring at least four to eight hours of care under direct supervision of the physician (includes application of medication and dressings)
UVB	96910	Photochemotherapy; tar & ultraviolet B (Goeckerman treatment) or petrolatum and ultraviolet B
Laser		
Laser	96920	Laser treatment for inflammatory skin disease (psoriasis); total area less than 250 sq cm
	96921	Laser treatment for inflammatory skin disease (psoriasis); total area 250 sq cm to 500 sq cm
	96922	Laser treatment for inflammatory skin disease (psoriasis); total area over 500 sq cm

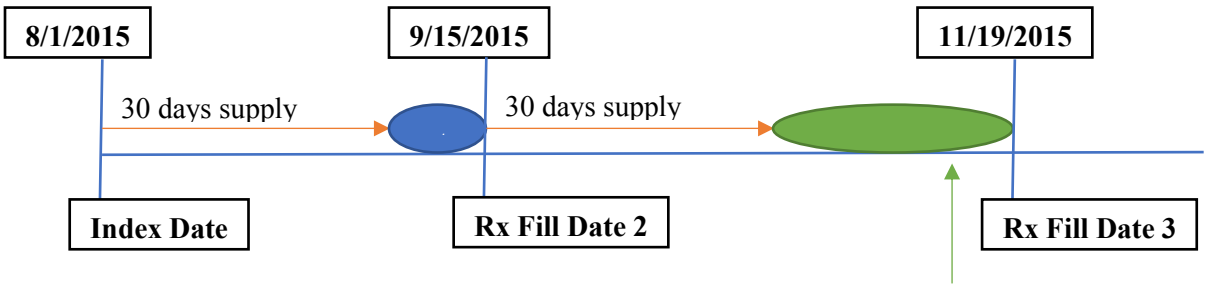
Appendix 4. Study Design



Appendix 5. Patient Selection Flow Chart


Patients who newly initiated psoriasis oral or biologic treatment (index date) in 2015 (N=)
>= 18 years (N=)
>=2 Psoriasis diagnosis 12 months prior index date (N=)
≥12 months of continuous medical and pharmacy benefit coverage *prior* to index date (N=)
Exclude those with inflammatory comorbidities if comorbidity prevalence <10% (N= 5933)
Final cut of psoriasis patients (N= 5281)

Appendix 6. Example Calculation of Persistence Variables



Time Variables (days)	Index Date	Rx Fill Date 2	Rx Fill Date 3
Time Since Index	0	45	110
Time Since Last Fill	0	45	65
Days Supply of Last Fill	0	30	30
Gap = Time Since Last Fill – Days Supply of Last Fill	NA	35	35
Time of Persistence Loss = [Service date in which gap >30 days] – gap + 31	NA	NA	105 Vertical green arrow signifies date of loss of persistence