**Do TNF Inhibitors (TNFi) Alter the Natural History of** **Ankylosing Spondylitis (AS) by Impacting the Incidence and Prevalence of Comorbidities and Extra-Articular Manifestations (EAMs)?**

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**Background:** TNFi treatment has led to reduction in signs and symptoms, improvement in physical function and quality of life in AS patients. Whether TNFi impact the incidence of AS-related comorbidities & EAMs is not known.

**Methods:** We conducted a retrospective cohort study using 3 commercial insurance claims databases (Multi-Payer Claims Database [MPCD 2007-2010], Truven MarketScan [2010-2014], and the US Medicare Fee-for-Service Claims data [2006-2014]) to evaluate EAMs (uveitis, psoriasis, inflammatory bowel disease) and physician-diagnosed comorbidities (cardiac, renal, pulmonary, neurologic) in AS patients diagnosed by a rheumatologist (index date), having 6-months baseline data prior to index date, and drug-specific exposures after AS diagnosis. Three mutually-exclusive hierarchical exposure groups were examined: (1) no therapy or prescription non-steroidal anti-inflammatory drugs (NSAIDs), (2) conventional disease modifying anti-rheumatic drugs (DMARDs), and (3) TNFi. Prevalence of comorbidities were ascertained in a 12-month period (6 months pre & post index date). Incidence of comorbidities & EAMs were ascertained during the period following treatment initiation and the earliest of death, loss of medical coverage, end of study, first outcome occurrence, treatment discontinuation or initiation of therapy at a higher level in exposure hierarchy. To ensure comparability of cohorts, a propensity score model predicting the propensity to be prescribed a TNFi using a multinomial logistic regression model was employed. Hazard ratios comparing TNFi versus DMARDs and no therapy or NSAIDs were estimated using inverse probability treatment weighted Cox proportional hazards models.

**Results:** Out of nearly 40 million beneficiaries, 37,566patients were included. Table 1 shows the prevalence of comorbidities and EAMs of AS, by treatment exposures, stratified by data source. As expected, comorbidities were more common in Medicare AS patients compared to MPCD or MarketScan in all exposure groups. Table 2 shows the incidence rates of outcomes by treatment exposures, stratified by data source. The propensity score matched incidence of solid cancers, myocardial infarction, conduction block, cord compression and vertebral fractures were lower in TNFi treated patients compared to those treated with NSAIDs or DMARDs alone, though TNFi treated Medicare patients had higher incidence of EAMs such as psoriasis, uveitis and ulcerative colitis.

**Conclusion**: This is the largest investigation of the prevalence & incidence of comorbidities & EAMs of AS within the US and suggests that TNFi have a complex effect on the incidence of comorbidities and EAMs of AS.

**Table 1:** Prevalence of physician-diagnosed comorbidities and EAMs during 12 months (6 months pre and 6 months post index date; per 100 cohort members), stratified by data source.

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| **Outcome categories** | **Specific manifestation** | **AS cohort** | | |
| **MPCD** | **Market Scan** | **Medicare** |
|  | N | 3,000 | 11,982 | 22,584 |
| Cancer | Hematologic Cancer | 0.5 | 0.6 | 1.6 |
| Non Melanoma Skin Cancer | 0.0 | 0.6 | 1.9 |
| Solid Cancer | 4.0 | 3.5 | 9.8 |
| Cardiac disease | Aortic Insufficiency/Aortic Regurgitation | 1.9 | 1.3 | 4.9 |
| Conduction Block | 0.6 | 1.3 | 4.5 |
| Myocardial infarction | 0.5 | 0.6 | 1.8 |
| Infection | Hospitalized infection | 5.2 | 6.9 | 19.4 |
| Opportunistic infection | 1.1 | 1.0 | 2.4 |
| Inflammatory bowel disease | Crohn’s Disease | 4.3 | 3.6 | 4.8 |
| Ulcerative Colitis | 2.5 | 2.6 | 2.7 |
| Kidney disease | Amyloidosis | 0.0 | 0.0 | 0.1 |
| IgA nephropathy | 0.1 | 0.1 | 0.2 |
| Nephrotic syndrome | 0.0 | 0.0 | 0.2 |
| Lung disease | Apical Pulmonary fibrosis | 0.0 | 0.0 | 0.0 |
| Interstitial lung disease | 0.1 | 0.1 | 0.7 |
| Restrictive lung disease | 1.3 | 1.4 | 3.2 |
| Neurological Disease | Cauda Equina syndrome | 0.1 | 0.1 | 0.2 |
| Spinal Cord compression | 0.2 | 0.2 | 0.9 |
| Osteoporotic fracture | Clinical vertebral fracture | 2.4 | 2.2 | 7.3 |
| Non-vertebral osteoporotic fracture | 2.9 | 1.9 | 4.5 |
| PsO/PsA | Psoriasis | 2.5 | 2.7 | 3.8 |
| Psoriatic arthritis | 3.7 | 4.1 | 5.0 |
| Uveitis | Uveitis | 7.0 | 7.6 | 4.0 |

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**Table 2:** Propensity score weighted hazard ratios of physician-diagnosed outcomes and EAMs by treatment exposures: 1) TNFi vs. NSAIDs/No treatment, 2) TNFi vs. DMARDs, stratified by data source.

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| **Outcome** | **Comparison** | **Data Source** | **N, TNF** | **N, Comparator** | **Hazard Ratio** | **Lower Bound** | **Upper Bound** |
| Hematologic Cancer | TNF vs DMARD | Marketscan | 4,790 | 1,790 | 0.40 | 0.14 | 1.10 |
| Hematologic Cancer | TNF vs DMARD | Medicare | 4,845 | 4,180 | 0.89 | 0.56 | 1.39 |
| Hematologic Cancer | TNF vs NSAID or no exposure | MPCD | 1,083 | 1,901 | 0.56 | 0.07 | 4.30 |
| Hematologic Cancer | TNF vs NSAID or no exposure | Marketscan | 4,790 | 7,884 | 0.49 | 0.21 | 1.17 |
| Hematologic Cancer | TNF vs NSAID or no exposure | Medicare | 4,845 | 17,740 | 0.67 | 0.47 | 0.97 |
| Non Melanoma Skin Cancer | TNF vs DMARD | MPCD | 1,083 | 421 | 1.96 | 0.54 | 7.03 |
| Non Melanoma Skin Cancer | TNF vs DMARD | Marketscan | 4,795 | 1,796 | 1.13 | 0.66 | 1.94 |
| Non Melanoma Skin Cancer | TNF vs DMARD | Medicare | 4,864 | 4,229 | 1.29 | 1.03 | 1.61 |
| Non Melanoma Skin Cancer | TNF vs NSAID or no exposure | MPCD | 1,083 | 1,901 | 1.51 | 0.74 | 3.07 |
| Non Melanoma Skin Cancer | TNF vs NSAID or no exposure | Marketscan | 4,795 | 7,897 | 1.22 | 0.83 | 1.80 |
| Non Melanoma Skin Cancer | TNF vs NSAID or no exposure | Medicare | 4,864 | 17,850 | 1.01 | 0.85 | 1.20 |
| Solid Cancer | TNF vs DMARD | MPCD | 1,074 | 417 | 1.75 | 0.68 | 4.55 |
| Solid Cancer | TNF vs DMARD | Marketscan | 4,740 | 1,751 | 0.86 | 0.58 | 1.26 |
| Solid Cancer | TNF vs DMARD | Medicare | 4,647 | 3,983 | 1.23 | 1.02 | 1.50 |
| Solid Cancer | TNF vs NSAID or no exposure | MPCD | 1,074 | 1,880 | 0.63 | 0.36 | 1.11 |
| Solid Cancer | TNF vs NSAID or no exposure | Marketscan | 4,740 | 7,794 | 0.73 | 0.55 | 0.96 |
| Solid Cancer | TNF vs NSAID or no exposure | Medicare | 4,647 | 17,285 | 0.76 | 0.65 | 0.88 |
| Aortic Insufficiency/Aortic Regurgitation | TNF vs DMARD | Marketscan | 4,771 | 1,785 | 1.13 | 0.57 | 2.24 |
| Aortic Insufficiency/Aortic Regurgitation | TNF vs DMARD | Medicare | 4,735 | 4,105 | 1.14 | 0.90 | 1.44 |
| Aortic Insufficiency/Aortic Regurgitation | TNF vs NSAID or no exposure | MPCD | 1,077 | 1,895 | 0.54 | 0.24 | 1.23 |
| Aortic Insufficiency/Aortic Regurgitation | TNF vs NSAID or no exposure | Marketscan | 4,771 | 7,863 | 0.99 | 0.61 | 1.61 |
| Aortic Insufficiency/Aortic Regurgitation | TNF vs NSAID or no exposure | Medicare | 4,735 | 17,568 | 0.85 | 0.70 | 1.03 |
| Conduction Block | TNF vs DMARD | Marketscan | 4,773 | 1,785 | 1.34 | 0.64 | 2.78 |
| Conduction Block | TNF vs DMARD | Medicare | 4,764 | 4,126 | 1.22 | 0.96 | 1.56 |
| Conduction Block | TNF vs NSAID or no exposure | MPCD | 1,082 | 1,899 | 0.84 | 0.17 | 4.28 |
| Conduction Block | TNF vs NSAID or no exposure | Marketscan | 4,773 | 7,849 | 0.98 | 0.63 | 1.53 |
| Conduction Block | TNF vs NSAID or no exposure | Medicare | 4,764 | 17,524 | 0.85 | 0.69 | 1.04 |
| Myocardial infarction | TNF vs DMARD | Marketscan | 4,785 | 1,791 | 1.38 | 0.47 | 4.10 |
| Myocardial infarction | TNF vs DMARD | Medicare | 4,820 | 4,186 | 0.79 | 0.57 | 1.08 |
| Myocardial infarction | TNF vs NSAID or no exposure | MPCD | 1,080 | 1,900 | 2.92 | 0.80 | 10.69 |
| Myocardial infarction | TNF vs NSAID or no exposure | Marketscan | 4,785 | 7,869 | 0.90 | 0.44 | 1.84 |
| Myocardial infarction | TNF vs NSAID or no exposure | Medicare | 4,820 | 17,702 | 0.70 | 0.53 | 0.92 |
| Hospitalized infection | TNF vs DMARD | MPCD | 1,083 | 421 | 1.57 | 0.74 | 3.30 |
| Hospitalized infection | TNF vs DMARD | Marketscan | 4,795 | 1,796 | 0.97 | 0.77 | 1.21 |
| Hospitalized infection | TNF vs DMARD | Medicare | 4,864 | 4,229 | 0.88 | 0.80 | 0.97 |
| Hospitalized infection | TNF vs NSAID or no exposure | MPCD | 1,083 | 1,901 | 0.80 | 0.53 | 1.21 |
| Hospitalized infection | TNF vs NSAID or no exposure | Marketscan | 4,795 | 7,897 | 0.80 | 0.69 | 0.93 |
| Hospitalized infection | TNF vs NSAID or no exposure | Medicare | 4,864 | 17,850 | 0.76 | 0.70 | 0.82 |
| Opportunistic infection | TNF vs DMARD | MPCD | 1,083 | 421 | 1.26 | 0.20 | 7.98 |
| Opportunistic infection | TNF vs DMARD | Marketscan | 4,795 | 1,796 | 0.78 | 0.41 | 1.48 |
| Opportunistic infection | TNF vs DMARD | Medicare | 4,864 | 4,229 | 0.92 | 0.68 | 1.25 |
| Opportunistic infection | TNF vs NSAID or no exposure | MPCD | 1,083 | 1,901 | 2.41 | 0.53 | 10.84 |
| Opportunistic infection | TNF vs NSAID or no exposure | Marketscan | 4,795 | 7,897 | 1.51 | 0.90 | 2.52 |
| Opportunistic infection | TNF vs NSAID or no exposure | Medicare | 4,864 | 17,850 | 0.93 | 0.72 | 1.21 |
| Crohn’s Disease | TNF vs DMARD | MPCD | 1,042 | 407 | 1.60 | 0.59 | 4.36 |
| Crohn’s Disease | TNF vs DMARD | Marketscan | 4,596 | 1,734 | 2.60 | 1.47 | 4.60 |
| Crohn’s Disease | TNF vs DMARD | Medicare | 4,515 | 3,966 | 1.51 | 1.08 | 2.09 |
| Crohn’s Disease | TNF vs NSAID or no exposure | MPCD | 1,042 | 1,874 | 1.06 | 0.61 | 1.84 |
| Crohn’s Disease | TNF vs NSAID or no exposure | Marketscan | 4,596 | 7,786 | 1.50 | 1.13 | 2.00 |
| Crohn’s Disease | TNF vs NSAID or no exposure | Medicare | 4,515 | 17,493 | 1.08 | 0.84 | 1.37 |
| Ulcerative Colitis | TNF vs DMARD | MPCD | 1,064 | 414 | 5.56 | 0.72 | 42.82 |
| Ulcerative Colitis | TNF vs DMARD | Marketscan | 4,682 | 1,773 | 0.89 | 0.55 | 1.44 |
| Ulcerative Colitis | TNF vs DMARD | Medicare | 4,695 | 4,072 | 1.44 | 1.05 | 1.97 |
| Ulcerative Colitis | TNF vs NSAID or no exposure | MPCD | 1,064 | 1,884 | 0.95 | 0.48 | 1.90 |
| Ulcerative Colitis | TNF vs NSAID or no exposure | Marketscan | 4,682 | 7,843 | 1.13 | 0.84 | 1.52 |
| Ulcerative Colitis | TNF vs NSAID or no exposure | Medicare | 4,695 | 17,670 | 1.29 | 1.03 | 1.63 |
| Amyloidosis | TNF vs DMARD | MPCD | 1,083 | 421 | 1.01 | 1.01 | 1.01 |
| Amyloidosis | TNF vs NSAID or no exposure | Medicare | 4,859 | 17,843 | 2.54 | 0.49 | 13.10 |
| IgA nephropathy | TNF vs DMARD | Medicare | 4,853 | 4,219 | 2.10 | 0.90 | 4.92 |
| IgA nephropathy | TNF vs NSAID or no exposure | MPCD | 1,082 | 1,900 | 5.71 | 0.57 | 57.00 |
| IgA nephropathy | TNF vs NSAID or no exposure | Marketscan | 4,792 | 7,894 | 1.25 | 0.38 | 4.18 |
| IgA nephropathy | TNF vs NSAID or no exposure | Medicare | 4,853 | 17,833 | 1.33 | 0.75 | 2.33 |
| Nephrotic syndrome | TNF vs DMARD | Marketscan | 4,793 | 1,796 | 0.60 | 0.08 | 4.33 |
| Nephrotic syndrome | TNF vs DMARD | Medicare | 4,858 | 4,222 | 1.37 | 0.55 | 3.42 |
| Nephrotic syndrome | TNF vs NSAID or no exposure | Marketscan | 4,793 | 7,897 | 1.24 | 0.22 | 6.94 |
| Nephrotic syndrome | TNF vs NSAID or no exposure | Medicare | 4,858 | 17,844 | 1.84 | 0.93 | 3.63 |
| Interstitial lung disease | TNF vs DMARD | MPCD | 1,083 | 421 | 1.02 | 0.87 | 1.19 |
| Interstitial lung disease | TNF vs DMARD | Marketscan | 4,792 | 1,795 | 1.30 | 0.14 | 11.81 |
| Interstitial lung disease | TNF vs DMARD | Medicare | 4,841 | 4,189 | 0.85 | 0.53 | 1.37 |
| Interstitial lung disease | TNF vs NSAID or no exposure | MPCD | 1,083 | 1,901 | 1.01 | 0.91 | 1.12 |
| Interstitial lung disease | TNF vs NSAID or no exposure | Marketscan | 4,792 | 7,892 | 2.22 | 0.38 | 12.80 |
| Interstitial lung disease | TNF vs NSAID or no exposure | Medicare | 4,841 | 17,791 | 1.56 | 1.02 | 2.39 |
| Restrictive lung disease | TNF vs DMARD | Marketscan | 4,769 | 1,780 | 1.35 | 0.67 | 2.73 |
| Restrictive lung disease | TNF vs DMARD | Medicare | 4,737 | 4,088 | 1.04 | 0.83 | 1.31 |
| Restrictive lung disease | TNF vs NSAID or no exposure | MPCD | 1,080 | 1,891 | 1.02 | 0.37 | 2.83 |
| Restrictive lung disease | TNF vs NSAID or no exposure | Marketscan | 4,769 | 7,853 | 1.04 | 0.66 | 1.62 |
| Restrictive lung disease | TNF vs NSAID or no exposure | Medicare | 4,737 | 17,629 | 1.00 | 0.83 | 1.19 |
| Cauda Equina syndrome | TNF vs DMARD | MPCD | 1,083 | 421 | 1.02 | 0.88 | 1.19 |
| Cauda Equina syndrome | TNF vs DMARD | Marketscan | 4,795 | 1,796 | 0.85 | 0.08 | 9.34 |
| Cauda Equina syndrome | TNF vs DMARD | Medicare | 4,861 | 4,224 | 15.92 | 1.87 | 135.76 |
| Cauda Equina syndrome | TNF vs NSAID or no exposure | Medicare | 4,861 | 17,837 | 2.52 | 0.98 | 6.51 |
| Spinal Cord compression | TNF vs DMARD | MPCD | 1,083 | 421 | 1.00 | 0.86 | 1.16 |
| Spinal Cord compression | TNF vs DMARD | Marketscan | 4,792 | 1,794 | 0.74 | 0.20 | 2.73 |
| Spinal Cord compression | TNF vs DMARD | Medicare | 4,846 | 4,208 | 0.59 | 0.33 | 1.06 |
| Spinal Cord compression | TNF vs NSAID or no exposure | Marketscan | 4,792 | 7,891 | 0.70 | 0.33 | 1.48 |
| Spinal Cord compression | TNF vs NSAID or no exposure | Medicare | 4,846 | 17,805 | 0.49 | 0.31 | 0.76 |
| Clinical vertebral fracture | TNF vs DMARD | MPCD | 1,079 | 420 | 1.88 | 0.23 | 15.06 |
| Clinical vertebral fracture | TNF vs DMARD | Marketscan | 4,777 | 1,792 | 1.10 | 0.48 | 2.52 |
| Clinical vertebral fracture | TNF vs DMARD | Medicare | 4,741 | 4,088 | 0.96 | 0.76 | 1.21 |
| Clinical vertebral fracture | TNF vs NSAID or no exposure | MPCD | 1,079 | 1,892 | 0.84 | 0.36 | 1.98 |
| Clinical vertebral fracture | TNF vs NSAID or no exposure | Marketscan | 4,777 | 7,826 | 0.51 | 0.30 | 0.87 |
| Clinical vertebral fracture | TNF vs NSAID or no exposure | Medicare | 4,741 | 17,263 | 0.69 | 0.57 | 0.83 |
| Non-vertebral osteoporotic fracture | TNF vs DMARD | MPCD | 1,073 | 416 | 1.23 | 0.37 | 4.17 |
| Non-vertebral osteoporotic fracture | TNF vs DMARD | Marketscan | 4,758 | 1,782 | 1.25 | 0.73 | 2.13 |
| Non-vertebral osteoporotic fracture | TNF vs DMARD | Medicare | 4,692 | 4,050 | 0.97 | 0.80 | 1.19 |
| Non-vertebral osteoporotic fracture | TNF vs NSAID or no exposure | MPCD | 1,073 | 1,884 | 0.62 | 0.32 | 1.20 |
| Non-vertebral osteoporotic fracture | TNF vs NSAID or no exposure | Marketscan | 4,758 | 7,816 | 1.05 | 0.76 | 1.45 |
| Non-vertebral osteoporotic fracture | TNF vs NSAID or no exposure | Medicare | 4,692 | 17,452 | 0.94 | 0.80 | 1.10 |
| Psoriasis | TNF vs DMARD | MPCD | 1,062 | 416 | 2.41 | 0.66 | 8.81 |
| Psoriasis | TNF vs DMARD | Marketscan | 4,664 | 1,756 | 1.35 | 0.87 | 2.09 |
| Psoriasis | TNF vs DMARD | Medicare | 4,590 | 4,034 | 1.11 | 0.88 | 1.41 |
| Psoriasis | TNF vs NSAID or no exposure | MPCD | 1,062 | 1,885 | 1.65 | 0.95 | 2.86 |
| Psoriasis | TNF vs NSAID or no exposure | Marketscan | 4,664 | 7,833 | 1.66 | 1.28 | 2.17 |
| Psoriasis | TNF vs NSAID or no exposure | Medicare | 4,590 | 17,595 | 1.37 | 1.14 | 1.65 |
| Psoriatic arthritis | TNF vs DMARD | MPCD | 1,038 | 403 | 1.29 | 0.54 | 3.09 |
| Psoriatic arthritis | TNF vs DMARD | Marketscan | 4,550 | 1,727 | 0.77 | 0.55 | 1.08 |
| Psoriatic arthritis | TNF vs DMARD | Medicare | 4,405 | 3,940 | 1.29 | 1.00 | 1.66 |
| Psoriatic arthritis | TNF vs NSAID or no exposure | MPCD | 1,038 | 1,882 | 1.82 | 1.04 | 3.16 |
| Psoriatic arthritis | TNF vs NSAID or no exposure | Marketscan | 4,550 | 7,808 | 2.02 | 1.54 | 2.65 |
| Psoriatic arthritis | TNF vs NSAID or no exposure | Medicare | 4,405 | 17,533 | 1.92 | 1.57 | 2.35 |
| Uveitis | TNF vs DMARD | MPCD | 1,020 | 394 | 0.88 | 0.45 | 1.70 |
| Uveitis | TNF vs DMARD | Marketscan | 4,489 | 1,703 | 1.29 | 0.92 | 1.81 |
| Uveitis | TNF vs DMARD | Medicare | 4,542 | 3,998 | 1.39 | 1.09 | 1.77 |
| Uveitis | TNF vs NSAID or no exposure | MPCD | 1,020 | 1,841 | 0.81 | 0.52 | 1.25 |
| Uveitis | TNF vs NSAID or no exposure | Marketscan | 4,489 | 7,686 | 0.87 | 0.72 | 1.06 |
| Uveitis | TNF vs NSAID or no exposure | Medicare | 4,542 | 17,547 | 1.21 | 1.02 | 1.44 |

**CONFLICTS:**

* AD has received research grants from Amgen, Eli Lilly, GSK, Janssen, Novartis, UCB; and has served on the advisory boards of Eli Lilly, Janssen, Novartis, UCB
* JC has research grants and consulting with UCB, Janssen, Amgen, Roche, Myriad Genetics, Lilly, Novartis, BMS, and Pfizer
* KLW has consulting with UCB, Roche, Lilly, Pfizer, GSK, AbbVie, Galapagos, and BMS; and has research grants with BMS.
* HY has research grants from BMS
* LP, JS, RYS are employed by UCB Biosciences, the sponsor of this study.
* RLB is a Contractor for UCB and Owner of Bohn Epidemiology, LLC; There are no conflicts with other clients