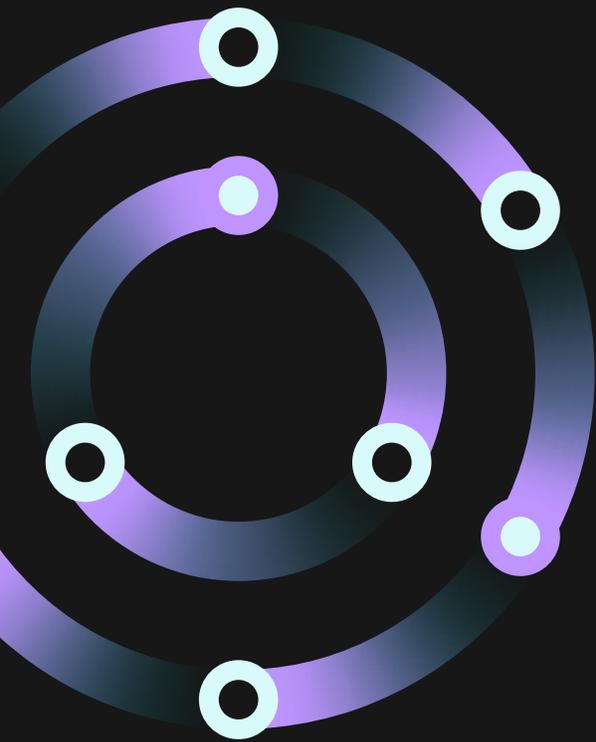


# IBM Watson Health data in action: Epidemiology studies



# Introduction

Access to the IBM MarketScan® Research Databases, Explorys® EHR data, combined claims-EHR data, and IBM Micromedex® offers opportunities for innovative research using complementary data sets.

For several decades, IBM® Watson Health™ researchers have been conducting epidemiology and outcomes research, consultation and collaboration on the execution of pre- and post-launch research agendas. Our researchers and our databases are known for high-quality studies in the US and abroad, as evidenced by our publication record and client feedback. While we keenly understand the complexity of using US administrative data to demonstrate product value, we also employ a global perspective through our access to and experience with international data. We have demonstrated market leadership in using linked claims, clinical and other patient-level data, enabling researchers to uncover critical insights.

This technical paper summarizes several epidemiology studies utilizing IBM Watson Health proprietary databases.

Please see the end of this paper for specifics about these databases.

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## Treatment patterns, adherence and persistence

With data from IBM Watson Health, epidemiologists can describe treatment patterns, persistence and adherence to therapy. The following studies illustrate the value of using IBM Watson Health data for this type of research.

### **Treatment patterns and associated healthcare costs before and after treatment initiation among pulmonary arterial hypertension patients in the United States**

This analysis aimed to provide a characterization of treatment patterns, health care utilization and costs in real-world settings by comparing periods before and after initiating pulmonary arterial hypertension (PAH)-specific treatment. This retrospective study identified PAH patients in the MarketScan Commercial and Medicare Supplemental Databases between 2010 and 2014 who initiated treatment with endothelin receptor antagonists (ERAs), phosphodiesterase-5 inhibitors (PDE-5Is), or soluble guanylate cyclase (sGC) stimulators. The index date was the date of the first PAH pharmacy claim. Outcomes were assessed 6 months before and after the index date. Treatment patterns were assessed at the drug class level (ERAs, PDE-5Is, sGC stimulators, and prostacyclins) using outpatient pharmacy claims. Time on therapy was determined via the days' supply recorded on the pharmacy claims. Treatment interruption was defined as a gap of 30 or more days. In addition to treatment patterns, all-cause and PAH-related utilization and costs were measured. McNemar's and paired t-tests were used to compare patients' health care resource utilization and costs in the 6-month pre- and post-treatment periods. Approximately 5% of patients initiated on combination therapy (i.e. more than one class concurrently). Treatment interruption of any PAH-specific medication was observed in over a third of patients. This study provided real-world evidence of current treatment patterns, including low prevalence of combination therapy. Recently published trials supporting the clinical benefit of combination therapy may lead to an increase in prescribing combination therapy in the future.

*Burger CD, Ozbay AB, Lazarus HM, Riehle E, Montejano LB, Lenhart G, White RJ. Treatment Patterns and Associated Health Care Costs Before and After Treatment Initiation Among Pulmonary Arterial Hypertension Patients in the United States. J Manag Care Spec Pharm. 2018 Aug;24(8):834–842.*

### **Long-term treatment patterns of prophylactic and acute migraine medications and incidence of opioid-related adverse events in patients with migraine**

The aim of this analysis was to describe the long-term treatment patterns in migraine patients initiating prophylactic therapy and to evaluate acute medication use and adverse events associated with opioids. The 2005–2014 IBM MarketScan databases were used to evaluate migraine patients initiating prophylactic medication.

Outcome measures included persistence with prophylactic migraine medications over 2–5 years. Acute medication use and gastrointestinal-related adverse events and opioid abuse following opioid use were also evaluated via the pharmacy and medical claims. Cox proportional hazards models were used to evaluate predictors of non-persistence and predictors of gastrointestinal-related AEs and opioid abuse associated with long-term opioid use. This study found that non-persistence to prophylactic treatment was frequent among migraine patients. Opioid use was common in migraine patients and the risk of gastrointestinal-related adverse events and opioid abuse increased with long-term use of opioids. These results suggest a need for more effective prophylactic migraine treatments.

*Bonafede M, Wilson K, Xue F. Long-term treatment patterns of prophylactic and acute migraine medications and incidence of opioid-related adverse events in patients with migraine. Cephalalgia. 2019 Feb 28 [Epub ahead of print]*

### **Women with newly diagnosed uterine fibroids: treatment patterns and cost comparison for select treatment options**

The objective of this study was to describe surgical treatment patterns among women with newly diagnosed uterine fibroids (UF). Women aged at least 30 years with a new diagnosis for UF were selected from the MarketScan Commercial and Medicare Supplemental Databases (2011–2016). The proportion of patients undergoing a surgical or radiologic procedure (hysterectomy, myomectomy, endometrial ablation, uterine artery embolization, and curettage) in the 12 months post-diagnosis was assessed via administrative claims. Each year in the study period, 2011 to 2016, was described separately in order to examine if treatment patterns changed over time. Among women who met selection criteria, approximately 1 in 3 underwent a surgical procedure. An increase was observed over time (i.e. from 2011 to 2016) in the percentage of women undergoing outpatient hysterectomy and hysteroscopic myomectomy. Hysterectomy was the most common surgical intervention. Patients undergoing inpatient hysterectomy had the highest healthcare costs. Minimally invasive approaches are becoming more common; however, they are performed infrequently in patients with newly diagnosed UF. The results of this study may be useful in guiding decisions regarding the most appropriate and cost-effective surgical treatment for UF.

*Bonafede MM, Pohlman SK, Miller JD, Thiel E, Troeger KA, Miller CE. Women with Newly Diagnosed Uterine Fibroids: Treatment Patterns and Cost Comparison for Select Treatment Options. Popul Health Manag. 2018 Mar;21(S1):S13–S20.*



## Treatment outcomes and adverse events

Due to their size and longitudinal integrity, IBM Watson Health data assets enable epidemiologists to examine shifts in treatment patterns, compare the impact of various interventions on outcomes and understand the context around adverse events.

### **Economic burden associated with adverse events of special interest in patients with relapsed Philadelphia chromosome-negative B-cell acute lymphoblastic leukemia in the United States**

The occurrence of adverse events (AEs) in acute lymphoblastic leukemia (ALL) do not only impose complications to treatment but also impact quality of life and patient survival. This study used the MarketScan Commercial Claims and Encounters Database from 2008–2016 to investigate the rate of AEs within a population of adults with relapsed Philadelphia chromosome negative B-cell ALL. AEs were common over the variable post-period (maximum of 100 days), with 92.5% of the sample evidencing at least one AE. The most common AEs were infection (64.6%), cytopenia (94.6%), and gastrointestinal toxicities (46.2%). AEs were frequently tied to hospitalization with 21.0% of events resulting in hospitalization and 94.3% of patients with an event requiring hospitalization. Results from this study defined the substantial burden of AEs in the treatment and management of relapsed ALL.

*Zhang X, Song X, Lopez-Gonzalez L, Jariwala-Parikh K, Cong Z. Economic bur-den associated with adverse events of special interest in patients with relapsed Philadelphia chromosome-negative B-cell acute lymphoblastic leukemia in the United States. Expert Review of Pharmacoeconomics & Outcomes Research. 2018;18(5):573–580.*

### **Long-term treatment patterns of prophylactic and acute migraine medications and incidence of opioid-related adverse events in patients with migraine**

Opioids are one of the various analgesics used to address acute migraine pain; however, these agents can be associated with various adverse events. Patients with a migraine diagnosis were identified within the MarketScan Commercial and Medicare Supplemental Database from 2005–2014. Rates of acute medication utilization along with gastrointestinal related adverse events and opioid abuse were investigated within the population over the 2–5 year post-period. Opioids were the most commonly prescribed acute pain medication, with 77.4% of patients evidencing at least one opioid prescription. Gastrointestinal related adverse events were somewhat common among opioid users with nausea/vomiting (16.6%), constipation (12.2%), and diarrhea (10.4%) being the most common. Opioid abuse diagnoses were rare, observed in <1% of opioid users. A trend towards an increased number of adverse events with increasing opioid days' supply was observed within opioid users. The results from this study indicate that adverse effects associated with the use of opioid analgesics are fairly common within migraineurs; methods to help reduce these effects could help to improve patient outcomes.

*Bonafede M, Wilson K, Xue F. Long-term treatment patterns of prophylactic and acute migraine medications and incidence of opioid-related adverse events in patients with migraine. Cephalagia. 2019;39(9):1086–1098.*

### **Association between glucocorticoid exposure and healthcare expenditures for potential glucocorticoid-related adverse events in patients with rheumatoid arthritis**

Oral glucocorticoids can be effective in reducing the inflammation that drives tissue damage in rheumatoid arthritis. However, their prolonged use is associated with various adverse events. This study investigated the relationship between oral glucocorticoid use and the incidence of associated adverse events within the MarketScan Commercial and Medicare Supplemental Database from 2012–2013. The sample was composed of adults with rheumatoid arthritis. Cumulative oral glucocorticoid use was investigated during the one-year baseline period, while the rate of adverse events was assessed over a one-year evaluation period. Just under half the sample (48%) had evidence of glucocorticoid use during the baseline period. Of these patients 26% evidenced an adverse event during the evaluation period. A cumulative oral glucocorticoid dose that was >1800mg over the baseline period was associated with a 19% increase in the odds of developing an adverse event over the evaluation period. The results of this study indicate that longer term oral glucocorticoid use is associated with the development of treatment-related adverse events in RA; treatment plans that reduce patient dependence on oral glucocorticoids could help to improve disease management.

*Best JH, Kong AM, Lenhart GM, Sarsour K, Stott-Miller M, Hwang Y. Association between glucocorticoid exposure and healthcare expenditures for potential gluco-corticoid-related adverse events in patients with rheumatoid arthritis. Journal of Rheumatology. 2018;45(3).*

### **Comparison of treatment-related adverse events recorded in administrative claims data with those recorded in electronic medical records for cancer patients**

This analysis was designed to evaluate whether adverse events (AE) data are better represented in an oncology-specific electronic medical records (EMR) database, an administrative claims database or a linked claims-EMR database for studying oncology outcomes research. Using multiple myeloma as a test case, researchers sought to understand the differences in the occurrence of selected AEs recorded in an oncology EMR database compared with an administrative claims database, as well as the occurrence of selected AEs using a patient-level linked claims-oncology EMR database.

EMR data do not typically contain information about health events occurring outside the clinical practice using that specific EMR system, while claims data provide the complete continuum of care. AEs typically monitored through routine laboratory values (such as neutropenia or thrombocytopenia) or by direct observations during follow-up visits (such as peripheral neuropathy) were recorded more often in the EMR compared to the claims data. AEs such as venous thromboembolism often resulted in inpatient admissions and were more likely to be recorded in the claims data compared to the EMR.

Similarly, conditions such as diarrhea, which may be due to a variety of causes including a chemotherapy-related AE or general gastrointestinal illnesses, were recorded more often in claims data compared to EMRs. This research suggests that linked claims-EMR data provide the most complete assessment of potential treatment for AEs and further support using a linked claims-EMR data source for oncology research.

*Irwin DE, Varker H, Prinicic N, Farr A. Comparison of treatment-related adverse events recorded in administrative claims data with those recorded in electronic medical records for multiple myeloma patients. Presented at ISPOR 2015 Philadelphia.*



## Pregnancy exposure studies and mother-infant linked outcomes

The IBM Watson Health data assets support linkages between mother and infants, enabling researchers to examine associations between exposures during pregnancy and infant outcomes.

### **Clinical Outcomes and Healthcare Expenditures in the First Year of Life among Infants of Mothers with Preeclampsia: An Analysis of Linked Maternal and Infant Insurance Claims**

Women with an infant delivery were identified in the MarketScan Commercial Database and linked to their newborns to describe outcomes among the infants stratified by whether or not the mother experienced preeclampsia during the pregnancy. Women aged 15–50 with evidence of a singleton delivery between January 1, 2010 and September 30, 2015 were selected and required to have at least 12 months of continuous enrollment before and after the delivery date to be included in the study. Infants linked to their mothers were identified as dependent children with birth dates that coincided with the delivery date and were also required to be continuously enrolled for 12 months following their birthdate. A total of 557,481 mother-infant pairs were identified that met all of the patient selection criteria. Maternal preeclampsia was identified if a diagnosis of preeclampsia was present during the pregnancy and prior to delivery. Infant clinical outcomes and healthcare expenditures were assessed using medical claims in the 12 months following birth and compared based on whether or not a diagnosis of maternal preeclampsia was present during the pregnancy. The proportion of deliveries resulting in cesarean section (55.9% vs. 36.6%) and preterm delivery (15.3% vs. 5.4%) were higher in the cohort of infants with maternal preeclampsia ( $p < 0.001$  for all) compared to the cohort without maternal preeclampsia. Adverse infant clinical outcomes, including congenital anomalies (27.6% vs. 22.1%), low birthweight (18.9% vs. 5.0%), and feeding problems (38.3% vs. 32.3%) were also significantly more common in infants with maternal preeclampsia ( $p < 0.001$  for all) compared to those without preeclampsia. Infant all-cause total health care expenditures (\$34,034 vs. \$15,067) and inpatient (\$28,295 vs. \$10,383) costs in the first year of life were significantly higher in infants with maternal preeclampsia; outpatient (\$5,739 vs. \$4,426) and pharmacy costs (\$436 vs. \$258) were also significantly higher ( $p < 0.001$  for all) compared to infants without maternal preeclampsia.

The observed differences in total medical expenditures and inpatient expenditures remained statistically significant after excluding expenditures related to the birth. It is feasible to link mothers with their newborn infants to evaluate health outcomes and healthcare related expenditures based on maternal prenatal comorbidities. Healthcare expenditures for all types of healthcare resource use were significantly higher in the first year of life in infants with maternal preeclampsia and these differences are likely attributable to the increased rate of preterm delivery and low birthweight in infants with maternal preeclampsia.

*Packnett ER, Varker HV, Evans KA, Irwin DE. Clinical Outcomes and Healthcare Expenditures in the First Year of Life among Infants of Mothers with Preeclampsia: An Analysis of Linked Maternal and Infant Insurance Claims. Presented ISPOR 2020.*

## Healthcare Resource Utilization and Costs in Children of Mothers with and without Postpartum Depression in the United States

This study used a population of infants linked to their mothers and compared the prevalence of adverse clinical morbidities and healthcare resource utilization (HRU) and costs in the first two years of life comparing children of mothers with and without postpartum depression (PPD). Women aged 15–50 years with a diagnosis or procedure code indicating a singleton delivery were identified in the MarketScan Commercial Database. Women included in the study were required to have 12 months continuous enrollment before and after the date of delivery. Children within the same family of eligible mothers and listed as dependents were identified, linked to their mothers, and were required to have 24 months of continuous enrollment following the index date. The mother-child pairs were stratified into cohorts based on the mother's PPD status. Mother-child pairs where the mother met at least one criteria for PPD between 15 and 365 days after the date of delivery were included in the PPD exposure cohort. Mother-child pairs with PPD exposure were propensity score matched 1:3 to mother-child pairs without PPD exposure. Clinical outcomes and HRU were assessed during the 24 month follow-up period and compared in children with maternal PPD exposure and children without maternal PPD exposure. During the 24 month follow-up period, adverse clinical morbidities such as major and minor congenital anomalies, feeding problems, fussiness/excessive crying, and vomiting were significantly higher among children of mothers with PPD. HRU across most service categories was significantly higher among children in the PPD exposure cohort than non-PPD exposure cohort during the 24 month follow-up period. Among outpatient services, the percentages of children with a physician specialist service, early-intervention screening, and an emergency room visit were greater in children of mothers with PPD. Furthermore, children of mothers with PPD incurred 12% higher total healthcare costs in the first 24 months of life compared to children of mothers without PPD. The results of this insurance claim-based analysis suggest that HRU and costs over the first 24 months of life in children of mothers with PPD exceeded that of children of mothers without evidence of PPD.

Moore Simas TA, Huang M, Packnett ER, Zimmerman NM, Moynihan M, Eldar-Lissai A. *Healthcare Resource Utilization and Costs in Children of Mothers with and without Postpartum Depression in the United States. Journal of Medical Economics.* 2019.

## Maternal Immunization in the United States: A Nationwide Cohort Study of Pregnant Women

Pregnancies that ended between January 1, 2010 and April 30, 2017 were identified in the MarketScan Commercial and Multi-State Medicaid Databases and date of last menstrual period (LMP) was estimated to assess maternal coverage of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) and influenza vaccines along with the gestational age at vaccination. Pregnancies were identified in each database and last menstrual period (LMP) was estimated using a published algorithm. Pregnancies were considered vaccinated if a Tdap or influenza vaccination was received between the estimated date of LMP and the pregnancy end date. Gestational age at vaccination was estimated using gestational weeks between the estimated LMP date the service date of the insurance claim for vaccination. Between 2010 and 2017 there were marked increases in vaccination coverage: from 1% to 56% (Commercial) and from 0.5% to 31% (Medicaid) for Tdap; from 15% to 31% (Commercial) and from 10% to 18% (Medicaid) for influenza. Among pregnancies vaccinated against Tdap, 89% of Commercial and Medicaid pregnancies received the vaccination in the time period of 27-36 weeks gestation, the recommended time period for Tdap vaccination with a mean gestational age of 31 weeks (SD: 5) at Tdap administration in both cohorts. Influenza vaccination can be administered at any point during pregnancy. In this study, the mean gestational age at influenza vaccination was 21 weeks (SD: 11) in Commercial pregnancies and 23 weeks (SD: 10) in Medicaid pregnancies. In multivariable analysis, the factors most strongly associated with likelihood of vaccination were receipt of another vaccination (ORs ranging from 3.4 to 5.2 depending on vaccine and database) or having pregnancy-related outpatient visits (ORs ranging from 2.5 to 4.4 depending on vaccine and database). Although maternal Tdap and influenza vaccination coverage increased substantially from 2010 to 2017 among large, geographically diverse US cohorts, coverage remained suboptimal, potentially putting newborns at risk of pertussis and influenza infection before they receive their infant vaccinations. In addition, a beneficial impact was observed in the relationship between the receipt of one vaccination on the receipt of the other, emphasizing the need for providers to offer vaccination at every opportunity.

Ghaswalla P, Poirrier JE, Packnett E, Irwin DE, Gray S, Buck P. *Maternal Immunization in the United States: A Nationwide Cohort Study of Pregnant Women. American Journal of Preventive Medicine.* 2019;57(3):e87–e93.



## Vaccination and disease prevention

The IBM Watson Health databases, with their ability to track the same patients over long periods of time, are well-suited to longitudinal studies examining vaccination effectiveness, compliance with recommended vaccination guidelines and disease prevention.

### **Meningococcal-group B vaccine series completion and adherence to dosing schedule in the United States: A retrospective analysis by vaccine and payer type**

This retrospective analysis used data from MarketScan Commercial Database, including Early View, and Multi-State Medicaid Database to examine vaccine series completion and adherence to dosing schedule in individuals who initiated a MenB series at ages 16–23 years. Vaccine series completion and dose schedule adherence were assessed during a 15 month follow-up period after the first dose. Completion was defined as individual receipt of the recommended number of doses, with current recommendations applied retroactively to allow individuals who initiated the MenB-FHbp series to be complete with either the 2- or the 3-dose schedule. In Commercial, 63% of individuals who initiated MenB-4C and 52% of individuals who initiated MenB-FHbp completed vaccination within 15 months; dosing schedule adherence was 62% for MenB-4C initiators and 18% for MenB-FHbp initiators. In Medicaid, 15-month completion rates for MenB-4C and MenB-FHbp initiators were 49% and 31%, respectively, with corresponding dosing schedule adherence of 48% and 8%. During the study period, MenB vaccine series completion was suboptimal. However, completion was significantly higher for MenB-4C, with notably shorter time to completion. This may reflect the flexible dosing schedule of MenB-4C.

*Packnett E, Irwin DE, Novy P, Watson PS, Whelan J, Moore-Schiltz L, Lucci M, Hoge C. Meningococcal-group B (MenB) vaccine completion and compliance in the United States: a retrospective study. Vaccine. In press 2019.*

### **Missed opportunities for pneumococcal conjugate vaccine among commercially insured adults in the United States**

This study was conducted to describe missed opportunities for vaccination with PCV13 in adults for whom PCV13 vaccination is recommended using the MarketScan Commercial and Medicare Supplemental Databases. Adults were included if eligible to receive PCV13 under the risk- or age-based recommendation, had no evidence of PCV13 prior to the 2014 recommendation, and continuous enrollment for 6 months prior to and 24 months after the index date. The index date was the first date of eligibility on/after September 19, 2014 (publication date of the age-based recommendation) (e.g., 9/19/14 or 65th birthday). Office visits after the index where PCV13 was not administered, or another healthcare encounter where other vaccines were administered were considered missed opportunities. HCPs associated with claims for PCV13 prior to the missed opportunity were considered PCV13 providers. Patients vaccinated during the study had fewer missed opportunities than patients who remained unvaccinated. Among

high-risk patients aged 19–64, approximately 1/3 of missed opportunities were primary care provider (PCP) visits, and 26% were with a PCV13 provider. High-risk patients 19–64 at index who turned 65 during the study showed similar patterns but were vaccinated at a higher rate (10%). In patients 65 or older, 41% of missed opportunities were with PCPs, and 31% were with PCV13 providers. Missed opportunities are common among PCV13 eligible patients, including among those seeing providers who provide PCV13 vaccine.

*Vietri J, Packnett E, Chilson E. Missed opportunities for Pneumococcal Conjugate 5 Vaccine among Commercially Insured Adults in the United States. Presented: Annual Conference on Vaccinology Research (ACVR) 2019.*



## Natural history of disease

The core MarketScan Databases capture all covered healthcare encounters for over 256 million unique patients from all care providers. In addition, MarketScan specialty databases link dental, lab results, hospital drug data, electronic medical records (EMRs), national death data, health risk assessments and health and productivity management data to these claims. The completeness of MarketScan data enables epidemiologists to describe the natural history of disease, as well as its incidence and prevalence.

### **Higher Incidence Rates of Comorbidities in Patients with Psoriatic Arthritis Compared with the General Population Using U.S. Administrative Claims Data**

Psoriatic arthritis (PSA) is an immune mediated disease that is associated with several other comorbidities that can impact treatment and disease management. This study utilized the MarketScan Commercial and Medicare Supplemental Database from January 1, 2008 through September 15, 2015 to investigate the frequency of comorbidities and hospitalizations in a population of patients with PSA and compare them to a general population, composed of a propensity score matched non-PSA sample. PSA patients had a higher rate of cardiovascular disease, autoimmune disorders, diabetes, anxiety/depression, fatigue, osteoporosis, and uveitis compared to the matched non-PSA sample. PSA patients were also more likely to smoke, use alcohol, or be overweight. Consistent with the higher rates of comorbidity within the sample, the all-cause hospitalization rate for PSA patients was significantly higher than that for the non-PSA population (24.9% vs. 16.2%). The results from this study demonstrate that the comorbidity burden in a PSA sample can be substantial; management of disease therefore needs to consider various conditions, and not just PSA, in defining a treatment regimen.

*Kaine J, Song X, Kim G, Hur P, Palmer JB. Higher incidence rates of comorbidities in patients with psoriatic arthritis compared with the general population using U.S. administrative claims data. JMCP. 2019;25(1):122–132.*

### **Variation in polycystic ovary syndrome patient Characteristics By Body Mass Index: A real-world analysis using a claims and electronic health record linked database**

The aim was to describe polycystic ovary syndrome (PCOS) patients in terms of clinical characteristics, medication utilization, and healthcare costs stratified by body mass index (BMI) categories. This retrospective, observational study utilized claims linked to electronic health record data contained in the IBM MarketScan Explorers Claims-EHR Data Set. PCOS patients were evaluated during a 12 month observation period (6 months before and after the first PCOS diagnosis on the database). Comorbidities were measured via diagnosis codes on claims; whereas BMI and HbA1c laboratory results were assessed via the standardized fields in the EHR. A total of 4,142 PCOS patients met the selection criteria, of whom, approximately 67% were either obese or morbidly obese. While the prevalence of type 2 diabetes was higher among the higher BMI patient categories; HbA1c levels did not differ between BMI categories. Mean and median total healthcare costs were highest in the morbidly obese patients. This descriptive analysis provides real-world evidence of the variation in the clinical and economic burden of PCOS based on the presence of comorbid obesity.

*Thiel E, Irwin DE. Variation in Polycystic Ovary Syndrome Patient Characteristics By Body Mass Index: A Real-world Analysis Using A Claims And Electronic Health Record Linked Database. Poster presented at ISPOR 2019, New Orleans.*

### **Progression from Metabolic Syndrome to Non-alcoholic Fatty Liver Disease**

The prevalence of non-alcoholic fatty liver disease (NAFLD) in the United States is increasing alongside known risk factors like metabolic syndrome (METS). Progression from METS to NAFLD was explored within a population of patients with no evidence of prior liver damage using the IBM MarketScan Explorers Claims-EMR Dataset. Time to NAFLD progression was then investigated over a two-year post-period. The sample of METS patients were further stratified based on baseline NAFLD risk level (high versus low), defined via a previously published algorithm, to account for other contributing clinical factors. Overall 5.2% of METS patients progressed to NAFLD over the two-year post-period. An increased proportion of high-risk patients (6.9% v. 3.9%) progressed to NAFLD compared to low-risk patients; progression also occurred within a shorter time (253 v. 316 days) in the high-risk group.

Progression to NAFLD was associated with elevated liver enzymes, low HDL, hypertension, hyperlipidemia, diabetes, and obesity at baseline. Throughout the study period, progression was also associated with increased utilization of inpatient and emergency services. The rate of inpatient admissions increased nearly 2-fold following progression to NAFLD. Results from this study suggest that early identification and management of METS patients with elevated NAFLD risk may help to delay the onset of chronic liver disease and improve patient outcomes.

*Brady BL, Irwin DE. Progression from Metabolic Syndrome to Non-alcoholic Fatty Liver Disease. Presented: ISPOR New Orleans 2019.*

### **A longitudinal healthcare use profile of children with a history of neonatal abstinence syndrome**

This retrospective claims-based analysis described healthcare use over time of children with a history of neonatal abstinence syndrome (NAS) compared with children without NAS. Administrative claims data were obtained from MarketScan Commercial Claims and Encounters database from 2005 to 2014. Children with and without NAS diagnoses were followed until 8 years of age or disenrollment from the database. Numbers of claims for inpatient, outpatient, and emergency department encounters; prescription drugs; and costs associated with these encounters were evaluated to describe the clinical burden of NAS. Comparisons of mean numbers of claims were adjusted for potentially confounding differences in baseline characteristics. Children with a diagnosis of NAS have significantly greater rates of healthcare use through age 8 years compared with children without NAS. The results from this study suggest that children affected by NAS have medical disparities that linger well beyond early infancy.

*Liu G, Kong L, Leslie DL, Corr TE. A Longitudinal Healthcare Use Profile of Children with a History of Neonatal Abstinence Syndrome. J Pediatr. 2019 Jan;204:111–117 Epub 2018 Sep 27.*



## Augmented claims data

The core MarketScan Commercial and Medicare Supplemental Databases have been linked to a variety of other data sources including but not limited to laboratory results, EHR data, death data, health and productivity data and weather data. Custom linkages are also possible. These novel linkages allow epidemiologists to examine covariates and outcomes that are not traditionally available in administrative claims data.

### **Weather conditions as predictors of severe migraines: A case-crossover study using linked weather and claims data**

This case-crossover analysis utilized the IBM MarketScan Weather Database to examine the association between daily meteorological data and the occurrence of severe migraine events, defined as medical claims with diagnoses for migraine in the emergency room or inpatient setting. For this case-crossover design, each patient acts as their own control. Daily weather conditions and air quality metrics on the date of the severe migraine were compared to three control dates without such events via conditional logistic regression modeling. The modeling results revealed that for each 1 inHg increase in the day's maximum barometric pressure, the odds of a severe migraine event increase by 19%. Maximum daily temperature was inversely associated with severe migraine events. This study provides real-world evidence of an association between daily weather and clinical events, demonstrating the utility of the novel linked weather and administrative claims database.

*Thiel E, Irwin DE. Weather Conditions as Predictors of Severe Migraines: A Case-Crossover Study Using Linked Weather and Claims Data. Presented ISPOR EU November 2019.*

### **Pollen exposure and asthma-related healthcare resource utilization in children with asthma; An analysis of patient-level claims and linked weather data**

This study's objective was to characterize the rate of asthma-related inpatient (IP) admissions and emergency department (ED) visits in children with asthma using patient-level claims from the MarketScan Commercial Database linked to the MarketScan Weather database. Asthma-related IP admissions and ED visits during 2016 were identified; grass and tree pollen levels (e.g., none, low, moderate, high/very high) were assigned using the maximum pollen index value in the five days prior to the encounter. Incidence rates (IR) of asthma-related IP admissions and ED visits per 100,000 patient days were calculated by pollen level. Rates of asthma-related IP admissions and ED visits were highest when pollen counts were high/very high. Incidence of asthma-related IP admissions on high/very high grass and tree pollen days were 1.5 times higher than rates on no pollen days. For ED visits, incidence rates were 1.5–2 times higher on high/very high grass pollen days. This study showed higher pollen counts are associated with a significantly higher incidence of asthma-related IP admissions and ED visits in children with asthma.

*Packnett E, Irwin DE. Pollen Exposure and Asthma-Related Healthcare Resource Utilization in Children with Asthma: An Analysis of Patient-level Claims and Linked Weather Data. Presented ISPOR EU November 2019.*

### **Depression treatment, healthcare expenditures and depression severity in patients with depression using Patient Health Questionnaire (PHQ-9) scores to assess depression severity**

This study examined adult patients with Patient Health Questionnaire-9 score in the MarketScan Claims and Electronic Medical Records Database (CED). Depression severity, assessed via PHQ-9 scores, was categorized as minimal (<5), mild (5–9), moderate (10–14), or severe (>14). Depression treatment and all-cause healthcare expenditures during follow-up were assessed and stratified by pre-existing mental health (MH) diagnoses. Patients with a pre-existing MH diagnosis reported more severe depression compared to those without a pre-existing MH diagnosis. Antidepressant treatment was more common in patients with severe depression during follow-up; those with a pre-existing MH diagnosis had the highest rates of treatment. Mean all-cause expenditures were similar in patients with mild, moderate, and severe depression; expenditures for each group were significantly higher than expenditures in patients with minimal depression. Use of pharmacologic treatments during follow-up were more common and healthcare expenditures were highest among patients with baseline mental health diagnosis and the relationship between more severe depression based on PHQ-9 score and increased healthcare expenditures was observed only in patients with a baseline MH diagnosis.

*Packnett ER, Irwin DE. Depression Treatment, Healthcare Expenditures, and De-pression Severity in Patients with Depression Using Patient Health Questionnaire-9 Scores to Assess Depression Severity. Presented: ISPOR New Orleans 2019.*

### **Healthcare quality measures among diabetics using linked insurance claims-EMR data**

The IBM® MarketScan® Explorys® Claims-EMR Dataset was used to examine the association of quality of care and patient clinical outcomes in diabetes in the 2015 calendar year. Healthcare quality was defined through four National Quality Forum (NQF) measures (HbA1c testing, Eye Exams, Nephropathy Screening / Medical Care, and Blood Pressure [BP] Control [<140/90]), while HbA1c results and comorbidities were to assess clinical outcomes. Overall, there was high compliance with the NQF measures, with over 70% of patients meeting the HbA1c testing, Nephropathy, and Blood Pressure measures; compliance with the eye exam measure was lower with only about 40% of the sample meeting the measure. To further examine the relationship between quality and outcomes, patients with HbA1c results available were stratified based on an HbA1c result of 8.0%. Among patients with

HbA1c results, approximately 74% of the sample evidenced an HbA1c value <8.0%. These patients were significantly more likely to meet the blood pressure control and eye exam measures compared to patients with an HbA1c 8.0%. Patients with an HbA1c value <8.0% also had a lower prevalence of neuropathy, nephropathy, retinopathy, and cardiovascular disease compared to patients with HbA1c values 8.0%. Results from this study indicated a positive relationship between HbA1c control and improved healthcare quality, measured via NQF quality measures, and improved outcomes examined via comorbidity.

*Brady BL, Irwin DE. Healthcare Quality Measures Among Diabetics Using Linked Insurance Claim-EMR Data. Presented: ICPE Prague 2018.*

### **Hysterectomy utilization among newly diagnosed endometrial cancer patients by body mass index category: A real-world analysis using a linked claims and electronic health record database**

The objective of this study was the measure the rates of laparoscopic hysterectomy (LH) and subsequent emergency room (ER) visits and rehospitalizations among endometrial cancer patients undergoing hysterectomy, and to compare outcomes across body mass index categories. This retrospective study utilized insurance claims linked to electronic health record (EHR) data contained in the IBM MarketScan Explorys Claims-EHR Data Set. BMI was ascertained via EHR data and type of hysterectomy procedure, ER visits and rehospitalization were determined via claims data. Outcomes were measured in the 30 days following the hysterectomy procedure. A total of 1,090 newly-diagnosed endometrial cancer patients met the selection criteria, of whom a majority were either obese or morbidly obese. The proportion of patients receiving LH increased as BMI category increased. Among those who received LH, rates of ER visits or rehospitalizations were lower than those receiving non-LH hysterectomy across all BMI strata, including among the obese. This study showed differential rates of LH and the associated ER visits and rehospitalization outcomes across the various BMI categories.

*Thiel E, Irwin DE. Hysterectomy Utilization Among Newly Diagnosed Endometrial Cancer Patients By Body Mass Index Category: A Real-world Analysis Using A Claims And Electronic Health Record Database Presented ICPE 2019, Philadelphia.*

### **Opioid use, healthcare expenditures, and pain severity in osteoarthritis patients using patient-reported pain scores to assess pain severity**

This study examined adult osteoarthritis patients with pain scores identified in the MarketScan Claims and Electronic Medical Records Database (CED). The prevalence of any opioid use, chronic opioid use and healthcare expenditures in the 12 months following pain assessment were described by patient reported pain severity. Strong opioid use was more prevalent in patients with mild, moderate, and severe pain relative to patients without pain; prevalence of strong opioid use was similar in patients with mild and moderate pain. Chronic use of strong opioids was low regardless of pain severity but was significantly more prevalent only among OA patients with severe pain relative to those with no pain. Though highest rates of strong opioid use were observed in patients with severe pain, strong opioid use was also prevalent in patients with mild pain.

*Packnett ER, Irwin DE. Opioid Use, Healthcare Expenditures, and Pain Severity in Osteoarthritis Patients Using Patient Reported Pain Scores to Assess Pain Severity. Presented: ISPOR New Orleans 2019.*

### **Impact of medication adherence on absenteeism and short-term disability for five chronic diseases**

The goal of this analysis was to estimate the impact of medication adherence on absenteeism and short-term disability among employees with chronic disease. This was across-sectional analysis of healthcare claims, absenteeism and short-term disability data from the MarketScan Commercial Health and Productivity Management (now known as IBM MarketScan Health and Productivity Management) Databases, which applied multivariate regression and instrumental variable models to analyze five cohorts of employees with diabetes, hypertension, congestive heart failure, dyslipidemia and asthma/chronic obstructive pulmonary disease (COPD). Adherence was defined as possessing medication on at least 80 percent of days during followup. Adherent employees with diabetes, hypertension, dyslipidemia and asthma/COPD realized between 1.7 and 7.1 fewer days absent from work and between 1.1 and 5.0 fewer days on short-term disability. Absenteeism and short-term disability days by adherent employees with congestive heart failure were not significantly different from nonadherent employees with the condition in most specifications. Appropriate management of chronic conditions can help employers minimize losses due to missed work.

*Carls GS, Roebuck MC, Brennan TA, Slezak JA, Matlin OS, Gibson TB. Impact of medication adherence on absenteeism and short-term disability for five chronic dis-eases. Journal of Occupational and Environmental Medicine 2012; 54(7): 792–805.*



## Novel study designs and regulatory submissions

IBM Watson Health data has also been utilized for a variety of novel study designs including linkages in the MarketScan Research Databases of mothers and their infants, patient support programs, internet surveys and real world data used for regulatory submissions.

### **Novel design methodology combining a registry with claims data to study fracture nonunion**

Low-intensity pulsed ultrasound (LIPUS) is an FDA-approved medical device to treat established fracture non-unions. Commercial insurers routinely cover off-label use in acute fractures to avoid costly surgical non-union repair. Given the low rate of non-union and challenges recruiting patients into a control arm when treatment is available, a traditional RCT was not feasible to assess the device's effectiveness in mitigating risk of non-union in patients with an acute fracture. A novel study design prospectively enrolled LIPUS-treated patients and compared them to patients in the MarketScan claims database to compare the incidence of fracture non-union in patients using LIPUS to those receiving standard of care.

*Mack CD, Pavesio A, Kelly K, Wester T, Jones JT, Maislin G, Irwin D, Brinkley E, Zura RD. Presented ICPE Montreal 2017.*

### **Effect of patient support programs on patient adherence and work productivity in patients initiating adalimumab therapy (ADA)**

Patient support programs (PSP) exist to assist adalimumab-treated patients with medication costs, nurse support, injection training, pen disposal, and medication reminders. The impact of these services on patient adherence and work productivity were examined in patients initiating adalimumab treatment. A longitudinal, retrospective study was conducted using patient-level data from the PSP linked to MarketScan Commercial Claims and Medicare Supplemental and the Health and Productivity Management Databases 2008–2014. The sample included patients dispensed an ADA who were aged  $\geq 18$  years and these patients were matched to those who did not enroll (non-PSP cohort). Adherence, persistence and workplace absenteeism was compared between cohorts. Participation in the PSP was associated with significantly greater adherence to and persistence with ADA therapy in patients with immune-mediated inflammatory diseases. Patients enrolled in the PSP also gained significant work productivity.

*Effect of Patient Support Program on Patient Adherence and Work Productivity in Patients Initiating Adalimumab Therapy (ADA). Mittall M, Sherman B, Liu H, Brouillett M, Juneau P, Gangulil A, Frendrick AM; Presented AMCP Denver 2017.*

## **Agreement between internet-based self- and proxy-reported health care resource utilization and administrative health care claims**

This analysis evaluated the level of agreement between self- and proxy-reported healthcare resource utilization (HCRU) data, as recorded through an internet-based survey and administrative claims-based HCRU data. This study involved primary data collection of self- and proxy-reported HCRU data monthly. Data included the occurrence and number of visits to hospitals, emergency departments, urgent care centers and outpatient offices for a respondent's and his/her household members' care. Linked administrative claims data from the MarketScan Research Databases were assessed during the same time and evaluated relative to survey-based metrics. The Kappa (k) statistic was used to evaluate visit concordance, and the intraclass correlation coefficient was used to describe frequency and consistency. This study's agreement values suggested that internet-based surveys are an effective method to collect self- and proxy-reported HCRU data. These results should increase confidence in the use of the internet for evaluating disease burden.

*Palmer L, Johnston SS, Rousculp MD, Chu BC, Nichol KL, Mahadevia PJ. Agreement between internet-based self-and proxy-reported health care resource utilization and administrative health care claims. Value in Health 2012; 15(3): 458–65.*

## About IBM Watson Health data

With more than 2,100 published studies since 1990, the IBM MarketScan Research Databases are among the most published proprietary claims databases in the United States.

The IBM MarketScan Research Databases for Life Sciences Researchers white paper offers more detail about the features of the MarketScan Research Databases including descriptions of the databases and their data elements.

To receive a copy, please visit: [ibm.com/downloads/cas/OWZWJ0QO](https://ibm.com/downloads/cas/OWZWJ0QO)

In addition to IBM proprietary databases, we also have access to and experience with other databases to use in our research services, including international and non-proprietary data.

## IBM Watson Health databases and data sets

- IBM MarketScan Commercial Database
- IBM MarketScan Medicare Supplemental Database
- IBM MarketScan Multi-State Medicaid Database
- IBM MarketScan Weather Database
- IBM MarketScan Health and Productivity Management Database
- IBM MarketScan Lab Results Database
- IBM MarketScan Health Risk Assessment Database
- IBM MarketScan Dental Database
- IBM MarketScan Benefit Plan Design Database
- IBM MarketScan Hospital Drug Database
- IBM MarketScan Inpatient Drug Linked Data Set
- Explorys EHR Database
- MarketScan Explorys Claims-EMR Data Set
- IBM Micromedex

## About IBM Watson Health

IBM Watson Health is a data, analytics, and technology partner for the health industry. Supported by the innovation of IBM and intelligence of Watson, we are committed to helping build smarter health ecosystems. Through the combination of our deep industry expertise in health, data and analytics, actionable insights, and reputation for security and trust, Watson Health is working together with its clients and partners to help them achieve simpler processes, better care insights, faster breakthroughs, and improved experiences for people around the world. Learn more at [ibm.com/watson/health](https://ibm.com/watson/health).

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