Impact of Pharmaceutical Marketing
on Healthcare in the District of Columbia

The Impact of Artificial Intelligence on Pharmaceutical Marketing in the District of Columbia

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Executive Summary

This report outlines the possible impact of the widespread application of artificial intelligence (AI) applications to the practice and effectiveness of pharmaceutical marketing.

A declining cost of computing power, the dramatically increasing availability of large data sets, and simplified access to sophisticated methods of data science have all contributed to the rapid adoption of artificial intelligence applications.

Artificial intelligence is forecast to transform pharmaceutical marketing in at least five ways:

- **Preemptive Campaigning**. Anticipate changes in disease patterns and health care use faster and thus roll out promotional and educational campaigns more proactively
- **Prioritization**. Identify more precisely individual prescribers and patients who will be receptive and responsive to marketing initiatives
- **Personalized Outreach**. Select channels and craft materials that are tailored more closely to recipients' preferences, knowledge, and needs
- **Progress Monitoring**. Track how prescribers and patients respond to pharmaceutical marketing efforts to evaluate effectiveness and to course-correct if necessary
- **Pricing**. Align prices charged more tightly with the clinical benefit projected for a given prescriber's patient population

Greater use of AI applications in pharmaceutical marketing will likely impact various stakeholder groups differentially:

- **Patients** may become matched more closely to clinically beneficial medication options and receive more effective support in medication adherence.
- **Physicians and other prescribers** may be alerted more often to rare and frequently overlooked diseases in their patient populations.
- **Pharmaceutical manufacturers** may improve the allocation of promotional resources and raise the effectiveness of marketing campaigns.
- **Payers** may pay more or may pay less when prices are more tightly aligned with their willingness to pay.
- **Public policy and regulatory oversight** must ensure algorithmic transparency and privacy protection.

A publicly available data set of prescribers in the District of Columbia that tracks medication use by Medicare Part D beneficiaries is used to illustrate how cluster analysis can identify prescribers who treat comparatively many beneficiaries and whose average beneficiary's risk score is high, yet whose average beneficiary's annual claims count and claims cost is low.

I. Introduction

Artificial intelligence is promising to transform many industries, including the pharmaceutical industry. This report aims to explore the potential impact of the increasing use of artificial intelligence on the practice, effectiveness, and consequences for stakeholders of pharmaceutical marketing.

Drivers of the Increasing Use of Artificial Intelligence

The emergence of artificial intelligence (AI) applications in recent years can be attributed to three principal reasons:

Declining Cost of Computing Power. The decreasing cost of computing power has made sophisticated AI algorithms more accessible to pharmaceutical companies. As computing technologies have advanced and become more affordable, organizations can now leverage AI to process vast amounts of data and perform complex computations at a fraction of previous costs. This has enabled the development of AI-driven marketing strategies that were previously unattainable due to budget constraints.

Availability of Large Data Sets. The pharmaceutical industry generates and collects vast amounts of data from various sources, including clinical trials, patient records, electronic health records (EHRs), and real-world evidence. The availability of these large data sets provides a wealth of information that can be analyzed and leveraged to inform marketing strategies. AI techniques such as machine learning and natural language processing allow pharmaceutical marketers to extract valuable insights from these data sets, identify patterns, trends, and correlations, and personalize marketing campaigns based on individual patient profiles and preferences.

Easy Access to Sophisticated Methods of Data Science. The proliferation of open-source tools, libraries, and platforms for data science and machine learning has made sophisticated analytical methods more accessible to pharmaceutical marketers. Tools like Python, R, TensorFlow, and scikit-learn provide user-friendly interfaces and extensive documentation, allowing marketers with varying levels of technical expertise to apply advanced analytics techniques to their marketing efforts. Additionally, cloud computing services and software-as-a-service (SaaS) platforms offer scalable infrastructure and pre-built AI solutions, enabling pharmaceutical companies to quickly deploy and integrate AI-driven marketing solutions into their existing workflows.

Building a Prediction Model

In a prediction project, the first step is to gather relevant data from various sources, such as structured data from databases, unstructured data from text documents, images, or sensor data.

Once the data have been collected and prepared for analysis, the appropriate machine learning model is selected based on the specific prediction problem, data type, and desired performance level. This choice might involve considering regression, classification, or clustering techniques, as well as ensemble methods or deep learning approaches.

The next step is to train a predictive model using machine learning algorithms. This involves preprocessing the data, selecting appropriate features, and training the model on historical data to learn patterns and relationships that can be used to make predictions.

After training the model, it is essential to evaluate its performance on a separate data set that the model hasn't seen before. This testing data set helps assess the model's generalization ability and identifies any potential overfitting or underfitting issues.

After training and testing the model, it can be deployed into production environments where it can be used to generate predictions on new, unseen data. Deployment involves integrating the model into existing systems or applications and ensuring that it operates smoothly and efficiently in real-time or batch processing environments.

After deployment, it is imperative to monitor the model's performance continuously in real-world settings. Monitoring involves tracking key performance metrics, identifying anomalies or drifts in data distributions, and updating the model as necessary to maintain its accuracy and relevance over time.

Subject matter experts can provide insight and domain knowledge that can enhance the predictive model. Their expertise can help identify relevant features, interpret model outputs, and validate the model's predictions against real-world scenarios.

Finally, the model is updated iteratively based on feedback, new data, and evolving business requirements. Insights from real-world performance monitoring and stakeholder feedback inform improvements to the model's predictive capabilities.

II. How AI Can Transform Pharmaceutical Marketing

Greater use of artificial intelligence has the potential to enhance the effectiveness of pharmaceutical marketing in at least five ways:

Preemptive Campaigning

The use of new data sources and the continuous evaluation and fine-tuning of prediction models based on large data sets allow pharmaceutical marketers to anticipate sooner than before emerging disease patterns and health care needs. Rather than react to these trends or, in some cases, sudden spikes, more precise prediction allows marketers to craft responses pro-actively.

For instance, and as has been shown year after year with the prediction of the course, strain, and severity of seasonal influenza and now of the Covid-19 virus in the United States, pharmaceutical marketers can anticipate emerging health trends and disease patterns through various analytical methods, including the analysis of wastewater, public health surveillance, and online internet searches.

Wastewater analysis involves the monitoring and testing of sewage water to detect traces of biological and chemical substances, including pathogens and metabolites. By analyzing wastewater samples from different communities, pharmaceutical marketers can identify trends in the prevalence of certain diseases or health conditions within specific populations. In addition, the presence of specific drug metabolites or biomarkers in wastewater can indicate the use (or lack thereof) of specific medications within a community, offering marketers guidance how to design educational and promotional campaigns. Wastewater analysis thus provides valuable insights into population-level health trends and disease patterns, allowing marketers to tailor their messaging and outreach efforts accordingly.

More generally, public health surveillance involves the systematic collection, analysis, and interpretation of health-related data to monitor and control disease outbreaks, track disease trends, and inform public health policies and interventions. Pharmaceutical marketers can leverage data from public health surveillance systems, including reports of infectious diseases, chronic conditions, and healthcare utilization patterns, to anticipate emerging health trends and disease patterns. By monitoring changes in disease incidence, geographic distribution, and demographic characteristics, marketers can identify emerging health concerns and adapt their marketing strategies to address evolving patient needs and priorities.

Online search histories, for their part, reveal public interest in and awareness of health-related topics, symptoms, treatments, and medications. Pharmaceutical marketers can study online search trends and patterns to identify emerging health concerns, consumer preferences, and information-seeking behaviors. By monitoring changes in search volume, keyword trends, and geographic variations, marketers can anticipate shifts in consumer demand, identify potential market opportunities, and tailor their digital marketing campaigns to reach target audiences more effectively.

Prioritization

AI algorithms can analyze vast amounts of patient data, including demographics, medical history, treatment preferences, and behavioral patterns, to identify patients whose medication adherence, treatment response, and healthcare utilization make them suitable targets of pharmaceutical marketing campaigns.

By the same token, AI-driven segmentation allows marketers to categorize healthcare providers based on various criteria such as specialty, patient population, geographic location, and prescribing behavior. By segmenting healthcare providers into distinct groups, marketers can tailor their messaging and promotional materials to address the specific needs, interests, and preferences of each segment, increasing the relevance and effectiveness of their communications.

In fact, and as illustrated in section "Pharmaceutical Marketing in the District of Columbia" below, AI algorithms can go beyond segmentation into groups and instead pin-point individual providers to "identify which physicians in a community are most likely to prescribe a treatment based on their practice makeup, network, prescribing behavior, and lifetime prescribing value" (Yuan Y, Zhao E 2018). By identifying key prescribing indicators and patterns, marketers can prioritize their outreach efforts and target healthcare providers who are most likely to be receptive to their messaging.

One well-known application involves the use of a combination of data sets to identify physicians who treat disproportionately many patients who may suffer from a rare and hence underdiagnosed disease.

Personalized Outreach

Once the patients or physicians have been identified, AI-driven personalization allows marketers to craft customized messages and outreach strategies tailored to individual patient and physician preferences, needs, and behaviors. By applying predictive analytics to patient and prescriber data, marketers can deliver targeted content through various channels to engage patients and physicians more effectively.

Pharmaceutical marketers can use AI to determine the most effective communication channels for reaching patients and prescribers. These channels can include email, social media, mobile apps, websites, online forums, or even traditional channels like direct mail, in-person visits, or medical conferences and patient-advocacy meetings. By analyzing past interactions and response rates, marketers can use AI to identify the channels that are most likely to resonate with each individual recipient.

AI can generate personalized messaging tailored to the unique and highly idiosyncratic needs, interests, and preferences of each patient and prescriber. Natural language processing (NLP) techniques can be combined with chatbots and voice cloning to create dynamic content that resonates with individual audiences, addressing their concerns, highlighting relevant benefits, and providing actionable information.

For patients, the communication strategies can be tailored to maximize the likelihood of medication adherence or treatment compliance.

For physicians, they can be tailored to ensure that the medications being promoted are being prescribed for patients who will derive the largest clinical benefit and least adverse side effects. Here, AI can be deployed to assist with the acquisition and retention of prescribers. For healthcare providers who are unaware of patients within their panel with a specific condition, pharmaceutical marketers can offer assistance in identifying these patients and provide education on diagnostic methods and therapeutic solutions. For healthcare providers who already are diagnosing the condition in their patient population but are using a competitor product, pharmaceutical marketers can tailor materials to encourage physicians to switch. Conversely, pharmaceutical marketers can tailor different messaging for physicians who are already the manufacturer's product but have been identified to be at risk of switching to the competitor product.

Beyond patients and physicians, AI algorithms can analyze social media activity, publication records, and professional affiliations to identify social-media influencers and professional "key opinion leaders" (KOLs) in various therapeutic areas and medical specialties. By identifying influential healthcare providers who have a significant impact on their peers' prescribing behaviors, marketers can engage with KOLs to advocate for their products, share clinical evidence, and build relationships that can influence prescribing decisions across broader healthcare networks.

Progress Monitoring

To evaluate the effectiveness of their marketing efforts, pharmaceutical marketers can access a diverse array of data sets. These data sets include information from:

- **Sensors**. Pharmaceutical companies can utilize sensor data from various sources such as wearable devices, medical equipment, and health monitoring devices. This data provides insights into patient behavior, medication adherence, and health outcomes. For example, sensors can track patient vitals, medication usage patterns, and activity levels, allowing marketers to assess the impact of their marketing campaigns on patient health and treatment adherence.
- **Social Listening**. Social listening involves monitoring and analyzing conversations and interactions on social media platforms, online forums, and healthcare websites. By analyzing social media mentions, comments, and sentiment related to their products or therapeutic areas, pharmaceutical marketers can gain valuable insights into patient perceptions, preferences, and experiences. Social listening data helps marketers understand patient needs, identify emerging trends, and measure the impact of their marketing efforts on brand awareness and reputation.
- **Prescription Refills**. Prescription refill data provides information on medication usage patterns, patient adherence rates, and treatment outcomes. Pharmaceutical marketers can analyze prescription refill data to track patient adherence to their medications, identify adherence barriers, and evaluate the effectiveness of their patient outreach programs. By monitoring refill rates and adherence trends over time, marketers can assess the impact of their marketing campaigns on patient behavior and treatment outcomes.
- **Patient Outreach Responses**. Pharmaceutical marketers often engage in patient outreach activities such as educational programs, patient support services, and direct communication campaigns. By tracking patient responses to these outreach efforts, marketers can measure the effectiveness of their communication strategies, content relevance, and engagement tactics. Response data allows marketers to assess patient engagement levels, identify areas for improvement, and tailor future outreach initiatives to better meet patient needs and preferences.

In addition, online search data allow marketers to track the effectiveness of their broad-based educational and promotional campaigns in shaping public perception, driving consumer engagement, and raising brand awareness.

These data sources can be used to monitor patient and prescriber responses and to adjust the frequency and intensity of communication to ensure that patients and prescribers receive the right amount of information without feeling overwhelmed or disengaged.

Specifically, AI-powered analytics can analyze patient interactions, engagement patterns, and response rates across different marketing channels and touchpoints to optimize marketing campaigns in real-time. By monitoring patient behaviors and preferences, marketers can identify which messages, channels, and interventions resonate most with patients and adjust their marketing strategies accordingly to maximize engagement and response rates.

For instance, by leveraging predictive modeling techniques, marketers can identify patients at risk of non-adherence or treatment discontinuation and intervene proactively with targeted interventions, support programs, or educational resources to improve patient outcomes and drive medication adherence.

Beyond the specific medication in focus, AI algorithms can analyze patient data to identify cross-sell and up-sell opportunities for pharmaceutical products and services. By understanding patient needs, preferences, and treatment journeys, marketers can recommend complementary products or services that align with patients' treatment goals and improve overall health outcomes.

More broadly, AI-powered analytics can provide marketers with real-time competitive intelligence and market insights, enabling them to monitor competitor activities, track market trends, and identify emerging opportunities and threats.

Pricing

Unprecedented access to large, comprehensive data sets and sophisticated data analysis capabilities will allow pharmaceutical marketers to track market dynamics, including competitor pricing, consumer behavior, and regulatory trends, which in turn can guide pricing decisions.

Most fundamentally, AI can estimate the average treatment response and thus the clinical benefit of a drug for a specific patient population that is assigned to a given physician or enrolled in a given health insurance plan. This treatment response in turn can be used to forecast downstream health care utilization as well as the value of patient-centric outcomes, such the maintenance of physical or mental function, the reduction in pain, or even more diffuse, yet no less important measures of overall well-being. These forecasts can then be mapped into payers' willingness to pay for the medication.

For instance, AI-powered predictive modeling can forecast demand elasticity, allowing manufacturers to understand how price changes will impact sales volume. By simulating various pricing scenarios, manufacturers can identify optimal price points that maximize revenue while minimizing the risk of losing customers due to price sensitivity.

AI also enables dynamic pricing strategies that adjust in real-time based on market conditions, demand fluctuations, and competitor actions. By continuously analyzing market data and consumer behavior, AI algorithms can automatically adjust prices to optimize revenue and market share.

AI segmentation techniques allow manufacturers to tailor pricing strategies to different customer segments based on factors such as geographic location, purchasing behavior, and willingness to pay. By personalizing pricing strategies, technically known as "price discrimination", manufacturers can maximize revenue and customer satisfaction while maintaining profitability.

In fact, AI algorithms can be designed to develop and adjust complex pricing strategies that respond to observed and verified patient outcomes, changes in health insurance plans' benefit designs, and the organization of physician practices or hospital pharmacies.

Finally, AI-powered competitive analysis tools can monitor competitor pricing strategies and market positioning in real-time. By analyzing competitor pricing trends and market reactions, manufacturers can adjust their pricing strategies to remain competitive and capture market share effectively.

III. Impact

While at this time the impact of the increased use of artificial intelligence (AI) in pharmaceutical marketing is difficult to forecast with certainty, the contours of its impact on specific stakeholder groups can be outlined.

Patients

To the extent the AI algorithms help predict more precisely treatment effectiveness, safety profiles, and patient outcomes, healthcare providers can make informed treatment recommendations, optimize therapy regimens, and achieve better clinical outcomes for their patients. By the same token, pharmaceutical marketers may find it beneficial to discourage healthcare providers from prescribing medication not suitable for their patients.

In addition to the improved matching of patients to medication, the use of AI may help improve patient medication adherence by providing personalized reminders, education, and support. Through predictive analytics and machine learning algorithms, pharmaceutical marketers can identify patients at risk of non-adherence and intervene proactively with targeted interventions to address barriers and improve medication compliance.

AI technologies can facilitate patient education and empowerment by delivering personalized health information, treatment recommendations, and lifestyle guidance. Pharmaceutical marketers can leverage AI-driven chatbots, virtual assistants, and educational resources to engage patients, answer their questions, and provide timely information about their medications, treatment options, and disease management strategies.

Of note, AI-driven marketing strategies can facilitate targeted outreach and education initiatives aimed at underserved communities and populations disproportionately affected by healthcare disparities. To the extent that pharmaceutical marketers can fill a deficit in monitoring medication adherence and treatment outcomes, this development may prove beneficial for patient communities with limited healthcare access.
For instance, AI technologies enable pharmaceutical marketers to design healthcare communication and engagement strategies that resonate with patients of diverse cultural backgrounds, language skills, and health literacy levels. Natural language processing and sentiment analysis can be used to adapt messaging and content delivery methods that enhance understanding, trust, and engagement in racially diverse patient populations.
By measuring treatment outcomes more closely, AI-powered platforms and digital health technologies can facilitate access to clinical trials for racially diverse patient populations. Patient matching algorithms can pair eligible patients with clinical trials and research studies based on

their demographic characteristics, medical history, and treatment preferences, thereby increasing participation rates and diversity in clinical research.

Physicians and Other Prescribers

By targeting physicians more precisely, AI-assisted pharmaceutical marketing can limit the marketing messages, educational materials, and promotional offers to those that resonate with the specific needs and interests of individual physicians. For example, AI-driven education platforms can capture physicians' learning styles and knowledge gaps to deliver personalized continuing medical education (CME) content. This enables physicians to access relevant educational materials, stay informed about new medical advancements, and earn CME credits in a more efficient and engaging manner.

Physicians in turn may become more receptive to pharmaceutical marketing if they perceive these efforts to aid them in their diagnostic and therapeutic tasks. A case in point is the diagnosis of patients with a rare disease. AI algorithms can analyze large data sets of patient symptoms, medical histories, and diagnostic criteria to identify patterns and markers associated with rare diseases. By assisting physicians in recognizing rare diseases faster and more reliably, AI algorithms can help physicians prescribe the correct treatment faster and avoid misdiagnosis or delayed diagnosis. Moreover, AI technologies enable physicians to collaborate and consult with experts and specialists in the field of rare diseases more effectively. Telemedicine platforms, virtual consultation services, and online medical communities allow physicians to seek guidance, share insights, and exchange best practices with colleagues and experts worldwide, enhancing the quality of care for patients with rare diseases.

In pay-for-performance contracts, physicians are often incentivized to achieve specific medication adherence rates in their patient populations. AI algorithms can help physicians identify patients who may lapse in medication adherence and suggest ways to restart a conversation with patients who have lapsed. Similarly, AI algorithms provide physicians with information and conversation starters to convince recalcitrant patients to try a new medication regimen.

Pharmaceutical Manufacturers

AI enables pharmaceutical companies to target their marketing efforts more precisely and personalize their interactions with healthcare professionals and patients, resulting in a greater likelihood that these prescribers and patients will opt for the medication in focus.

The increased effectiveness of marketing campaigns in turn can raise sales and profits for drug companies by allowing them to allocate their marketing budgets more efficiently, prioritize high-impact initiatives, and maximize return on investment (ROI) across different marketing channels and campaigns.

In the medium to long run, enhanced customer engagement can strengthen brand loyalty, foster more sustainable relationships, and drive repeat business for drug companies.

AI-driven insights and predictive analytics can accelerate the drug development and commercialization process, leading to faster time to market and revenue generation for drug companies. By analyzing clinical trial data, patient outcomes, and real-world evidence, AI algorithms can identify promising drug candidates, optimize clinical trial designs, and predict market demand more accurately. This enables drug companies to bring innovative therapies to market more quickly, capture market share, and gain a competitive advantage over rivals.

AI technologies enable pharmaceutical companies to gather real-time market insights and feedback on drug performance and patient preferences. By scanning social media data, patient forums, and online discussions, AI algorithms can monitor trends, sentiment, and adverse events associated with specific medications or therapeutic interventions. This real-time feedback loop allows drug companies to adapt their marketing strategies, refine product messaging, and address emerging patient needs or concerns more effectively. This loop also allows drug companies to mitigate their regulatory and legal impact more securely and comprehensively, reducing the risk of fines, penalties, and legal liabilities. Perhaps even more important, this risk mitigation strategy enhances the reputation and credibility of drug companies, safeguarding their profitability and long-term viability in the pharmaceutical industry.

Taken together, the more efficient use of marketing resources coupled with more accurate anticipation of market trends and faster identification and mitigation of adverse drug events improves the profitability of a given drug and thus encourages the development of new drugs, including for drugs meant to treat rare diseases.

Payers

As noted earlier, AI-assisted pharmaceutical marketing will allow drug companies to calculate with greater precision the clinical value that a drug confers to patient health and thus the amount that a payer should be willing to pay for it. This data-driven approach allows companies to set prices that maximize revenue while remaining competitive in the marketplace.

AI-powered dynamic pricing models can adjust drug prices in real-time based on changing market conditions, supply chain dynamics, and competitive pressures. By monitoring factors such as demand fluctuations, inventory levels, and competitor pricing movements, AI algorithms can recommend optimal pricing decisions to maximize profitability and market share. Payers may thus be faced with prices that can change rapidly and markedly over time.

AI technologies enable pharmaceutical companies to adopt value-based pricing models that align drug prices with the clinical outcomes and economic value delivered to patients and healthcare systems. By analyzing real-world evidence, patient outcomes, and healthcare utilization data, AI algorithms can quantify the value proposition of drugs in terms of improved patient outcomes, reduced healthcare costs, and enhanced quality of life. Value-based pricing models incentivize innovation and reward pharmaceutical companies for developing drugs that deliver meaningful clinical benefits and economic value to patients and payers.

While AI-driven pricing strategies can result in higher prices for some prescriber and patient groups, these same pricing strategies may also identify payers whose willingness is lower and who were ignored before large data sets and sophisticated predictive analytics flagged them as potentially profitable partners. AI-assisted pharmaceutical marketing may begin targeting these new customer segments with reduced prices.

Public Policy and Regulatory Oversight

As AI algorithms become increasingly complex and opaque, there is a need for transparency and accountability in patient and prescriber prioritization, the personalized design of promotional materials, the monitoring of treatment responses, and pricing.

AI-driven marketing relies heavily on the collection and analysis of vast amounts of data, including patient health records, demographic information, and online behaviors. The aggregation and processing of sensitive personal data raise concerns about privacy breaches, unauthorized access, and data misuse. The storage and transmission of large data sets necessary for AI-driven marketing campaigns create vulnerabilities that malicious actors may exploit. Data breaches can result in the unauthorized disclosure of personal health information, leading to identity theft, financial fraud, and reputational damage for individuals and organizations involved.

Despite its potential benefits, the use of AI in pharmaceutical marketing raises concerns about algorithmic bias that may inadvertently perpetuate or exacerbate discrimination based on race, gender, age, or socioeconomic status. The biases might reinforce stereotypes, lead to unequal access to healthcare resources, cement disparities in treatment outcomes, or undermine trust in healthcare systems.

Patients may not be fully aware of how their data are collected, stored, and used for AI-driven marketing purposes. Lack of transparency and informed consent practices can erode patient trust and autonomy, compromising the ethical foundation of healthcare marketing initiatives. Pharmaceutical companies may repurpose patient data collected for marketing purposes for other commercial or research activities without explicit consent. The secondary use of data raises ethical concerns regarding patient privacy, autonomy, and control over their personal information.

AI can help manufacturers ensure compliance with pricing regulations and industry standards by monitoring pricing practices and identifying potential compliance risks. By proactively addressing regulatory concerns, manufacturers can avoid penalties and maintain trust with regulatory authorities and customers.

AI-driven pharmaceutical marketing must comply with strict privacy regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in the European Union. Failure to adhere to regulatory requirements can result in legal penalties, fines, and reputational damage for non-compliant organizations.

IV. Pharmaceutical Marketing in the District of Columbia

Market Overview

The market for pharmaceutical drugs in the District of Columbia reflects a diverse and dynamic healthcare landscape influenced by various factors including demographics, healthcare policies, and the presence of healthcare institutions.

The District's population is characterized by significant racial and ethnic diversity, with African American residents comprising a substantial portion of the population. Additionally, the District has a relatively high proportion of young professionals, government employees, and individuals with advanced educational backgrounds due to its status as the nation's capital and hub for government, education, and professional services.

Like many urban areas, D.C. struggles with high rates of chronic diseases such as hypertension, diabetes, obesity, and heart disease. These conditions are often associated with lifestyle factors, including diet, physical activity levels, and access to healthcare services. D.C. has one of the highest rates of HIV/AIDS prevalence in the United States. The city has made significant efforts to address the HIV/AIDS epidemic through prevention, testing, treatment, and support services. D.C. faces challenges related to mental health disorders and substance abuse, including opioid addiction and overdose deaths. Access to mental health services and substance abuse treatment remains a priority for the city's healthcare system. Despite efforts to improve healthcare access and equity, disparities in health outcomes persist among different population groups in D.C., particularly among racial and ethnic minorities and low-income communities. While D.C. has a relatively high concentration of healthcare facilities and providers, access to healthcare services remains a concern for underserved communities, including those living in areas with limited healthcare infrastructure and resources.

The District is home to a diverse array of healthcare providers, including large academic medical centers, community hospitals, specialty hospitals, and outpatient clinics. These institutions offer a wide range of medical services, from primary care and preventive services to specialized treatments and surgical procedures.
Specifically, the District boasts several renowned academic medical centers affiliated with prestigious universities and medical schools. These institutions play a crucial role in medical education, research, and innovation while providing advanced patient care services. Examples include MedStar Georgetown University Hospital and George Washington University Hospital. The hospital market in D.C. includes both public and private hospitals, each with its own unique mission, patient population, and service offerings. Public hospitals, such as United Medical

Center, often serve a significant number of uninsured and underinsured patients and play a vital role in providing essential healthcare services to vulnerable populations.

As outlined in the companion report “Pharmaceutical Marketing Expenditures in the District of Columbia in 2022”, the District is served by various pharmaceutical distributors and wholesalers that supply medications to pharmacies, hospitals, clinics, and other healthcare facilities across the city. The pharmaceutical market in the District is shaped by emerging trends and innovations in drug development, healthcare delivery, and patient care. Advances in precision medicine, biotechnology, digital health, and personalized therapies are driving innovation and transforming the way pharmaceutical products are developed, prescribed, and utilized in clinical practice.

A Data Set of Prescribers

The Centers for Medicare & Medicaid Services (CMS) publishes data sets that are freely accessible for the public. The Medicare Part D Prescribers by Provider data set (CMS 2024) contains information on prescription drugs prescribed by individual physicians and other health care providers and paid for under the Medicare Part D Prescription Drug Program. The data set identifies providers by their National Provider Identifier (NPI) and summarizes for each prescriber the total number of prescriptions that were dispensed, which include original prescriptions and any refills, and the total drug cost.

This data set is based on information gathered from CMS administrative claims data for Medicare beneficiaries enrolled in the Part D program available from the CMS Chronic Condition Data Warehouse.

The results described below refer to prescribing data from 2021, the most recent year available. For the District of Columbia, the data set contains information on 4,916 prescribers.

Prescribing Patterns by ZIP Code

The data set contains information on each prescriber’s ZIP code. Figure 1 shows the number of prescribers by ZIP code in the District of Columbia in 2021. The map shows considerable variation in the number of providers per ZIP code who were listed on at least one Medicare Part D claim, ranging from one prescriber to as many as 1,026. The ZIP codes with the largest numbers of prescribers were found in the northwestern quadrant of the District.

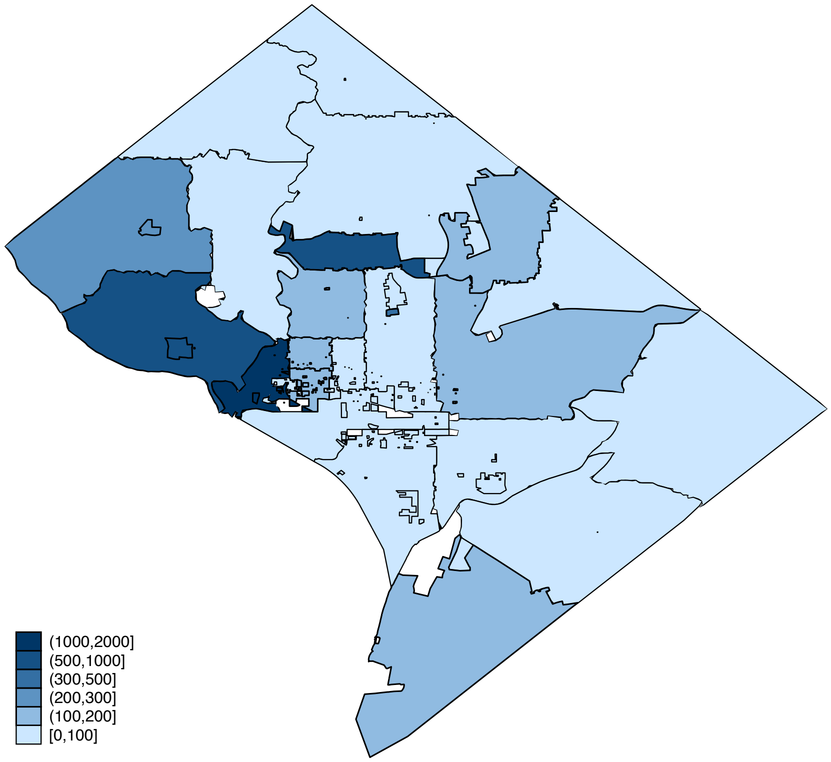

Figure 1. Numbers of Prescribers by ZIP Code, 2021

While the northwestern quadrant includes ZIP codes with the largest numbers of prescribers, the prescribers with the largest numbers of Medicare Part D beneficiaries aged 65 and older were found in ZIP codes in the northeastern and southeastern quadrants (Figure 2). While the average number of beneficiaries per prescriber was between 40 and 100 in more than half of all ZIP codes, that number reached 181 and 205 in the top two ZIP codes.

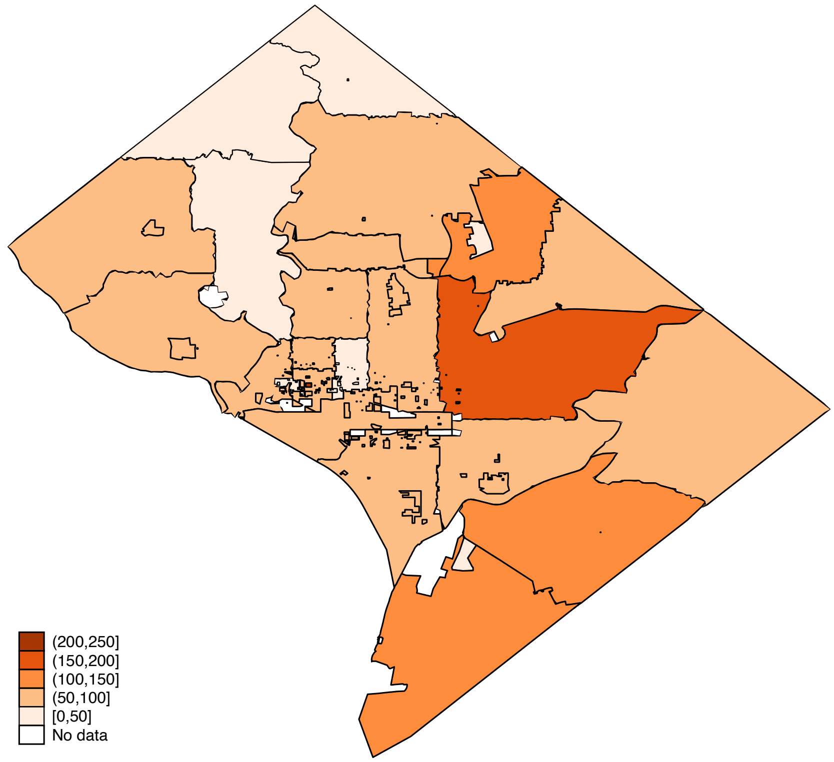

Figure 2. Medicare Part D Beneficiaries Aged 65 and Older per Prescriber by ZIP Code, 2021

For purposes of pharmaceutical marketing, it is instructive to examine the average annual total count and cost of drug claims filed on behalf of Medicare Part D beneficiaries per prescriber. Figure 3 shows the average annual number of drug claims per beneficiary by ZIP code in the District of Columbia in 2021. On a per-prescriber basis, the annual claim counts were highest in ZIP codes in the northeastern and southeastern quadrants. Two ZIP codes recorded average annual claim counts of at least ten, while the ZIP code average was just over five.

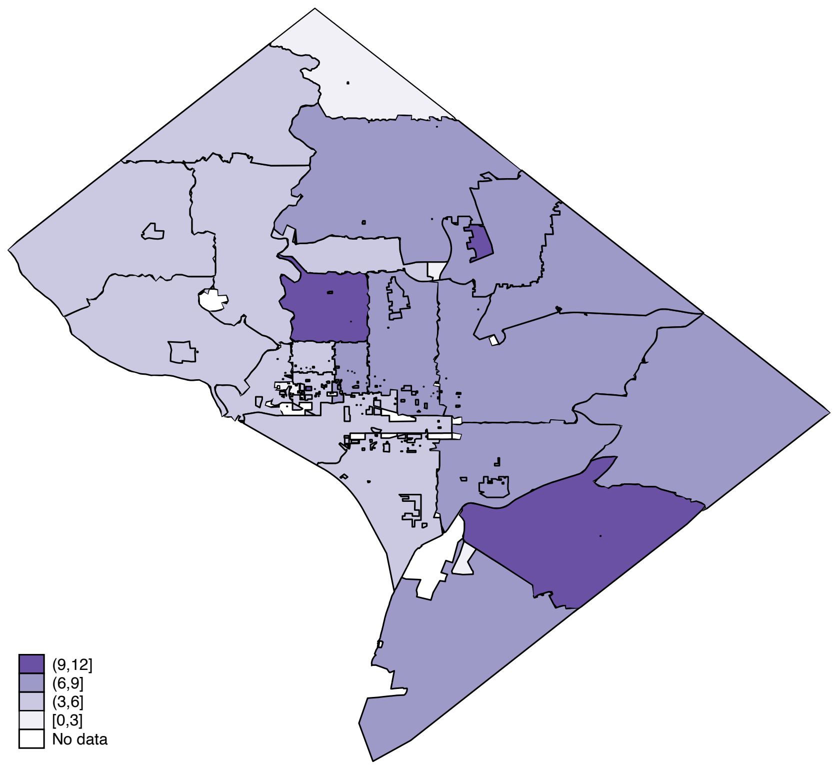

Figure 3. Average Annual Number of Drug Claims per Beneficiary by ZIP Code, 2021

Finally, Figure 4 shows the average total annual drug cost ($) per beneficiary by ZIP code in the District of Columbia in 2021. The ZIP codes with the highest average annual drug claims cost were found just north of the center of the District. These ZIP codes recorded average annual drug claims cost per beneficiary in excess of $2,200 compared to an average of $1,100 across all ZIP codes.

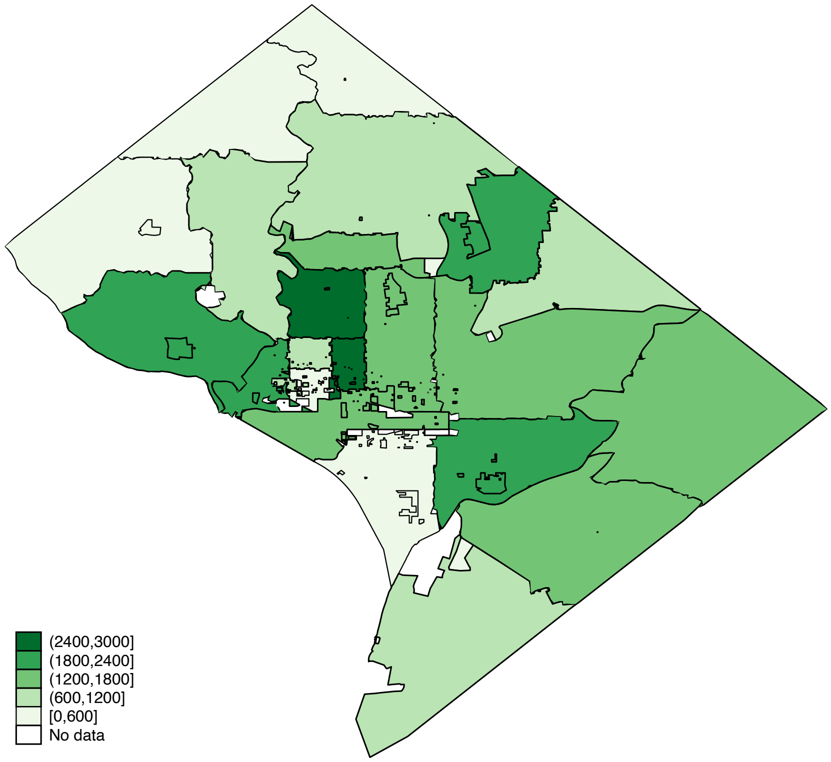

Figure 4. Average Total Annual Drug Cost ($) per Beneficiary by ZIP Code, 2021

These patterns show that ZIP code alone is an imperfect guide for identifying prescribers who might be receptive and responsive to pharmaceutical marketing.

Prescribing Patterns by Beneficiary Risk Score

The data also show substantial variation in the average beneficiary's Hierarchical Condition Category (HCC) risk score per prescriber. The Hierarchical Condition Category (HCC) risk score is "a risk-adjustment model originally designed to estimate future health care costs for patients." The HCC is designed to capture disease characteristics such as "type and underlying cause (e.g., diabetes type 1 or 2, due to underlying condition, postprocedural or due to genetic defects), control status, severity, site, location or laterality, associated co-morbid conditions, and substance use/exposure" (AAFP 2024).

Figure 5 shows the distribution of the average beneficiary's HCC risk score per prescriber in the District of Columbia in 2021. While the typical beneficiary's risk score in the average prescriber's panel was 1.5, one quarter of prescribers treated beneficiaries with an average risk score of more than 2.1 and 5% of prescribers, or 262, treated beneficiaries with an average risk score of more than 3.5. The distribution is right-skewed; for instance, 69 prescribers treated beneficiaries with an average risk score of at least 5, 25 with at least 7.

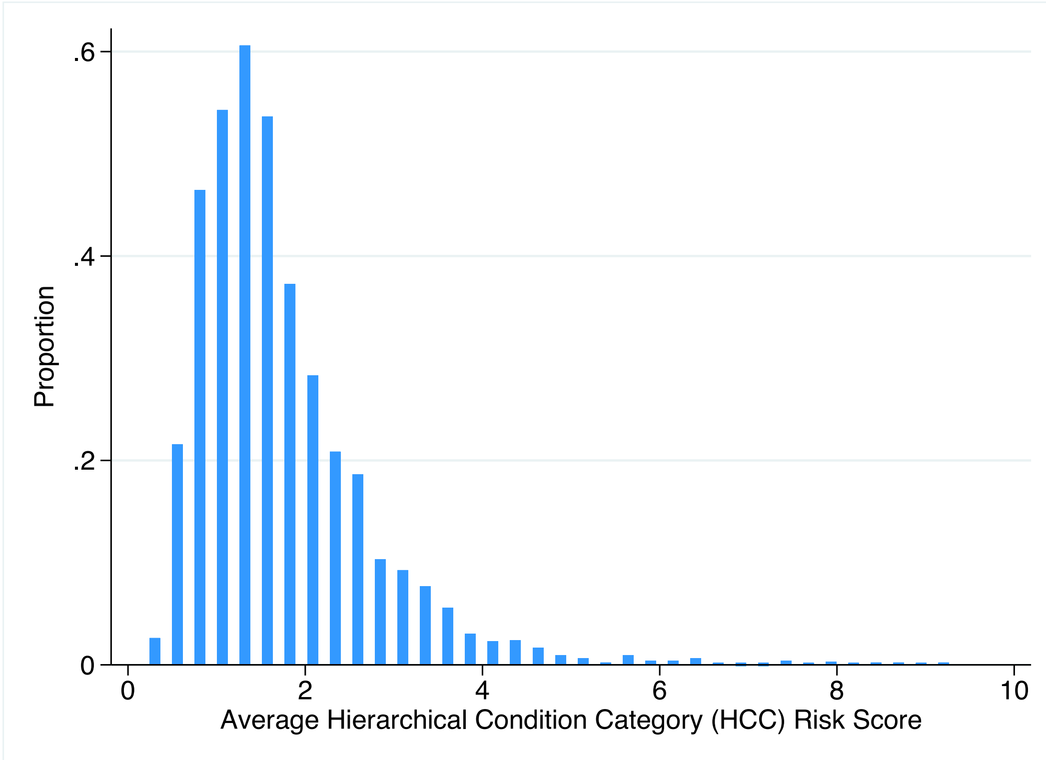

Figure 5. Distribution of Average Beneficiary Risk Score per Prescriber, District of Columbia, 2021

The HCC risk score "incorporates the health risk of beneficiaries by using multiple factors that influence health. These factors include the beneficiary's age; sex; eligibility for Medicaid; initial reason for Medicare qualification; residence in an institution such as a long-term care facility; and the diagnoses assigned to the beneficiary in inpatient, outpatient, and office-based settings during a base year" (Hoffman, Reiter, and Randolph 2018).

As such, the HCC risk score can be used to gauge a beneficiary's likely medication needs. A high average beneficiary's risk score in turn may point to providers who treat patients with multiple medical conditions and who therefore may be receptive to pharmaceutical marketing.

Figure 6 shows a scatter plot of a prescriber's annual number of claims per beneficiary against that prescriber's number of beneficiaries in the District of Columbia in 2021. The claims count (on the vertical axis) and the number (on the horizontal axis) are shown in logarithmic scale to reveal greater detail in the parts of the joint distribution with smaller claim counts and beneficiary numbers. Prescribers whose beneficiaries' risk scores were less than 3.5 on average are shown in blue, prescribers whose beneficiaries' risk scores were at least 3.5 on average are shown in red.

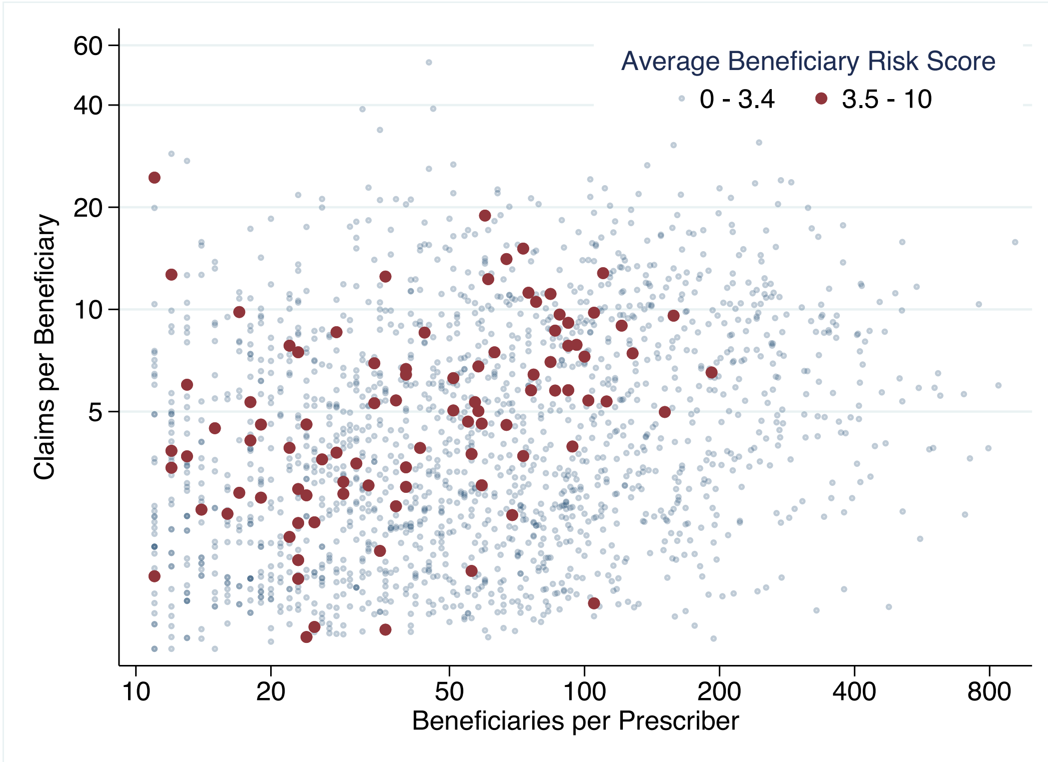

Figure 6. Annual Claims per Beneficiary, Number of Beneficiaries, and Average Beneficiary Risk Score, by Prescriber, District of Columbia, 2021

The figure allows the identification of prescribers who treat many beneficiaries and who average beneficiary risk score is high, yet whose number of claims per beneficiary is low. As a first, coarse approximation, this approach suggests how pharmaceutical marketers could identify providers who might offer an opportunity for increased medication prescription. For instance, in the data shown in Figure 6, there were eleven prescribers who each treated at least 50 beneficiaries and whose average beneficiary's risk score was at least 3.5, i.e. whose patient population comprises the top 5% as measured by the number and severity of medical conditions. Yet these prescribers' beneficiaries on average generated fewer than five claims per year.

Analogous to Figure 6, Figure 7 shows a scatter plot of a prescriber's annual total cost of drug claims per beneficiary against that prescriber's number of beneficiaries in the District of Columbia in 2021. The claims cost (on the vertical axis) and the number (on the horizontal axis) are shown in logarithmic scale to reveal greater detail in the parts of the joint distribution with smaller claim cost and beneficiary numbers.

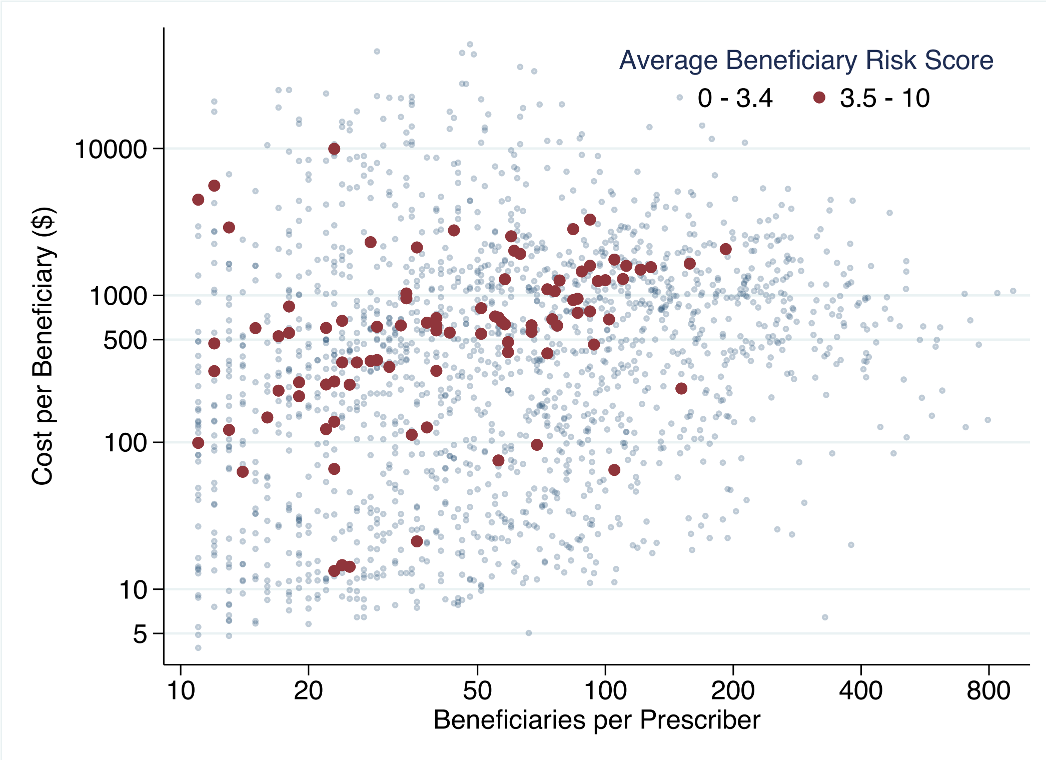

Figure 7. Annual Cost per Beneficiary, Number of Beneficiaries, and Average Beneficiary Risk Score, by Prescriber, District of Columbia, 2021

Again, we can use the figure to identify prescribers who treat comparatively many beneficiaries and whose average beneficiary risk score is high, yet whose beneficiaries' average annual claims cost is fairly low. For instance, Figure 7 show eight prescribers who treated at least 50 beneficiaries and whose average beneficiary risk score was at least 3.5, yet whose beneficiaries' average annual claims cost was no more than $500.

V. Conclusion

Artificial intelligence applications hold the promise of harnessing large data sets to yield actionable insight.

Greater use of AI in pharmaceutical marketing has the potential to empower physicians with personalized insights, streamlined communication channels, and evidence-based decision support tools. At the same time, greater use of AI in pharmaceutical marketing also has the potential to influence drug pricing by enabling optimized pricing strategies, dynamic pricing models, value-based pricing approaches.

An example with a publicly available real-world data set of prescribers in the District of Columbia shows how cluster analysis can help identify prescribers with comparatively many beneficiaries and a high average beneficiary risk score who nevertheless generate few claims and low annual drug claim cost.

Perhaps most important, in the near future it has the potential to benefit patients by enabling targeted outreach and personalized communication, improving treatment adherence, enhancing patient education, and ultimately leading to better treatment outcomes.

In the medium term, greater use of AI in pharmaceutical marketing has the potential to enhance the profitability of drug companies by improving targeting and personalization, enhancing engagement with patients and prescribers, optimizing the allocation of marketing resources, accelerating time to market, and mitigating risks stemming from adverse drug events. Greater profitability in turn may spur innovation in drug development.

The use of AI in pharmaceutical marketing has the potential to introduce potential biases that can impact decision-making and patient outcomes. It is essential for pharmaceutical companies, healthcare providers, and policymakers to address these biases proactively by fostering transparency around the use of data sources and the types of outcomes that the algorithms are designed to predict. Addressing privacy risks in particular requires a multifaceted approach that strengthens data protection and accountability.

Following best practices in the development and use of AI algorithms is imperative if pharmaceutical marketers are to reap the productivity gains while maintaining the trust of patients and prescribers alike.

VI. References

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Appendix. Previous Impact Reports

Expenditure Patterns in the Second Year of the Covid-19 Pandemic (2022)

Expenditure Patterns in the First Year of the Covid-19 Pandemic (2021)

Large Payments to Health Care Providers in the District of Columbia, 2014-2018 (2020)

The Marketing and Prescribing of Hepatitis C Drugs in the District of Columbia (2019)

The Marketing and Prescribing of Anticoagulants in the District of Columbia (2018)

The High Cost of Highly Promoted Drugs in the District of Columbia (2017)

Diabetes in the District of Columbia (2016)

Reporting Changes and the Effect of Gifts on Prescribing Behavior (2015)

Focus on Gifts to Organizations and Influential Physicians (2014)

Focus on Use of Antipsychotics in Seniors (2013)

Report on the Use of Antipsychotics in Children (2012)