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The Association of Lower Medication Adherence and Increased Medical Spending

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Chapter 1 – Introduction

Abstract:

Medical prescribing is a common occurrence in daily clinical practice. According to the Centers for Disease Control and Prevention, in 2015-2016 45.8% of the U.S. population used prescription drugs in the past 30 days. (CDC, 2019) Although drug therapy can be effective in treating disease, full benefits are often not realized because many patients do not take their medications as prescribed. There is quite a bit of research out there about non-adherence to medication. Some studies focus on the financial impacts of non-adherence, but most of the studies examine the reasons for medication non-adherence. A gap exists in research about the economic impact medication adherence has on the patients themselves. This research project will dive into the financial impact on patients of medication adherence vs. non-adherence. The study aims to highlight the association of increased medical spending and lower medication adherence. Similar to other studies, the results demonstrated that non-adherent patients showed higher pharmacy copays and that Medicare paid more for non-adherent Medicare beneficiaries. These findings highlight that greater importance needs to be placed on ensuring medication adherence.

Research Question: What is the Association of Increased Medical Spending and Lower Medication Adherence?

Specific Aims:

1. Do higher pharmacy co-payment amounts have an impact on medication adherence of Medicare beneficiaries?
2. What is the impact of non-adherence on overall health care costs?
3. What is the impact on spending for patients who are dual-eligible?

Significance: As the population continues to rise in this country, so will the expenditures on healthcare. A study by the Urban Institute indicated that, "The number of Americans ages 65 and older will more than double over the next 40 years, reaching 80 million in 2040. The number of adults ages 85 and older will nearly quadruple between 2000 and 2040." (Urban Institute , 2021) Given the increasing number of older Americans, medication adherence will be even more crucial to managing chronic conditions. However, one of the challenges is ensuring those prescribed medications are taken as instructed. Medication adherence is a crucial determinant of a patient's health outcome, not to mention the costs that are incurred from provider to patient. "Despite causing an estimated 125,000 avoidable deaths each year and $100 billion annually in preventable health care costs, medication non-adherence is barely on the radar of most practicing physicians." (Kleinsinger, 2018)

Chapter 2 – Background and Literature Review

An accountable care organization (ACO) seek to enhance the quality of care, reduce costs, and improve health outcomes of patients enrolled. ACOs are defined by the Center for Medicare and Medicaid (CMS) as, "groups of doctors, hospitals, and other health care providers, who come together voluntarily to give coordinated high-quality care to their Medicare patients. (Accountable care organizations, 2021) Research was done in collaboration with the Nebraska Health Network (NHN), an ACO that serves the greater Omaha area. ACOs strive to meet designated cost and quality metrics for the patients and the ACO. An example of a quality metric for preventative care is the percentage of patients screened for influenza immunization. Medication adherence is one of the key factors to ensure that Medicare beneficiaries stay healthy and achieve better health outcomes. In addition to a quality metrics, ACOs are also held accountable for specific cost metrics such as care coordination/patient safety to reduce the number of patients that are re-admitted to a hospital. Since Medicare ACOs generally have a larger number of older patients, they try to control medical costs by ensuring that patients are adhering to their medication regimen. Non-adherent patients with certain chronic conditions, such as diabetes or hypertension can face worsening conditions, with prolonged illness and possible hospitalization. In addition to the adverse impact on the patient's health, increased medical costs would ensue. Research demonstrates that non-adherent patients are more likely to have higher total health care costs, including co-pays. (Watanabe & McInnis & Hirsch, 2018) To that end, ACO's can help control health care costs if patients meet a certain benchmark for adhering to their medication. ACO's can determine those who are adherent or non-adherent by evaluating if they are above or below the cut point. The cut point used by NHN is an 80% Medication Possession Ratio (MPR). The calculation measures the percentage of time a patient

has access to medication on hand. MPR is the sum of the days' supply for all fills of a given drug (or drug class) in a particular time period. Although there will be other factors that lead to non-adherence, research has shown that an important factor is the cost of obtaining medication.

Literature Review

The United States healthcare system is constantly evolving. Over the past decade, the U.S. healthcare system has attempted to shift from the fee-for-service model to value-based pay-for-performance model. This transition is the result of higher health care costs and poorer health outcomes relative to other industrialized nations. Accountable care organizations (ACO's) were introduced in the Patient Protection and Affordable Care Act, and they have been an integral piece in the transition to a value-based pay-for-performance model. A goal of the ACOs is to achieve the quadruple aim which includes improving the patient experience, improving population health, reducing the per capita costs, and ensuring positive provider experiences. (Hacker & Walker, 2013) The goals are broad, so they require considerable collaboration among all of the healthcare providers to help ensure these goals are being met. Although it can be a complex process, ACOs must meet certain cost and quality standards to maximize their reimbursement. The value-based pay-for-performance model lets providers share in the total savings which are related, to achieving population-based performance standards on quality and cost savings. (American Academy of Family Physicians, 2015) ACOs utilize various cost containments methods for the different payers, but one of the major cost reduction strategies for Medicare patients is to ensure medication adherence.

Medication adherence is typically defined as a ratio of the number of drug doses taken to the number of doses prescribed over a given time period. (Morrison & Stauffer, 2015) Taking an antibiotic may prevent a more severe infection and adhering to a drug regimen for a chronic

condition such as diabetes or high blood pressure may prevent complications and other long-term health conditions. In either of those circumstances, not taking the medication and adhering to the prescription and dosages, may lead to frequent clinic visits, urgent care visits, and hospitalizations. (Congressional Budget Office, 2012) The Congressional Budget Office reported that decreased use of prescription drugs was associated with increased use of medical services. One study estimated that adjusted total health care costs or total costs with annual costs per patient ranging from $2,741-$9,819, if patients adhered to their prescriptions. (Jha, 2012) A study done by Eaddy examined over 66 existing studies that looked at out of pocket costs OOP costs and adherence to medication. The conclusion was that, 85% of those identified studies demonstrated that raising the patient's portion of medication OOP costs was associated with lower adherence levels. (Eaddy, 2012)

In the US, nearly half of all adults suffer from at least one chronic disease and the percentage of Americans prescribed at least one drug rose from 38% in the period 1988–1994 to 49% in the period 2007–2010; and during the same time, adults taking three or more prescription drugs doubled. (National Center for Health Statistics, 2013) As our population ages, so will the need for more prescriptions. As more prescriptions are administered to people of all ages, non-adherence may become an even greater issue. (National Center for Health Statistics, 2013) Patients who do not follow the proper medication regimen will suffer the consequences physically and financially. Most of the costs related to medication non-adherence can result from avoidable hospitalization. (Institute of Healthcare Informatics)

A study of 33,816 Medicare beneficiaries diagnosed with Chronic Obstructive Pulmonary Disease found a reduction of $2,185 per patient in the annual Medicare spending for patients with proportion of days covered (PDC) higher than 80%, compared to patients with PDC below

80%. (Simoni-Wastila, 2012) PDC is calculated as the total number of days supplied during an interval, divided by the total number of days during that interval. A different study found an association of higher PDC and fewer emergency department visits and hospitalizations, resulting in a 2.2% reduction in overall costs. (Toy, 2011)

Diabetes is a common chronic condition that is costly and affects millions of people. Several studies have shown an increased adherence is associated with lower costs compared to non-adherent patients. A study examined the relationship between costs and diabetes, and concluded every 10% increase in adherence was associated with an 8.6% to 28.9% decrease in costs. (Balkrishnan, 2003) The results of these studies provide evidence that there is a direct relationship between healthcare spending and adherence to medication regimens.

Hypertension impact almost one-half of the adult population in the United States. (Ritchey, 2018) Using administrative claims data, Sokol and colleagues estimated the health care costs associated with poor adherence to hypertension and hypercholesterolemia medications. They found that savings from lower medication costs were offset by increased total medical costs driven in part by decreased hospitalizations such that poor adherence was associated with higher overall health care costs.

Bipolar disorder (BD) is a mental health condition with extreme mood swings. A systematic literature review researched the economic burden associated with BD in the United States. The estimated total annual national economic burden of BD was more than $195 billions… Individuals with BD used health-care services more frequently and had higher direct medical costs than matched individuals without the disease.” (Bessonova, 2020) The study demonstrated poor adherence was a factor in higher costs. (Bessonova, 2020)

Nearly 50% of patients with cardiovascular disease have poor adherence to their prescribed medications. (Kronsih, 2013) Esposito looked at Medicare and Medicaid beneficiaries with congestive heart failure, and showed that total health care costs are associated to adherence of medication. Total health care costs were as much as 23% less per year for adherent patients as compared with non-adherent patients. (Esposito, 2009)

For patients, their direct costs of medication is their portion of the co-pay. A co-pay is considered a cost sharing strategy that is the sum per prescription a patient is required to pay. (Mann, 2014) Many studies have examined the impact a co-pay can have on adhering to medication. In a high-risk group of US veterans with coronary disease, raising the copayment amount by $5 per prescription, with or without an annual maximum out-of-pocket expenditure, resulted in a 30–40% lower adjusted odds of adherence. (Doshi, 2009)

A study in Louisiana examined at the association between copay elimination with medication adherence and total cost. The study compared medication adherence a year before and after expanding the zero-dollar co-pay prescription benefit. The results of the study were significant and showed that lower co-pays led to greater adherence as a result of fewer financial hurdles that a patient had to face. Among the zero-dollar co-pay members, medication adherence went up in each income category. The most significant increase was seen in low-income households, with smaller increases in the middle and high-income groups. (Cong, 2021) The conclusion of this study was each income category raised their adherence levels, especially low-income individuals using the zero-dollar co-pay benefit, validating that lower patient costs increase medication adherence.

Chapter 3 – Data and Methods

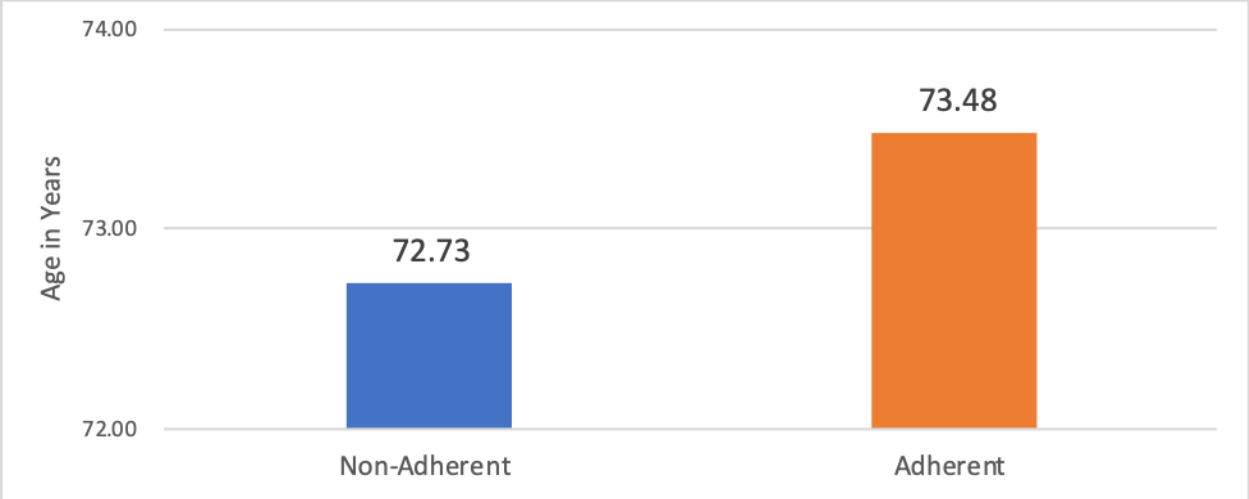
Methods:

The (NHN) is an (ACO) that serves the greater Omaha metro area with over 170,000 lives in value-based arrangements with commercial, Medicare, and Medicaid payers. NHN participates in Medicare's Alternative Payment Model the Medicare Shared Savings Program (MSSP) and is assigned over 30,000 Medicare beneficiaries each year. Through this agreement with Medicare, NHN receives medical and pharmacy claims data which allows the opportunity for analysis and research. These claims data are aggregated and organized through a 3rd party Vendor contractor that provides NHN a wealth of data analytic tools including information regarding medication adherence. For this project, a query from this data set was performed to examine de-identified MSSP patient data from July 2019 through July 2020. This de-identified data includes medical claims cost, pharmacy copayment amount, resource utilization, risk index number, common conditions, and limited patient demographic information including age, gender, and zip code. CMS shares copay amount on prescription claims, and the amount they reimbursed for medical claims. This data is further divided between patients who were adherent to medications (i.e., >80% Medication Possession Ration) for the timeframe or were non-adherent over the timeframe. The data provided allowed further research into specific chronic conditions, including diabetes, hypertension, COPD, congestive heart failure, rheumatoid arthritis, and bi-polar disorder.

Chapter 4 – Results

A total of 36,910 Medicare beneficiaries were included in this study. The demographics of the study population are shown in Figure 1. The age is the only available demographic to include.

Figure. 1. Average Age of Adherent and Non-Adherent Medicare Patients, July 2019-July 2020



The average age includes people who are less than 65 years of age, because some patients are considered “dual-eligible” meaning they are typically part of a disabled population (or other extenuating circumstances that make them eligible for Medicare coverage before age 65) and often have both Medicaid and Medicare. There are 3,326 dual-eligible patients in MSSP. The non-adherent group is in blue with an average age of 72.73. The adherent group has an average age of 73.48.

Figure. 2. Average Medical Paid and Average Copay for Medicare Patients, July 2019 – July 2020

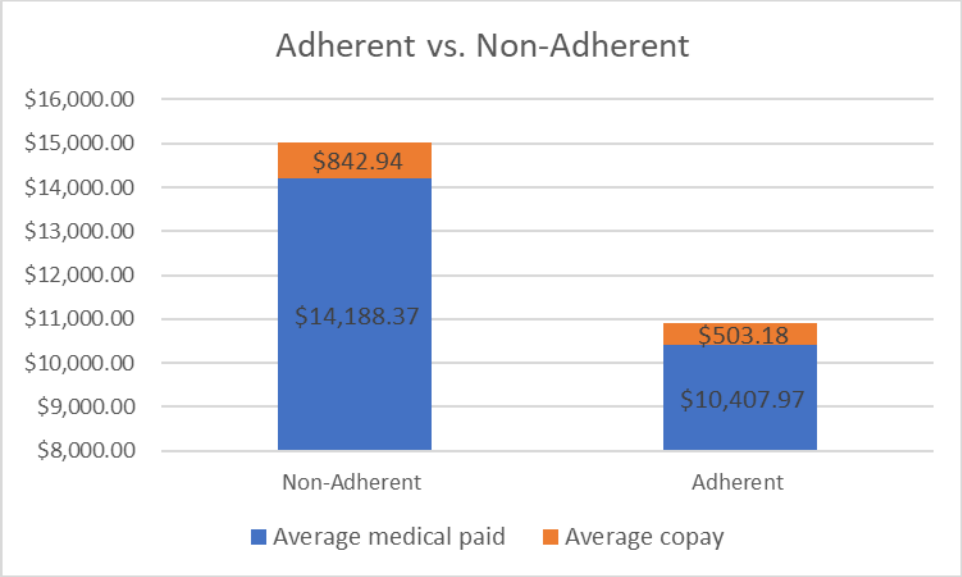


Figure 2 shows the average medical paid by Medicare in blue and pharmacy co-payment amounts paid by Medicare beneficiaries in orange, from July 2019 through July 2020. CMS shares how much they reimbursed the health system providers for medical services, and the pharmacy copay amount paid by the patient.

Figure. 3. Average Medical Expenses Paid and Average Copays for Medicare Patients with Diabetes, July 2019- July 2020

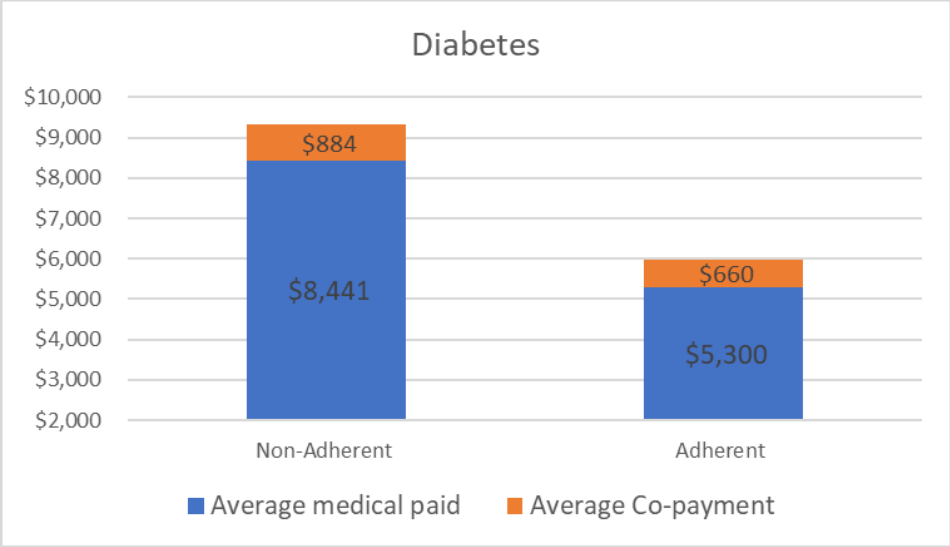


Figure 3 shows on average what Medicare paid for medical expenses in blue and what pharmacy copay amounts Medicare beneficiaries paid in orange. Medicare paid $3,141 more to health systems for non-adherent patients and Medicare beneficiaries paid $224 more on pharmacy copays from July 2019-July 2020.

Figure. 4. Average Medical Expenses Paid and Average Copays for Medicare Patients with Hypertension, July 2019- July 2020

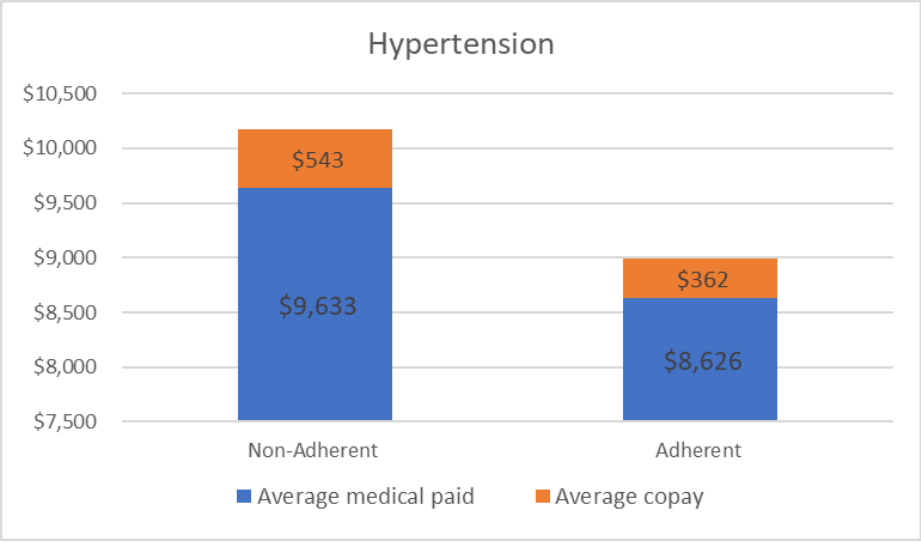


Figure 4 illustrates what Medicare paid for medical expenses in blue and pharmacy copays paid by Medicare beneficiaries with hypertension in orange, from July 2019 – July 2020. On average, Medicare reimbursed health systems $1,007 more for non-adherent patients. Non-adherent patients paid $181 more on pharmacy copayments.

Figure. 5. Average Medical Expenses Paid and Average Copays for Medicare Patients with COPD, July 2019- July 2020

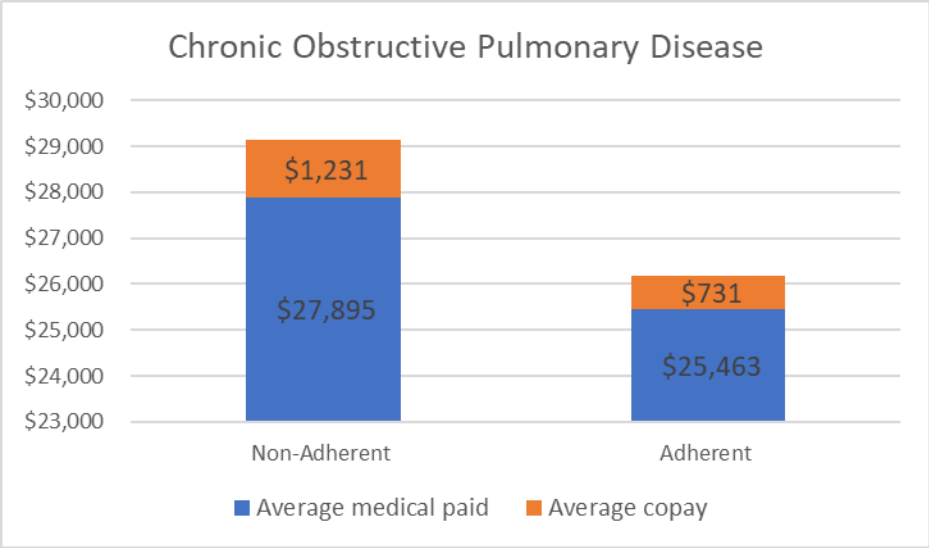


Figure 5 shows what Medicare paid for medical expenses in blue and what patients owed for pharmacy copays in orange. On average, Medicare beneficiaries paid $500 more on pharmacy copays. Medicare reimbursed health systems $2,432 more for non-adherent patients.

Figure. 6. Average Medical Expenses Paid and Average Copays for Medicare Patients with Congestive Heart Failure, July 2019- July 2020

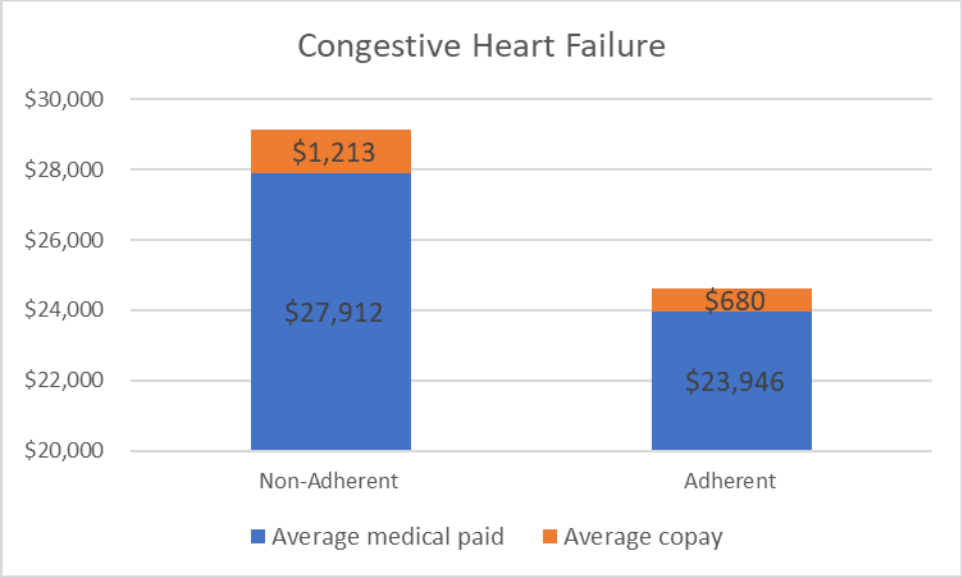


Figure 6 shows what Medicare paid for medical expenses in blue and what patients paid for pharmacy copays in orange, from July 2019 – July 2020. Non-adherent Medicare beneficiaries paid $533 more on pharmacy copays. Medicare paid $3,966 more on medical expenses for non-adherent patients.

Figure. 7. Average Medical Expenses Paid and Average Copays for Medicare patients with Rheumatoid Arthritis, July 2019- July 2020

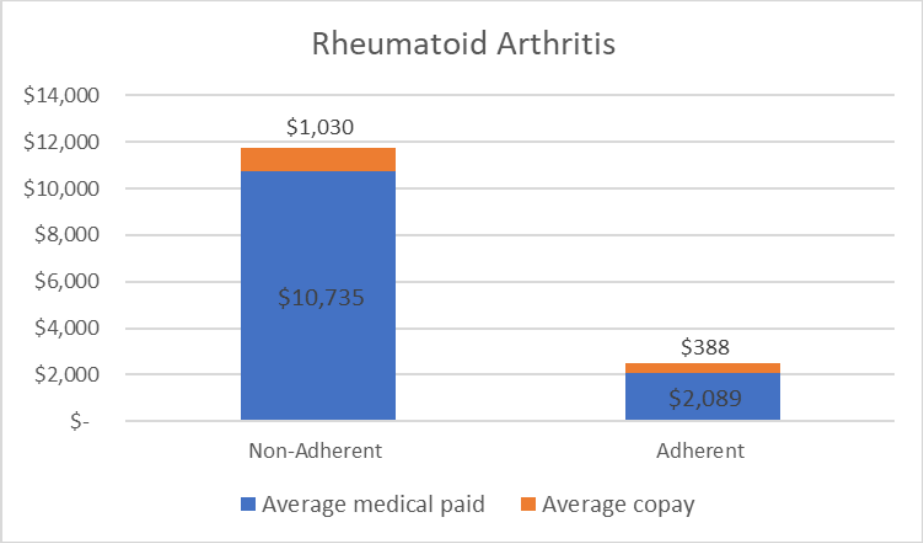


Figure 7 illustrates the amount Medicare paid on medical expenses in blue and what Medicare beneficiaries paid for pharmacy copays in orange. On average, Medicare reimbursed health systems $8,646 more for non-adherent patients. Medicare beneficiaries paid $642 more on pharmacy copays.

Figure. 8. Average Medical Expenses Paid and Average Copays for Medicare patients with Bi-Polar Disorder, July 2019- July 2020

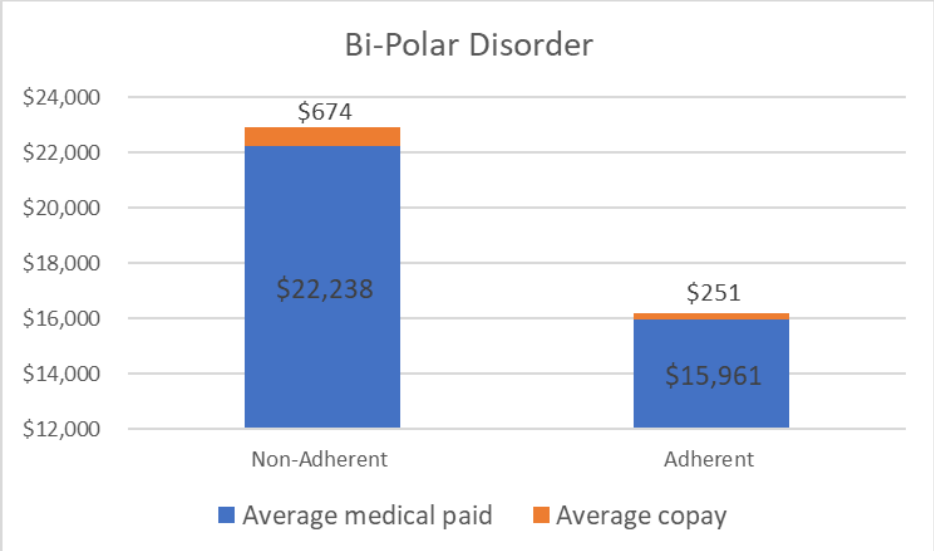


Figure 8 shows the amount paid on medical expenses by Medicare in blue and pharmacy copays Medicare beneficiaries paid in orange. Medicare paid $6,277 more to health systems for non-adherent patients. Medicare beneficiaries paid $423 more on pharmacy copays from July 2019-July 2020.

An additional finding in this study was looking at association of costs between dual eligible and Medicare only beneficiaries. Dual eligible patients paid a considerable amount more than those who are enrolled in Medicare only. “There are 12.2 million people nationwide who are simultaneously enrolled in Medicare and Medicaid, a population often referred to as “dual-eligible” beneficiaries.” (Arnold Adventures, 2020) Dual eligible individuals usually have complex care needs that results in increased spending for both programs.

Table. 1. Average Medical Paid and Average Copays for Dual Eligible and Medicare Only Patients, July 2019 – July 2020

	Dual eligible	Medicare only
Average medical paid	$ 14,970.71	$ 10,085.89
Average copay	$ 214.83	$ 543.40

Table 1 breaks down what Medicare paid out and pharmacy copay amounts that dual eligible participants paid compared to Medicare only patients. Medicare paid $4,884 more on medical expenses for dual eligible patients. Medicare only patients paid $329 more on copays.

Chapter 5 – Discussion

Summary

This study provides evidence that increased medical spending is associated with lower medication adherence. The data shows several aims of my capstone project. The first is that higher copayment leads to more non-adherence which leads then leads to higher medical expenses. In my study, Medicare beneficiaries paid $340 more on pharmacy copayments. On average, Medicare reimbursed health systems $3,780 more on medical expenses for non-adherent patients showing there is an association of increased medical spending and lower adherence levels. The results of this study are consistent with existing research that correlates lower medication adherence to increased medical spending. A literature review was conducted that looked at studies associated with adherence levels. Of the studies that reported healthcare costs, 39 studies reported non-adherent costs to be greater than adherent costs. (Cutler, 2018) The overall findings of adherent vs. non-adherent are consistent with chronic conditions.

The World Health Organization identified hypertension as the primary cause of premature mortality. There is a connection between non-adherence and costs that has been proven as a continuous cycle. Generally, low medication adherence from a patient leads to poor health outcomes, leading to an increase in service utilization. Corrao found poor adherence to antihypertensive therapy is associated with a higher risk of experiencing a coronary event. (Corrao, 2011.) The effects of this cycle fall on the patient as well as the health care system. This study found Medicare paid $1,007 more on medical expenses for non-adherent beneficiaries and $181 more on copayments.

Current treatment for rheumatoid arthritis recommends the treat-to-target approach. The treat-to-target approach can include various techniques to find the correct drugs and dosage to

achieve the goal of lessening disease activity. The only way this strategy can be successful is if patients are adherent to their recommended regimen. (Marengo, 2015) The findings concluded that Medicare paid $8,646 more on medical expenses for non-adherent beneficiaries and Medicare beneficiaries paid $642 more on pharmacy copays from July 2019-July 2020.

For diabetes, Medicare paid $3,141 more on medical expenses for non-adherent Medicare beneficiaries and Medicare beneficiaries paid $224 more on pharmacy copays. The implications of non-adherence associated with diabetes has a profound effect on individuals and the overall health care system. Several studies have found that type 2 diabetes represents the largest budget item in many health care systems, mainly due to the high rates of morbidity and mortality associated with the disease. (Currie, 2012) Potential effects of medication non-adherence are associated with poor glycemic control, increased morbidity, and mortality. (Polonsky, 2016)

Non-adherent patients with bi-polar disease paid $423 more on pharmacy copays. Medicare paid $6,277 more on medical expenses for non-adherent Medicare beneficiaries. Non-adherence in bi-polar disorder not only has an effect on patients financially, but on their overall health as well. “BD has the highest suicide rate of any psychiatric condition.” (Schaffer, 2015) A study examined patients with bi-polar disorder over an extended period of time and found that long term adherence to medication was associated with a much lower suicide rate. (Angst, 2005)

Strengths/Limitations

A limitation of this study is that there are many reasons for adherence levels and they are not solely related to paid medical expenses and copayments. A patient may not fully understand why there is a need for them to take the medication. The fear of potential side effect can play a major role in the choice of a patient to not take the medication as recommended by the provider. Since the data are based on claims data, cash payments are excluded from the analysis. One of the main strengths of this study was the lack of bias in the research design. It was a very straightforward approach to collect the data, and then compare the costs between adherent vs. non-adherent. Additionally, the total number of Medicare enrollees in this study was substantial. My study was consistent with studies that already exist looking at the association between increased medical spending and lower medication adherence.

Interpretation

The National Health Expenditure in 2020 was $4.1 trillion which is 19.7% of Gross Domestic Product. (Centers for Medicare and Medicaid Services, 2020) It is estimated that 20%-30% of money spent on healthcare in the U.S. is considered wasteful. (Centers for Medicare and Medicaid Services, 2011) One of the many challenges the healthcare industry faces is identifying wasteful spending and reducing costs. One effort to rein in costs is to focus on medication adherence. A root cause of medication non-adherence are costs associated with obtaining prescriptions, like higher copays. Non-adherent patients lead to an increase in healthcare service utilization which increases overall healthcare spending. This study highlights the increased costs that burden patients and the U.S. healthcare system. Costs may not immediately decline if adherence goes up, but it will save money in the long run. The results highlight the importance that needs to be placed on adherence to medication. It has been proven that non-adherence is one

underlying cause of wasteful spending in healthcare. Future studies are needed to find validated programs that improve medication adherence.

Public Health Competencies

My research project falls under the foundational competency of evidence-based approaches to public health. I selected a project that interprets results of data analysis for public health research, policy or practice. Public health is often associated with identifying barriers to care and researching gaps that can be improved to help a specific group of people or population. Access to care and costs will always be associated with one another. In the 2020 NHIS survey, 1 in 11 adults reported delaying or going without medical care due to cost reasons. Medication adherence is an understudied topic that can significantly affect the total cost of care a patient must pay annually. Collecting data through Nebraska Health Network (NHN) will highlight an area that can improve patients' overall health. The first concentration competency is BIOSMPH4. BIOSMPH4 is to develop written and oral presentations based on statistical findings for both public health professionals and lay audiences. I can accomplish this by summarizing the data I received from NHN and translating that to a final paper. I will also be doing an oral presentation on the results from the statistical findings. The second concentration competency is HPROMPH3. HPROMPH3 is to develop rigorous projects to improve public health outcomes, community wellbeing, and reduce health disparities. My project aims to research the association between higher medical spending and lower medication adherence. By exploring these cost differences between the adherent vs. non-adherent, my capstone project will highlight gaps that can be focused on to improve health disparities.

References:

American Academy of Family Physicians . Accountable Care Organizations *:* A *Physician's Perspective 2015*, http://www.aafp.org/practice-management/payment/acos/faq.html

Angst J, Angst F, Gerber-Werder R, et al. Suicide in 406 mood-disorder patients with and without long-term medication: a 40 to 44 years' follow-up. *Arch Suicide Res* 2005; 9: 279–300.

Arnold Adventures. Complex Care Team. *Who is the Dual-Eligible Population and Why is Change Needed?* Who is the Dual-Eligible Population and Why is… | Arnold Ventures

Balkrishnan R, Rajagopalan R, Camacho FT, et al. Predictors of medication adherence and associated health care costs in an older population with type 2 diabetes mellitus: a longitudinal cohort study. Clin Ther. 2003 Nov;25(11):2958–2971

Bessonova, L., Ogden, K., Doane, M. J., O'Sullivan, A. K., & Tohen, M. (2020). The Economic Burden of Bipolar Disorder in the United States: A Systematic Literature Review. *ClinicoEconomics and outcomes research : CEOR*, *12*, 481–497. https://doi.org/10.2147/CEOR.S259338

Centers for Medicare and Medicaid Services, editor. *NHE Projections 2010–2020.* Washington, DC: US Department of Health and Human Services; 2011

Cong M, Chaisson J, Cantrell D, Mohundro BL, Carby M, Ford M, Liu M, Kemp LS, Ouyang J, Zhang Y, Williams HC, Vicidomina BV, Nigam SC. Association of co-pay elimination with medication adherence and total cost. Am J Manage Care. 2021 Jun;27(6):249-254.

Corrao G., Parodi A., Nicotra F., Zambon A., Merlino L., Cesana G., et al. (2011). Better compliance to antihypertensive medications reduces cardiovascular risk. *J. Hypertens.* 29 610–618. 10.1097/HJH.0b013e328342ca97

Currie CJ, Peyrot M, Morgan CL, et al. The impact of treatment noncompliance on mortality in people with type 2 diabetes. *Diabetes Care.* 2012;35(6):1279–1284

Cutler, R. L., Fernandez-Llimos, F., Frommer, M., Benrimoj, C., & Garcia-Cardenas, V. (2018). Economic impact of medication non-adherence by disease groups: a systematic review. *BMJ open*, *8*(1), e016982. https://doi.org/10.1136/bmjopen-2017-016982

Doshi JA, Zhu J, Lee BY, Kimmel SE, Volpp KG (2009) Impact of a prescription copayment increase on lipid-lowering medication adherence in veterans. *Circulation* 119: 390–397

Eaddy MT, Cook CL, O'Day K, Burch SP, Cantrell CR. How patient cost-sharing trends affect adherence and outcomes: a literature review. P T. 2012 Jan;37(1):45-55. PMID: 22346336; PMCID: PMC3278192.

Esposito D, Bagchi AD, Verdier JM, Bencio DS, Kim MS. Medicaid beneficiaries with congestive heart failure: Association of medication adherence with health care use and costs. *Am J Manag Care.* 2009;15(7):437–445

Hacker, K, Walker, DK. Achieving population health in accountable care organizations. Am J Public Health 2013; 103: 1163–1167.

IMS Institute for Healthcare Informatics. Avoidable costs in US health care. 2013. Available at: http://www.imshealth.com/ deployedfiles/imshealth/Global/Content/Corporate/IMS%20Institute/ RUOM-2013/IHII_Responsible_Use_Medicines_2013.pdf. Accessed September 10, 2013.

Kleinsinger F. (2018). The Unmet Challenge of Medication Nonadherence. *The Permanente journal*, *22*, 18–033. https://doi.org/10.7812/TPP/18-033

Kronish IM, Ye S. Adherence to cardiovascular medications: Lessons learned and future directions. *Prog Cardiovasc Dis.* 2013;55(6):590–600.

Mann, B. S., Barnieh, L., Tang, K., Campbell, D. J., Clement, F., Hemmelgarn, B., Tonelli, M., Lorenzetti, D., & Manns, B. J. (2014). Association between drug insurance cost sharing strategies and outcomes in patients with chronic diseases: a systematic review. *PloS one*, *9*(3), e89168. https://doi.org/10.1371/journal.pone.0089168

Morrison, A., Stauffer, M. E., & Kaufman, A. S. (2015). Defining medication adherence in individual patients. *Patient preference and adherence, 9*, 893–897. https://doi.org/10.2147/PPA.S86249

National Center for Health Statistics. Health, United States, 2012: With special feature on emergency care. 2013. Available from: http://www. cdc.gov/nchs/data/hus/hus12.pdf. Accessed September 21, 2013

Polonsky, W. H., & Henry, R. R. (2016). Poor medication adherence in type 2 diabetes: recognizing the scope of the problem and its key contributors. *Patient preference and adherence, 10*, 1299–1307. https://doi.org/10.2147/PPA.S106821

Ritchey MD, Gillespie C, Wozniak G, Shay CM, Thompson-Paul AM, Loustalot F, Hong Y. Potential need for expanded pharmacologic treatment and lifestyle modification services under the 2017 ACC/AHA Hypertension Guideline. J Clin Hypertens (Greenwich) 2018; 20:1377–1391.

Schaffer A, Isometsa ET, Tondo L, et al. Epidemiology, neurobiology and pharmacological interventions related to suicide deaths and suicide attempts in bipolar disorder: part I of a report of the International Society for Bipolar Disorders Task Force on Suicide in Bipolar Disorder. *Aust N Z J Psychiatry* 2015; 49: 785–802.

Simoni-Wastila L, Wei YJ, Qian J, et al. Association of chronic obstructive pulmonary disease maintenance medication adherence with all-cause hospitalization and spending in a medicare population. Am J Geriatr Pharmacother. 2012;10(3):201–210.

Sokol MC, McGuigan KA, Verbrugge RR, Epstein RS. Impact of medication adherence on hospitalization risk and healthcare cost. *Med Care.* 2005;43:521–30.

Toy EL, Beaulieu NU, McHale JM, et al. Treatment of COPD: Relationships between daily dosing frequency, adherence, resource use, and costs. *Respir Med.* 2011;105(3):435–441

Vrijens B., De Geest S., Hughes D. A., Przemyslaw K., Demonceau J., Ruppar T., et al. (2012). A new taxonomy for describing and defining adherence to medications. *Br. J. Clin. Pharmacol.* 73 691–705. 10.1111/j.1365-2125.2012.04167