

Table 2: Demographic Characteristics of OUD Patients (2005 – 2014)

	Year									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total (N)	9884	14026	17737	27835	32076	44053	67839	81422	76237	95160
Gender of Patient										
Male	57.50%	58.40%	58.70%	60.00%	59.70%	60.80%	62.20%	62.70%	62.40%	61.90%
Female	42.50%	41.60%	41.30%	40.00%	40.30%	39.20%	37.80%	37.30%	37.60%	38.10%
Age Group										
0-17	4.10%	4.30%	3.70%	3.20%	3.00%	2.70%	2.20%	1.80%	1.50%	1.00%
18-34	37.30%	39.70%	42.20%	44.10%	46.50%	48.70%	55.40%	55.60%	54.50%	52.20%
35-44	23.20%	22.50%	22.00%	21.50%	20.20%	20.50%	18.40%	18.40%	18.50%	19.50%
45-54	26.50%	24.10%	23.00%	21.90%	20.60%	18.90%	16.00%	15.60%	15.40%	15.80%
55-64	8.90%	9.30%	9.10%	9.40%	9.80%	9.30%	8.10%	8.60%	10.20%	11.40%
Metropolitan Area										
Metropolitan	87.30%	86.10%	86.20%	87.50%	86.40%	83.70%	81.60%	82.90%	84.00%	84.10%
Non-metropolitan	11.50%	13.10%	13.50%	12.20%	13.40%	15.20%	15.30%	15.20%	13.70%	13.80%
Unknown	1.20%	0.70%	0.30%	0.30%	0.20%	1.10%	3.10%	1.90%	2.30%	2.00%
Region										
Northeast	12.00%	15.00%	14.30%	23.20%	16.40%	22.00%	27.00%	28.40%	29.20%	31.40%
North central	24.80%	28.20%	27.40%	22.60%	23.40%	22.70%	21.70%	19.50%	18.50%	17.40%
South	43.50%	42.30%	42.60%	38.70%	43.10%	36.30%	32.60%	33.30%	31.40%	34.10%
West	18.40%	13.80%	15.30%	15.20%	16.90%	17.90%	15.60%	16.90%	18.50%	15.00%

Note: the percentiles in each demographic category may not sum up to 100% due to rounding errors

1.5 million dollars to 11.3 million dollars during this period, more than a 7-fold increase. The OUD prevalence rate (3) increased from 0.04% to 0.20% during this period, a 5-fold increase.

The right panel of Figure 1 depicts the per-patient healthcare costs for OUD patients during this period. As a comparison, we also plotted per-patient healthcare costs for the control group. As shown, both series remained relatively stable during this period, with average per-patient healthcare costs for OUD patients being \$19,265 compared to \$4,679 for the control group. The average excess annual per-patient healthcare cost was \$14,586. To further investigate the different components of healthcare costs for OUD patients, we plotted the trends of per-patient inpatient, outpatient, and drug costs for OUD patients in Figure 2.

Again, the corresponding cost components for non-OUD individuals were also plotted for comparison. For OUD patients, the per-patient inpatient cost trended downward considerably from \$8,017 (39.4% of the total costs) to \$5,725 (27.4% of the total costs) as the per-patient outpatient cost increased considerably from \$8,927 (43.9% of the total costs) to \$12,027 (57.6% of the total costs) from 2005 to 2014. The per-patient drug costs remained stable, with the

average per-patient drug costs being \$3,083 (16.0% of the total costs). For the non-OUD group, there were no evident trends in the change of the three cost components. The annual excess per-patient inpatient cost decreased from \$6,816 in 2005 to \$4,763 in 2014 as the excess per-patient outpatient cost increased from \$6,352 to \$9,479. The excess per-patient drug cost fluctuated around \$2,105. To better understand the change in outpatient and inpatient costs for OUD patients, we calculated the costs based on two categories: OUD-related costs (from claims with OUD diagnosis as the principal diagnosis) and other medical costs. As seen in Figure 3, the per-patient inpatient cost for both categories trended downward over this period. The per-patient OUD-related outpatient cost did not change much from 2005 to 2008, but increased considerably afterwards. The outpatient costs for other medical treatments varied before 2011 and experienced a rapid increase afterwards.

Trends of Healthcare Service Utilization for OUD Patients

In this section, we presented the trends of healthcare service utilization for OUD patients. In particular, we investigated inpatient, ED and outpatient care utilization for OUD patients compared to the non-OUD group.

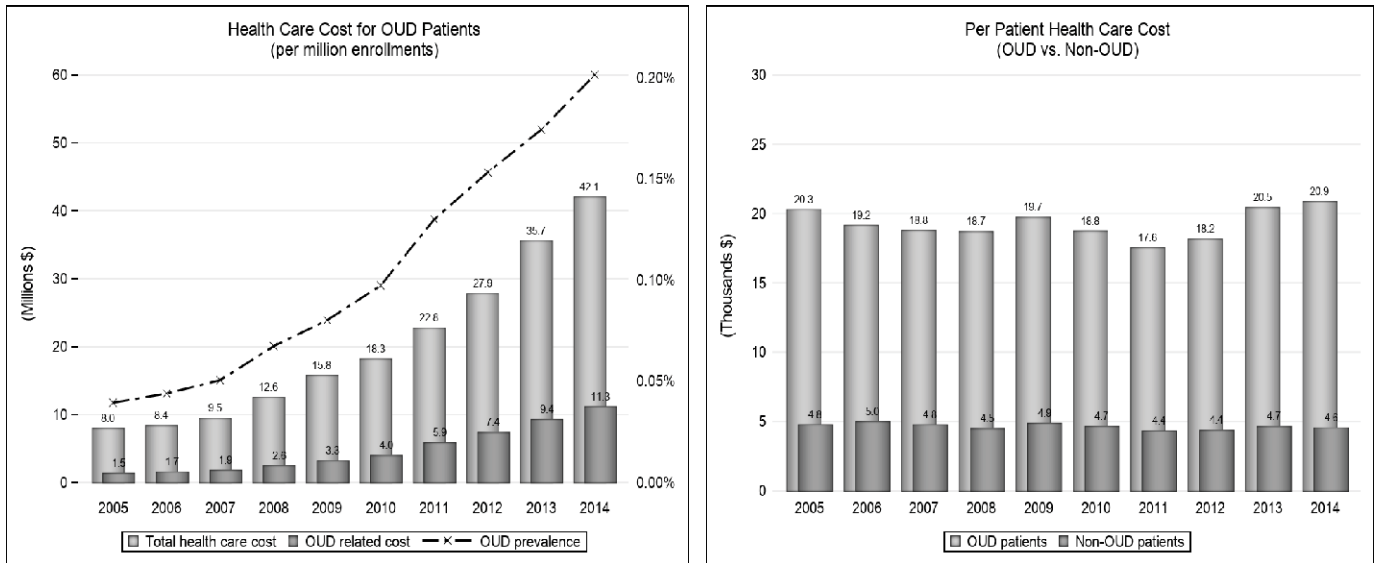


Figure 1: Medical costs of OUD patients vs. non-OUD patients (2005 – 2014)

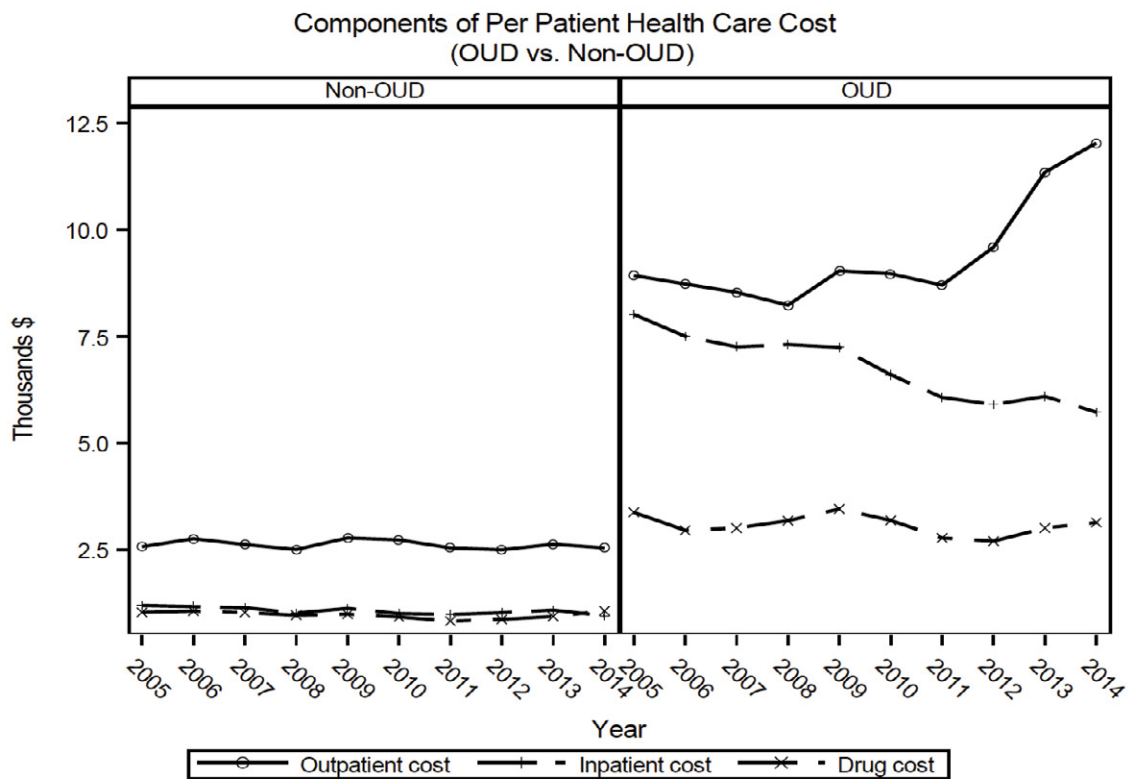


Figure 2: Average per-patient inpatient care, outpatient care and drug costs of OUD patients vs. non-OUD patients (2005 – 2014)

Inpatient Care and Emergency Department Visits

The left panel of Figure 4 shows the average hospitalization days for OUD patients (total hospitalization days / total number of OUD patients who were hospitalized at least once during that year) and the utilization rate of inpatient service (number of OUD patients who were hospitalized at least once

/ total number of OUD patients identified in the same year). As a comparison, we also presented the average hospitalization days and the inpatient service utilization rate for the control group. Similarly, in the right panel, we reported the average number of ED visits (total ED visits / total number of OUD patients who had at least one ED visit during that year) and

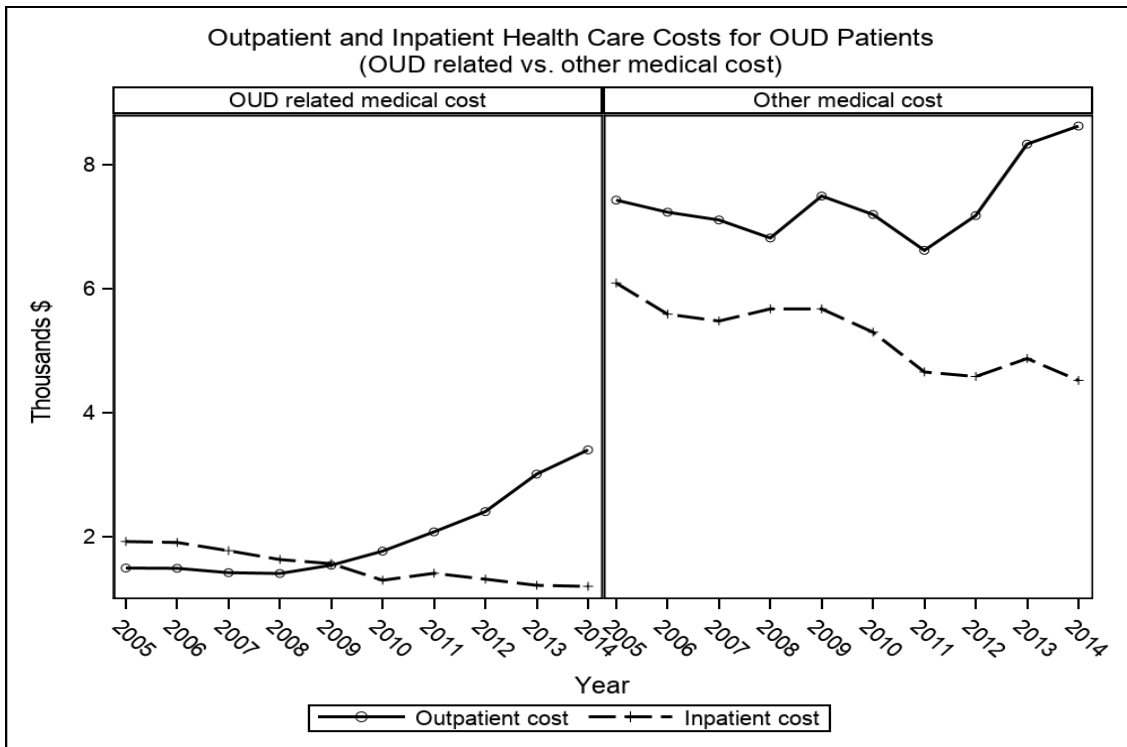


Figure 3: Per-patient Inpatient and Outpatient Costs of OUD patients

the ED utilization rate (number of OUD patients who had at least one ED visit / total number of OUD patients identified in the same year).

From the left panel we can see that the inpatient care utilization rate for OUD patients decreased dramatically during this period from 45.7% in 2005 to 25.8% in 2014, but the average hospitalization days trended upward slightly, from 10.4 days in 2005 to 11.8 days in 2014 with some fluctuation between the two years. During the same period, there was a slight decrease in the inpatient care utilization rate for non-OUD individuals from 4.7% in 2005 to 3.4% in 2014. The average hospitalization stay of non-OUD patients also increased slightly from 5.3 days in 2005 to 5.7 days in 2014 with some fluctuation between the two years. The utilization rate of inpatient care dropped 19.9% (45.7% of the level in 2005) for OUD patients, compared to a 1.3% drop (27.7% of the level in 2005) for non-OUD individuals.

The right panel of Figure 4 shows the trends of ED utilization for OUD patients from 2006 to 2014 compared to non-OUD individuals (4). There was a decrease in the utilization rate of ED services, as well as in the number of per-patient ED visits for OUD patients who utilized ED services during that year. The ED service utilization rate decreased from 53.2% in 2006 to 40.0% in 2014, and per-patient ED visits decreased from 3.3 in 2006 to 2.6 in 2014. For non-OUD individuals, the utilization rate of ED services did not show any systematic change and fluctuated around

its average of 13.7%. However, per-patient ED visits did increase slightly on average from 1.5 in 2006 to 1.6 in 2014 with some variation between the two years. To summarize, although OUD patients utilized substantially more ED services than non-OUD individuals, the decrease in the utilization both in terms of the utilization rate and per-patient ED visits was remarkable among OUD patients. There was no sign of a decreasing utilization rate of ED services among non-OUD individuals and the number of per-patient ED visits even experienced a slight increase during this period.

Outpatient care

In this section, we investigated outpatient care utilization for OUD patients compared with non-OUD individuals. The outpatient care utilization rate (number of OUD patients who had at least one outpatient claim / total number of OUD patients identified in that year) and the number of per-patient outpatient visits (total number of outpatient visits/number of OUD patients who had at least one outpatient claim during that year) are presented in the left panel of Figure 5. The corresponding measures for non-OUD individuals are also presented. From the left panel of Figure 5, we can see that the outpatient care utilization rate among OUD patients was above 99% throughout the period. This is not surprising since each year we defined OUD patients as those who had at least one inpatient or outpatient claim with an OUD diagnosis as the principal diagnosis. It is rare for OUD patients identified through inpatient claims to never have had any outpatient

claims. The outpatient care utilization rate for non-OD individuals was approximately 75%. The number of per-patient outpatient visits for OD patients exhibited a pattern of first decreasing and then increasing with the average number of visits being 22.5, compared to 8.42 for non-OD individuals.

To further investigate the utilization of outpatient services among OD patients, we focused on the utilization of OD related outpatient care in particular. We plotted the OD related outpatient utilization rate and the number of per-patient visits in the right panel of Figure 5. The utilization rate increased from 88.1% in 2005 to 97.6% in 2014 which implies that some OD patients identified through inpatient claims never received outpatient treatment that year, although that percentage decreased during this period. The number of per-patient visits remained stable from 2005 to 2008 and

increased significantly starting in 2009. By 2014, the number of per-patient visits reached 9.4 compared to 6.7 in 2005, an increase of 2.7 or 40.6%.

Discussion

The total healthcare cost for OD patients reached 42.1 million dollars in 2014, slightly more than a 5-fold increase from the total cost of 8.0 million dollars in 2005. During this sample period, the OD prevalence rate increased from 0.04% to 0.20%, with an increasing rate similar to that of the total healthcare cost. This implies that the increase in the total healthcare cost of OD was mainly driven by the increase in OD prevalence, which further explains why per-patient healthcare costs for OD patients did not change much during this period. The average excess annual per-patient healthcare cost fluctuated around an average

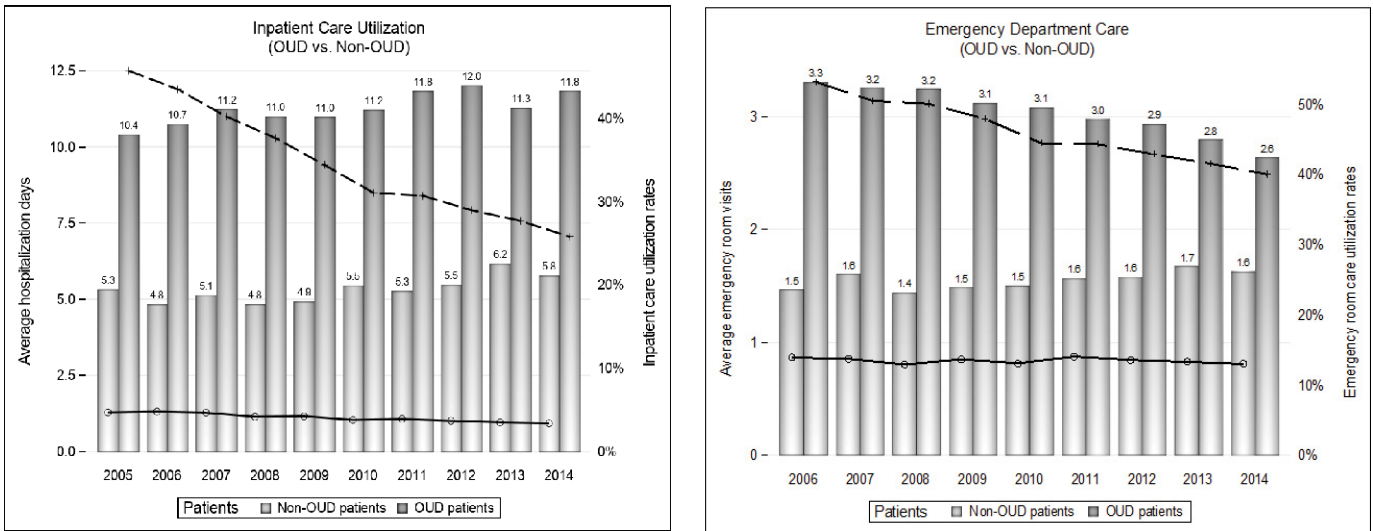


Figure 4: Utilization of inpatient care and ED service for OD patients vs. non-OD patients

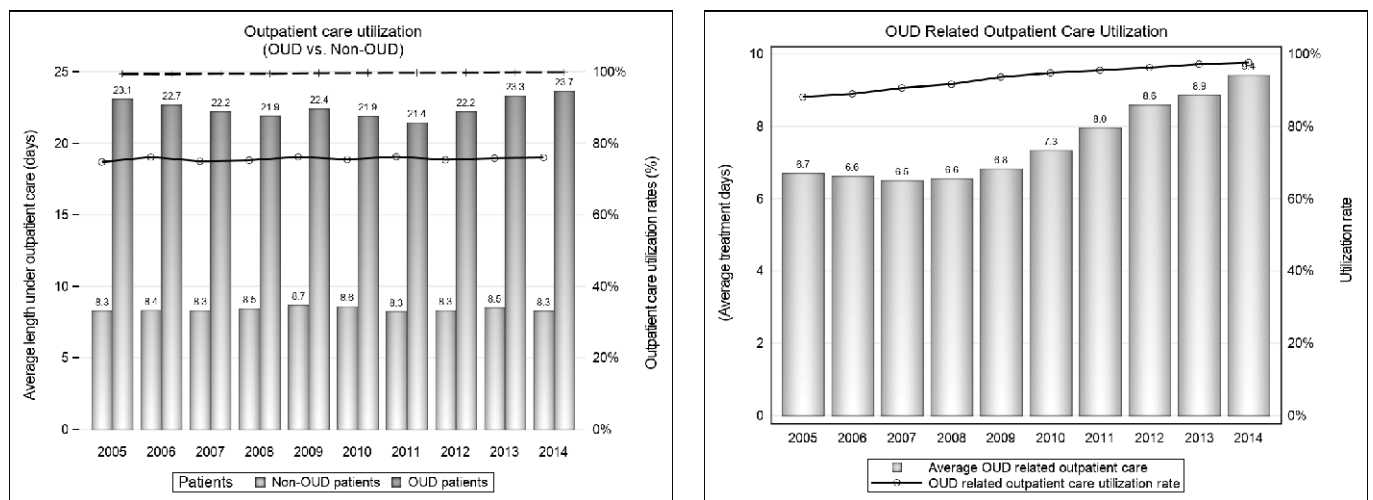


Figure 5: Outpatient service utilization for OD patients vs. non-OD patients

of \$14,586. It is worth noting that OUD-related healthcare costs increased at a faster rate than overall healthcare costs for OUD patients. The percentage of OUD-related costs accounted for 18.8% in 2005 compared to 26.8% in 2014 of the overall healthcare costs. This indicates that more medical resources were used for the treatment for the disease itself. However, even in 2014, a major portion (73.2%) of the healthcare costs for OUD patients were from treatment of other health problems. Therefore, reducing the risks of contracting serious OUD morbidities, such as HIV, is crucial in controlling the healthcare costs for OUD patients. A better control for the disease itself may be to potentially reduce the risk of developing morbidities.

Although the per-patient healthcare costs for OUD did not change greatly from 2005 to 2014, the distribution of the costs among outpatient, inpatient and drug utilization did change over time. The per-patient outpatient cost increased from \$8,927 (43.9% of the total costs) to \$12,027 (57.6% of the total costs) and the per-patient inpatient cost decreased from \$8,017 (39.4% of the total costs) to \$5,725 (27.4% of the total costs). This is consistent with the findings on the utilization of inpatient and outpatient services among OUD patients. The inpatient care utilization rate for OUD patients decreased dramatically during this period, from 45.7% in 2005 to 25.8% in 2014 although the average hospitalization stays among those who used inpatient services increased slightly from 10.4 days in 2005 to 11.8 days in 2014. The vast decline in the inpatient care utilization rate is likely the reason for the significant decrease in the per-patient inpatient costs for OUD patients. During the same period, there was a slight decrease in the inpatient care utilization rate for non-OUD individuals, from 4.7% in 2005 to 3.4% in 2014 and similarly, the average hospitalization length of stay slightly increased from 5.3 days in 2005 to 5.7 days in 2014. For both groups, the decrease in the inpatient care utilization rates and increase in average hospitalization days among those who used inpatient services might partially be attributed to the growing efforts on reducing unnecessary hospitalizations, greater use of chronic disease management programs, and a shift toward outpatient treatment. Those who did not need to be hospitalized were referred to outpatient services, which made the inpatient utilization rate lower. Those being hospitalized were likely to be more ill and therefore the average hospitalization stays increased.

However, this general trend toward utilizing more outpatient care might not be sufficient in explaining the dramatic drop in the inpatient care utilization rate for OUD patients. The utilization rate of inpatient care dropped 19.9% (45.7% of the level in 2005) for OUD patients, significantly more than the 1.3% decrease (27.7% of the level in 2005) for non-OUD individuals. Of course, the decline could also be caused by OUD treatment preference switching from inpatient

to outpatient, for example, from inpatient rehabilitation to outpatient rehabilitation. Although we did not find evidence of such a shift in treatment preference, it could still exist. However, the fact that the per-patient inpatient costs for both treating OUD and other health problems declined (Figure 3) significantly during this period suggests that a shift in OUD treatment preference was not the only potential factor contributing to the drop even if such a shift did exist. Although the decrease in inpatient service utilization might be due to a shift toward outpatient treatment, the evident decrease in ED utilization among OUD patients (both in terms of utilization rates and average number of visits among those who utilized ED services) likely indicates better control of health conditions since ED services are usually needed to handle acute and even fatal health conditions. It is less likely to be affected by a shift in treatment preference. Moreover, this pattern did not appear in non-OUD group.

Contrary to the decrease in inpatient and ED care utilization, there was an increase in both OUD-related outpatient care utilization rates and the average number of OUD-related outpatient visits among those who received treatment through outpatient care. The increase in the average number of visits from 2009 (Figure 5) coincided with the enactment of the Paul Wellstone and Pete Domenici Mental Health Parity and Addiction Equity Act of 2008 (MHPAEA). This federal law generally prevents group health plans and health insurance providers that provide mental health or substance use disorder (MH/SUD) benefits from imposing less favorable benefit limitations on those benefits than on medical/surgical benefits [22] MHPAEA, together with the Patient Protection and Affordable Care Act increased access to OUD treatment and likely encouraged OUD patients to more proactively seek treatment. This could help reduce the percentage of undiagnosed OUD patients in the privately insured population. Kirson et.al found that the ratio of undiagnosed to diagnosed opioid abusers declined considerably from 2006 to 2011 among commercially insured individuals with a ratio of 2:1 in 2011 [23]. Another study found a similar trend of increasing rates of diagnosed opioid abuse cases among commercially insured individuals continuing into 2012 [14] When new OUD patients in relatively good health were diagnosed and joined the cohort, the utilization rate of inpatient care and ED services was likely to decrease. On the other hand, more proactively seeking OUD treatment could assist existing OUD patients in better managing their disease, reducing their risk of developing morbidities, and limiting their use of ED or inpatient services. Although not the primary focuses of this paper, it is worth noting that as more outpatient services and fewer inpatient and ED services were used, the indirect costs of the disease, such as workday loss from OUD patients and their family members, were likely to decrease, although the excess per-patient direct healthcare cost did not decrease (nor increase) over this period.

Limitations

The findings in this research are subject to the following limitations. First, the study was based on claims data from MarketScan, which is a large data set but not nationally representative. The trends in per-patient healthcare cost and service utilization presented in this paper might not reflect the corresponding trends in the privately insured population within the U.S. Additional research is needed to study the per-patient healthcare cost and service utilization in different patient populations.

Second, this study did not specifically examine the factors that caused the changes in per-patient healthcare cost and service utilization but instead focused on identifying trends in per-patient healthcare cost and service utilization among OUD patients with private insurance. The finding that an increased utilization rate of OUD-related outpatient services coincided with a decreased utilization rate in ED and inpatient services might indicate better management of the disease among OUD patients. However, other factors, such as varying demographic characteristics of OUD patients over time, might also contribute to the decrease in inpatient and ED utilization rates, although we did not see such a pattern in the control group. Further investigation on this issue would be helpful to fully understand the driving forces of these trends. Finally, like all studies based on claims data, this study was not able to capture OUD patients who never sought treatment. This is likely to render overestimation of the utilization rates for inpatient, ED and outpatient services among OUD patients with private insurance.

Conclusion

The increase in the total healthcare cost for OUD patients with private insurance from 2005 to 2016 was mainly driven by an increase in OUD prevalence. Excess annual per-patient healthcare costs remained relatively stable over this period. Among OUD patients, the increasing per-patient utilization of OUD related outpatient care, together with the decline in per-patient utilization of more urgent care including inpatient and ED care, might indicate increased awareness and diagnosis of OUD and better management of the disease among existing patients with private insurance. Efforts focused on reducing existing opioid treatment barriers are crucial in combating the opioid epidemic.

Footnotes

1. To adjust for cross-year variation in the number of enrolled individuals in the database, the reported healthcare costs were based on one million enrollments.
2. OUD-related drugs include methadone, buprenorphine and naltrexone. Although these drugs could be prescribed for other addictions, such as alcohol addiction, we assumed

that these drugs prescribed for OUD patients were used for OUD treatment. This was because no information was available in the dataset to identify prescribing purposes.

3. Each year, OUD prevalence was defined as the total number of patients who had at least one claim on OUD treatment in that year divided by the total number of enrollments in the same year.
4. The estimates on ED service utilization in 2005 were not reliable due to lots of missing values on the variable used to identify ED service. No missing values were found on this variable from 2006 to 2014. Because of this reason, we only used data between 2006 and 2014 to analyze trends of ED service utilization.

References

1. Rudd RA, Aleshire N, Zibbell JE, Gladden RM. Increases in Drug and Opioid Overdose Deaths--United States, 2000-2014. *MMWR Morb Mortal Wkly Rep* 64 (2016): 1378-1382.
2. Cicero TJ, Ellis MS. Oral and non-oral routes of administration among prescription opioid users: Pathways, decision-making and directionality. *Addict Behav* 86 (2018): 11-16.
3. Reinhart M, Scarpati LM, Kirson NY, Patton C, Shak N, Erensen JG. The Economic Burden of Abuse of Prescription Opioids: A Systematic Literature Review from 2012 to 2017. *Appl Health Econ Health Policy* 16 (2018): 609-632.
4. CDC. Drug Poisoning Mortality: United States, 1999-2015 (2017).
5. Rudd RA, Seth P, David F, Scholl L. Increases in Drug and Opioid-Involved Overdose Deaths - United States, 2010-2015. *MMWR Morb Mortal Wkly Rep* 65 (2016): 1445-1452.
6. Prevention USCFDCa. Increases in Drug and Opioid-Involved Overdose Deaths — United States, 2010–2015.: *Morbidity and Mortality Weekly Report* (2016).
7. CDC. Overdose Deaths Involving Opioids, Cocaine, and Psychostimulants — United States, 2015–2016. *Morbidity and Mortality Weekly Report (MMWR)* 67 (2018): 10.
8. Cicero TJ, Wong G, Tian Y, Lynskey M, Todorov A, Isenberg K. Co-morbidity and utilization of medical services by pain patients receiving opioid medications: data from an insurance claims database. *Pain* 144 (2009): 20-27.
9. Volkow ND, Frieden TR, Hyde PS, Cha SS. Medication-assisted therapies--tackling the opioid-overdose epidemic. *N Engl J Med* 370 (2014): 2063-2066.

10. Birnbaum HG, White AG, Reynolds JL, et al. Estimated costs of prescription opioid analgesic abuse in the United States in 2001: a societal perspective. *Clin J Pain* 22 (2006): 667-676.
11. Birnbaum HG, White AG, Schiller M, Waldman T, Cleveland JM, Roland CL. Societal costs of prescription opioid abuse, dependence, and misuse in the United States. *Pain Med* 12 (2011): 657-667.
12. Meyer R, Patel AM, Rattana SK, Quock TP, Mody SH. Prescription opioid abuse: a literature review of the clinical and economic burden in the United States. *Popul Health Manag* 17 (2014): 372-387.
13. Rice JB, Kirson NY, Shei A, et al. Estimating the costs of opioid abuse and dependence from an employer perspective: a retrospective analysis using administrative claims data. *Appl Health Econ Health Policy* 12 (2014): 435-446.
14. Rice JB, Kirson NY, Shei A, et al. The economic burden of diagnosed opioid abuse among commercially insured individuals. *Postgrad Med* 126 (2014): 53-58.
15. Volkow ND, McLellan TA. Curtailing diversion and abuse of opioid analgesics without jeopardizing pain treatment. *JAMA* 305 (2011): 1346-1347.
16. Owens PL, Barrett ML, Weiss AJ, Washington RE, Kronick R. Hospital Inpatient Utilization Related to Opioid Overuse Among Adults, 1993-2012: Statistical Brief #177. In: *Healthcare Cost and Utilization Project (HCUP) Statistical Briefs*. Rockville (MD) (2006).
17. Hasegawa K, Espinola JA, Brown DF, Camargo CA, Jr. Trends in U.S. emergency department visits for opioid overdose, 1993-2010. *Pain Med* 15 (2014): 1765-1770.
18. Jones CM, Logan J, Gladden RM, Bohm MK. Vital Signs: Demographic and Substance Use Trends Among Heroin Users - United States, 2002-2013. *MMWR Morb Mortal Wkly Rep* 64 (2015): 719-725.
19. Cochran BN, Flentje A, Heck NC, et al. Factors predicting development of opioid use disorders among individuals who receive an initial opioid prescription: mathematical modeling using a database of commercially-insured individuals. *Drug Alcohol Depend* 138 (2014): 202-208.
20. Morgan JR, Schackman BR, Leff JA, Linas BP, Walley AY. Injectable naltrexone, oral naltrexone, and buprenorphine utilization and discontinuation among individuals treated for opioid use disorder in a United States commercially insured population. *J Subst Abuse Treat* 85 (2018): 90-96.
21. Florence CS, Zhou C, Luo F, Xu L. The Economic Burden of Prescription Opioid Overdose, Abuse, and Dependence in the United States, 2013. *Med Care* 54 (2016): 901-906.
22. CMS. The Mental Health Parity and Addiction Equity Act (MHPAEA). In.
23. Kirson NY, Shei A, Rice JB, et al. The Burden of Undiagnosed Opioid Abuse Among Commercially Insured Individuals. *Pain Med* 16 (2015): 1325-1332.
24. The National Practice Guideline: For the Use of Medications in the Treatment of Addiction Involving Opioid Use In (2015).