



*Predictive Analytics Can Help Reduce Prescription Opioid
Overdoses and Health Care Costs*

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Executive Summary

Prescription opioid overdose is a growing problem in the United States. It results in thousands of deaths, tens of thousands of hospitalizations, and hundreds of thousands of emergency department visits each year.

Venebio Opioid Advisor is a predictive analytics tool that enables health plans and health care providers to identify and manage risks associated with using prescription opioid therapy.

The clinical decision support feature of Venebio Opioid Advisor helps clinicians and case managers transform analytical insight into action by identifying risk factors for opioid overdose and providing recommendations to help mitigate that risk.

Implementing Venebio Opioid Advisor risk assessment and its evidence-based risk mitigation guidance can prevent, on average, more than 500 overdoses per 100,000 opioid recipients per year. This translates into more than 400 fewer prescription opioid overdose-related emergency department visits and more than 120 fewer hospitalizations. The reduction in emergency department and inpatient utilization can yield more than \$2 million in annual cost savings per 100,000 patients receiving opioid therapy per year.

Venebio Opioid Advisor is available in a variety of implementation formats. For more information, please contact Mark Tripodi:

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Venebio Opioid Advisor can help health care systems and clinicians:

- **Prevent more than 400 ED visits**
- **Avoid over 120 hospitalizations**
- **Reduce costs by over \$2 Million**

(per 100,000 patients receiving opioid therapy per year)

Predictive analytics can help reduce the occurrence and costs of prescription opioid overdose

Prescription opioids (*e.g.*, hydrocodone, oxycodone, methadone) are an important part of the treatment plan for the estimated 100 million Americans suffering from chronic pain in a given year.^{1,2,3} The use of prescription opioids quadrupled between 1999 and 2010^{1,4} and U.S. deaths involving prescription opioid analgesics have increased in near parallel proportions, from 4,030 in 1999 to more than 15,000 in 2015.^{5,6} Emergency department visits for opioid overdose quadrupled between 1993 and 2010, approximately 1% of which are fatal and 10% serious, but non-fatal.^{7,8,9}

Balancing effective pain control with the risk of misuse and abuse is a complicated decision process. More than 90% of commercially insured patients on chronic opioid therapy who are treated at a hospital for a non-fatal overdose continue to receive opioids after the event, and 7% experience another overdose within two years.¹⁰

Every day, over 1,000 people are treated in emergency departments for misusing prescription opioids.⁶

The importance of opioid analgesics in pain management is generally accepted, but the epidemic of overdose-related emergency department visits, hospitalizations, and deaths is an alarming threat to public health. A variety of initiatives have been implemented, or are underway, in an effort to reverse the trend. Clinical and public health organizations, including the Center for Disease Control, the Veterans Health Administration, the U.S. Department of Defense, National Institute on Drug Abuse, Substance Abuse and Mental Health Services Administration, and the American Society of Interventional Pain Physicians, have all developed evidence-based treatment guidelines and prescriber training programs.^{12,13,14} At the legislative level, state-based prescription drug monitoring programs have been established to track opioid prescribing practices and help identify risky patient drug-using behavior.¹⁵ Some states are taking even more aggressive action and have enacted laws specifically limiting the ability of physicians to prescribe opioid analgesics.¹⁶

Beyond the clear human impact, there are substantial economic costs associated with the epidemic of prescription opioid overdose. A serious opioid overdose that is not immediately fatal usually results in an emergency department visit with charges ranging from \$4,000 to \$10,000 and average reimbursement costs of \$1,967.^{6,18} The half-life of many prescription opioids is significantly longer than the half-life of the lifesaving opioid reversal drug naloxone, and approximately half of opioid overdoses require inpatient treatment.⁶ Billed charges for patient treatment are \$30,000 or more, with average actual reimbursed costs of \$9,696.^{10,17,19}

Each year in the United States, opioid overdose results in several hundred thousand emergency department visits with several thousand requiring inpatient treatment⁶ and overall, the medical and prescription costs associated with opioid addiction and diversion have been estimated at **\$72.5 billion** annually for private and public healthcare payers.⁸⁻¹¹

Under traditional fee-for-service arrangements, health plans absorb the majority of the costs related to opioid overdoses. However, at the state and federal level, legislation such as the Affordable Care Act (ACA) and the Medicare Access and CHIP Reauthorization Act (MACRA) have increased the prevalence of pay-for-performance arrangements. The proliferation of these new reimbursement models has driven healthcare organizations into quality-based payment programs, such as accountable care organizations, bundled payment initiatives, and full-risk capitation arrangements. While the details of those programs vary, healthcare organizations incur financial risk because avoidable treatment complications, such as opioid overdose, are not reimbursable.^{20,21} For example, a provider receiving a \$20,000 bundled payment for knee replacement surgery could see their margin on the procedure swing from a profit to a loss due to treatment of a post-operative prescription opioid overdose for which they do not receive payment.

Venebio Opioid Advisor calculates the risk of a prescription opioid overdose, provides the patient's individualized risk factor profile and offers personalized guidance regarding interventions to reduce risk

In response to the public health threat posed by the prescription opioid overdose epidemic, Venebio developed the Venebio Opioid Advisor (VOA). It is a predictive screening algorithm that quantitatively estimates a patient's likelihood of experiencing serious prescription opioid-induced respiratory depression (overdose) and characterizes their associated risk factor profile. Venebio Opioid Advisor is built on Venebio's previously published work in developing predictive models and scoring systems to estimate the likelihood of a health outcome.

Venebio first examined potential predictors of prescription opioid overdose in a retrospective case-control study using administrative health care claims data from nearly 1.9 million U.S. Veterans Health Administration (VHA) patients who were dispensed an opioid during 2010-2012.²² The factors most strongly associated with experiencing an overdose included a higher total prescribed opioid dose (morphine equivalent dose (MED) exceeding 100 mg/day), diagnosis of opioid dependence, hospitalization or emergency department visit during the six months before the overdose event, liver disease, and use of opioids with extended-release or long-acting formulations. A risk index was then created with 15 of the variables most strongly associated with experiencing a life-threatening opioid emergency.²³ **The risk index calculates the risk score and the associated probability of experiencing an overdose for each patient based on their risk factors and has excellent predictive performance,** with an 88% probability of correctly differentiating VHA opioid users with an overdose (N=817) and those without. There was also strong concordance between the actual occurrence of overdose and the average predicted probability of an overdose across all risk classes as determined from the predicted probability distribution for overdose.

Subsequently, Venebio assessed the predictive performance of the algorithm in a more representative population of U.S. medical users of prescription opioids. Validation was based on administrative health care claims data from 18,365,497 patients in a commercial health plan database who were treated with a prescription opioid during 2009-2013.²⁴

Venebio Opioid Advisor again showed very strong predictive performance. It correctly discriminated the opioid users who experienced a serious overdose (N=7,234) and those who did not in 90% of instances. The average predicted probability of serious overdose ranged from a low of 2% to a high of 83%, and there was excellent agreement with the observed occurrence of overdose across all risk classes (Figure 1). The strongest clinical risk factors for overdose in the commercially insured population were diagnosed substance use disorder and depression, other mental health disorders, impaired liver, kidney, vascular, or lung function, and non-cancer pancreatic disease. Medication-related risk factors included higher daily opioid doses, certain specific opioids, opioids with extended-release or long-acting formulations, and concurrent psychoactive medications such as antidepressants and benzodiazepines.²⁵

In an analysis of more than 18 million commercially insured individuals who used prescription opioids, **Venebio Opioid Advisor correctly discriminated in 90% of instances** those who experienced a serious overdose and those who did not.

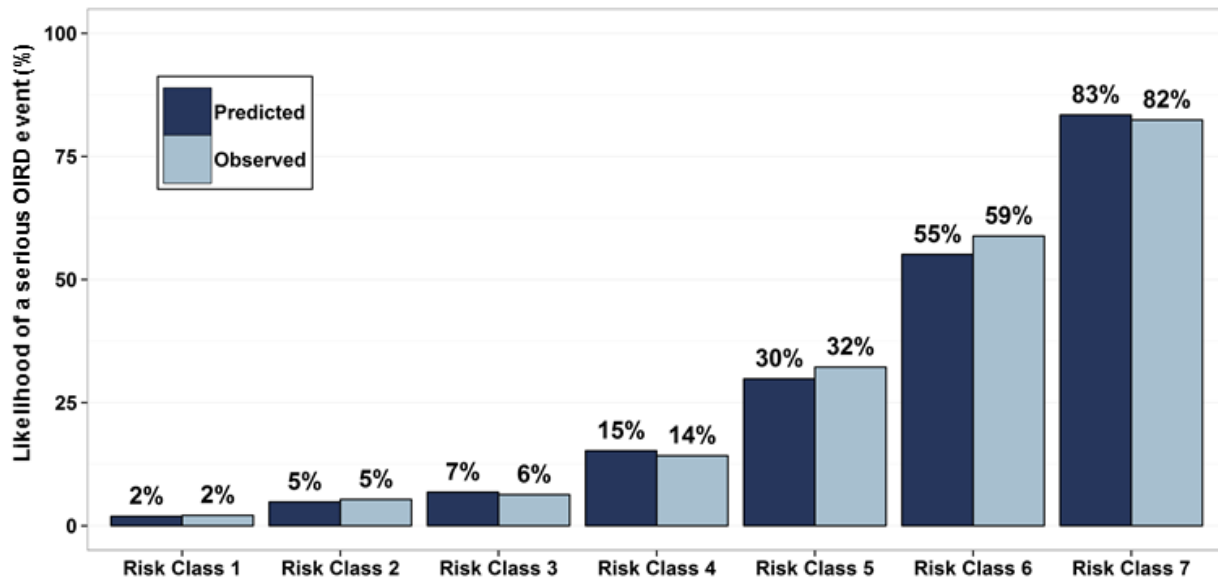


Figure 1: Average predicted probability according to Venebio Opioid Advisor compared to observed incidence of overdose across the seven risk classes in a U.S. commercially insured population. Risk Class 1 includes patients with the lowest average risk of experiencing an overdose (2%) and Risk Class 7 includes patients with the highest average risk (83%).

Customizing pain management and opioid prescribing based on risk stratification can reduce the number of opioid overdoses and related costs

Venebio Opioid Advisor provides case managers and prescribing clinicians with practical, personalized, and evidence-based information and guidance regarding risk-reduction interventions to consider when making clinical management decisions for opioid-treated patients. For instance, discontinuing a concomitant benzodiazepine can shift a patient from Risk Class 4 with an average 15.1% risk of overdose to Risk Class 1, the lowest risk class, with an average 1.9% risk of overdose. Venebio Opioid Advisor also provides patient-specific information that is written at a patient-appropriate level. This information educates the patient about opioids and overdose and describes their personal risk factor profile and what they can do to reduce their risk of overdose.

Discontinuing a concomitant benzodiazepine can shift a patient from **Risk Class 4** with an average **15.1%** risk of overdose to **Risk Class 1**, the lowest risk class, with an average **1.9%** risk of overdose.

Not all recommendations may be clinically appropriate for all patients in all circumstances. Venebio Opioid Advisor guidance is intended to inform clinical decision-making for patients who are treated with opioids, but it is not a replacement for clinical judgment. While a patient taking more than 100 mg morphine equivalents per day is at higher risk for overdose than one on less than 100 mg per day, the physician and patient must decide together how best to balance risk of overdose with adequate management of pain.

Analysis of health and economic outcomes from Venebio Opioid Advisor implementation

Successful implementation of Venebio Opioid Advisor is intended to shift opioid-treated patients from higher risk classes to lower risk classes and decrease the incidence of opioid overdose. To evaluate health outcomes and economic impact, we conducted an analysis of the aggregate effect of implementing Venebio Opioid Advisor in a population of 100,000 patients treated with opioids (see Appendix A for analysis details). The range of potential impact is based on the effectiveness of computerized clinical decision support tools in studies of similar serious adverse clinical outcomes as published in peer-reviewed journals.

A sampling of studies showed a wide range in performance. A system deployed to reduce the risk of a prolonged electrocardiographic QT interval known to cause torsades de pointes, a lethal heart arrhythmia, resulted in a 35% reduction in QT prolongation and was associated with a 21% reduction in the prescription of specific risky non-cardiac medications.²⁶ A decision support tool to aid in the treatment of surgical sepsis resulted in a 48% decrease in mortality for high-risk patients and a 73% decrease in patients at moderate risk, while a system deployed to improve management of TIA/stroke victims resulted in a 73% reduction in cerebrovascular events and death.^{27,28} Although the effectiveness of CDS systems varies across settings, even modest changes to prescribing behavior (*e.g.*, the observed 21% reduction in prescriptions that can trigger torsades de pointes) can, in this setting, substantially reduce prescription opioid overdose.

Although the effectiveness of clinical decision support systems varies across settings, **even modest changes to prescribing behavior can, in this setting, substantially reduce prescription opioid overdose.**

Using Venebio Opioid Advisor risk scores to provide personalized, preventive care

Implementing Venebio Opioid Advisor can help clinicians reduce risk scores of individuals in elevated risk classes. For lower risk classes, where fewer or less hazardous risk factors are present, risk score reduction potential is more modest. For higher risk classes, where patients may have a number of clinical and pharmacological risk factors, the potential to reduce the risk score is greater. **VOA includes 16 risk factors, with half being coexisting chronic health conditions and half related to prescription medications.** Examining the point values of the 16 risk factors in VOA, approximately 50% of the risk of overdose is attributable to readily modifiable risk factors (medications). However, the actual potential to reduce risk scores will vary by patient, with some having no modifiable risk (*i.e.*, either all chronic comorbidity risk factors and/or medication risk factors that, in certain clinical situations, cannot be changed) and others having 100% modifiable risk (*i.e.*, if all risk factors represent medications that can be changed).

To model the potential impact of Venebio Opioid Advisor, we extrapolated the effect of an approximately 15% reduction in risk score. Table 1 shows the baseline distribution of patients across the seven risk classes and the average potential risk score reduction by class.

Risk Class	VOA Risk score range and (mean) as measured in points	Average predicted probability of overdose (during the next 6 months)	Baseline proportion of population in risk class	Impact of 15% average reduction in risk score as measured in points
1	< 5 (0.0)	1.9%	79.8%	0.0
2	5 – 7 (6.0)	4.8%	9.5%	-0.9
3	8 – 9 (8.5)	6.8%	4.6%	-1.3
4	10 – 17 (13.5)	15.1%	2.6%	-2.0
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6	26 – 41 (33.5)	55.1%	0.9%	-5.0
7	≥ 42 (66.0)	83.4%	1.1%	-9.9

Table 1: Baseline population risk classification and risk reduction potential by risk class. The impact on opioid overdoses and associated costs in scenarios where clinicians are able to reduce the average risk score in each risk class by 30% and 50% is presented in *Appendix B*.

Venebio Opioid Advisor implementation results in shifting of patients into lower risk classes

The analysis focused on the population level effect of Venebio Opioid Advisor on opioid overdose-related emergency department visits, inpatient hospitalizations, and cost of care. The effects were modelled by simulating the impact of risk score reductions derived from implementing Venebio Opioid Advisor guidance on subsequent risk of experiencing opioid overdose. **Based on risk score reductions, patients were reclassified from higher risk classes into lower risk classes.** For example, a patient with diagnosed heart failure (which contributes 7 points to risk score) who is receiving 110 mg morphine equivalents per day (which contributes another 7 points to the risk score) would have a total risk score of 14 and be in Risk Class 4 with a 15% chance of overdose (see Figure 1). By reducing the morphine equivalent dose to less than 100 mg per day, the patient would shift to Risk Class 2, with only a 5% chance of overdose. Figure 2 shows the resulting change in the number of opioid recipients in each risk class due to average reductions in risk score given in Table 1.

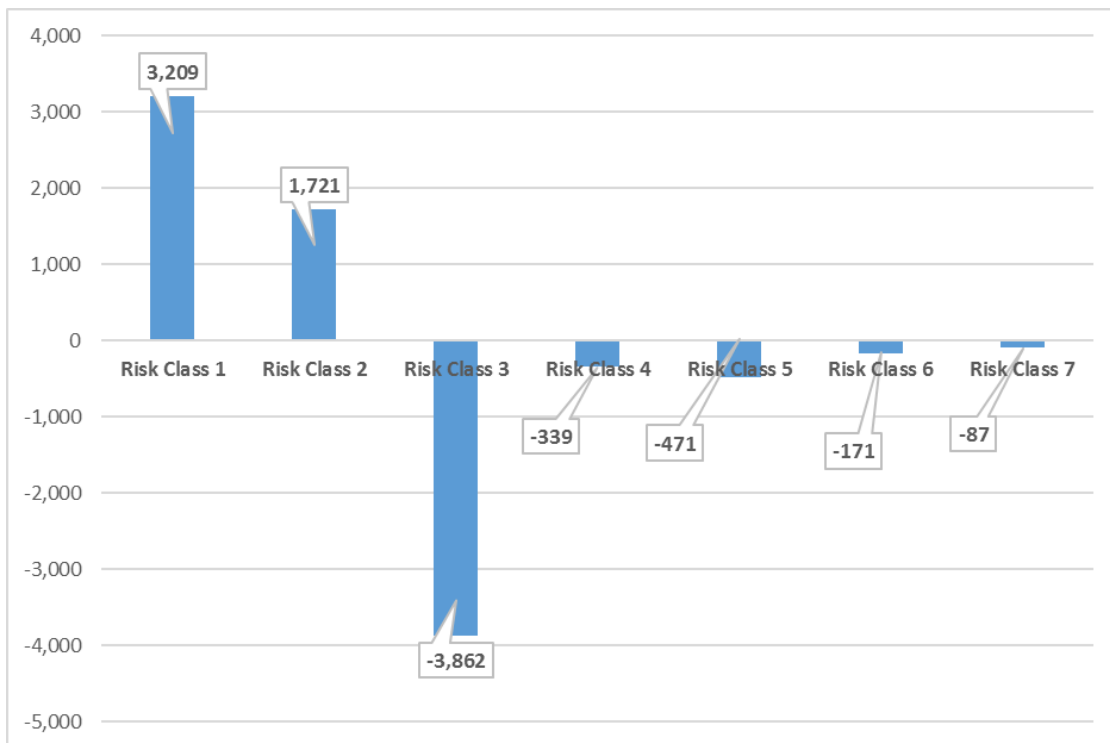


Figure 2: 15% average reductions in risk scores in the entire patient population shift patients into lower risk classes, with an additional 10% of the 100,000 opioid recipients reclassified into lower risk classes.

From risk assessment to improved patient outcomes and reduced healthcare costs

The shifting of patients from higher risk classes to lower risk classes reduces the likelihood of opioid overdose-related emergency department visits and hospitalization for inpatient treatment. Approximately 53% of opioid overdoses require inpatient treatment; therefore, our analysis conservatively assumed a 40% likelihood that patients experiencing a serious overdose will require hospitalization. Figure 3 shows the impact of shifting patients into lower risk classes on the incidence of overdose-related emergency department visits and subsequent hospitalization for longer-term treatment. The numbers shown are totals across all risk classes during a six-month baseline period and the six-month period after implementing VOA.

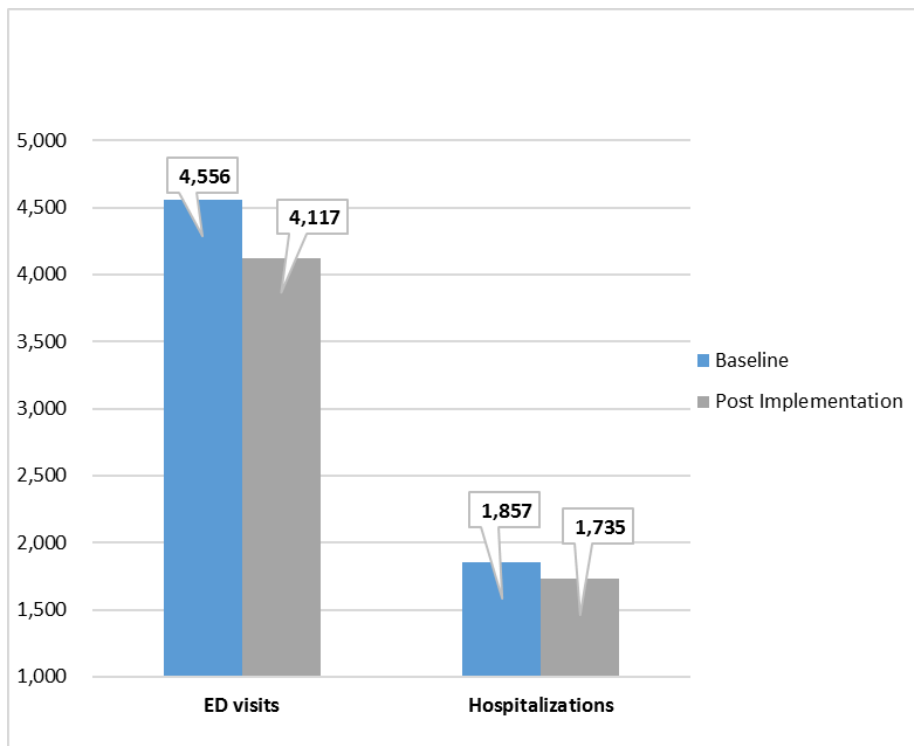


Figure 3: Venebio Opioid Advisor can substantially reduce prescription opioid overdose-related emergency department visits and hospitalizations.

Risk score reduction and subsequent reclassification of patients into lower risk classes will decrease overdose events in all risk classes except Risk Class 1. Figure 4 shows the expected number of overdoses prevented in each risk class based on the risk score reductions shown in Table 1. In particular, Figure 4 shows the *difference* between the number of overdoses expected in each risk class before and after implementing VOA with an average 15% reduction in risk scores (*i.e.*, the numbers are not the total number of overdoses in each risk class).

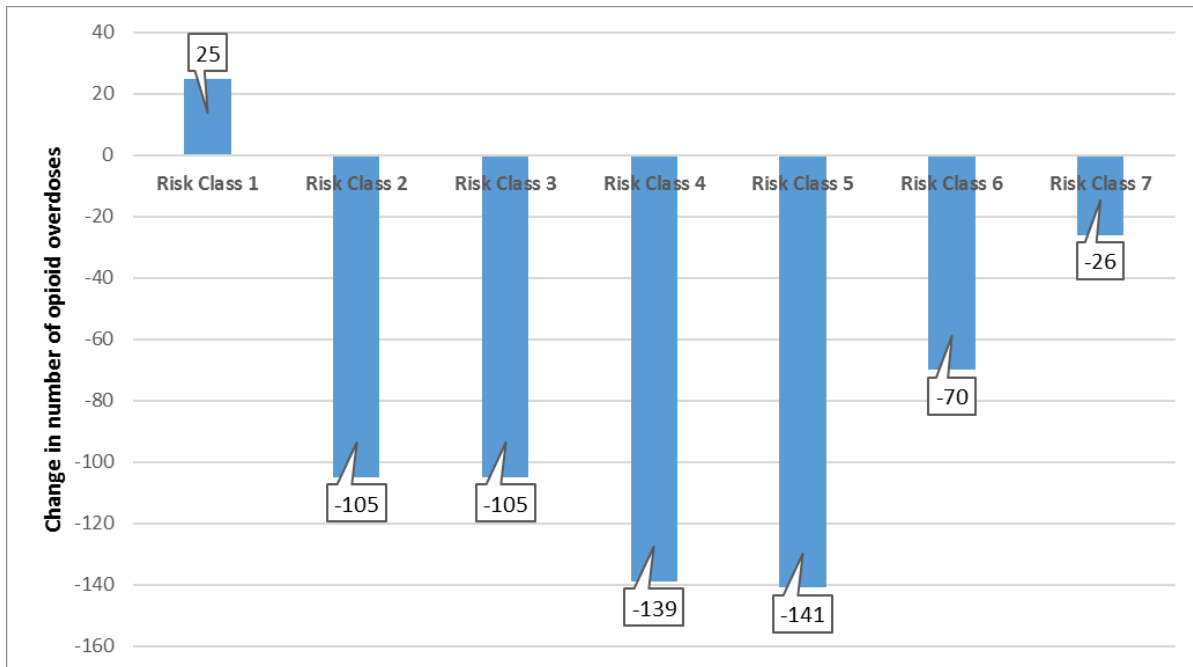


Figure 4: Venebio Opioid Advisor can help prevent overdoses across all elevated risk classes.

Figure 4 further demonstrates that by **shifting patients from higher risk classes to lower risk classes, the number of overdoses in all elevated risk class decreases**. This occurs because as some patients, for example, in Risk Class 7 move to Risk Class 6, some patients in Risk Class 6 are also shifting to Risk Class 5 or Risk Class 4. With the exception of Risk Class 1, more individuals leave a particular risk class than enter that particular risk class. Risk Class 1 is the lowest risk class and, therefore, sees a slight *increase* in the expected number of overdoses. However, the increase is driven by a *substantial increase in the number of individuals* who shifted into the lowest risk class due to their lower absolute risk of overdose and does *not reflect an increase in relative risk in Risk Class 1*.

Venebio Opioid Advisor implementation leads to significant cost reductions across all high-risk classes

Figure 5 presents the *difference* between the cost of treating the number of overdoses expected in each risk class prior to risk score reduction and the cost associated with treating the number achieved with risk score reduction. The performed analysis assumes the cost of an opioid overdose-related emergency department visit to be approximately \$2,000 and the cost of inpatient treatment for more complicated cases to be approximately \$10,000. The amounts shown represent the *cost savings* by risk class, rather than the total cost of treating overdoses in each risk class.



Figure 5: Cost reductions are achieved across all higher risk classes.

Consistent with the lower incidence of opioid overdose across risk classes, associated costs also decrease for all risk classes above Risk Class 1. Again, Risk Class 1 is the exception where the increase in cost is due to the substantial increase in the number of individuals in that risk class rather than an increase in per-patient risk.

Preventing opioid overdose-related emergency department visits and inpatient hospitalizations has a significant impact on the total cost of care

Figure 6 shows the expected economic impact of risk reduction on cost reduction. Again, the analysis assumes the cost of an opioid overdose-related emergency department visit to be approximately \$2,000 and the cost of inpatient treatment for more complicated cases to be approximately \$10,000.

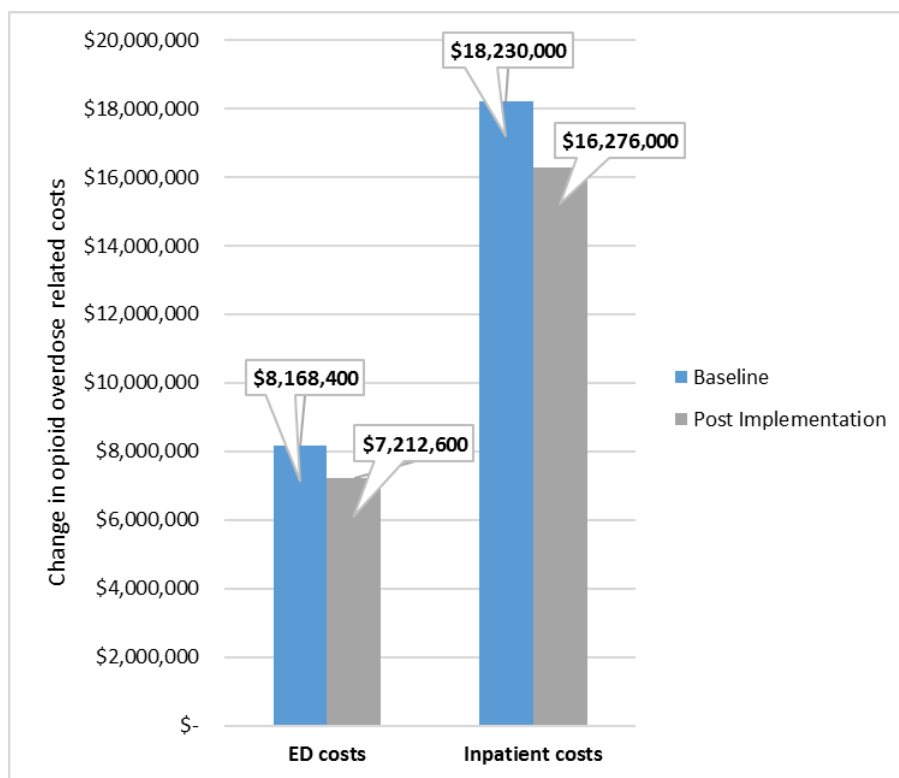


Figure 6: Preventing opioid overdose-related emergency department visits and hospitalizations yields significant savings.

While emergency department-based treatment for opioid overdose is more common, **avoiding the high cost of inpatient treatment is the most substantial contributor to reducing health care costs.**

Summary

Implementation of Venebio Opioid Advisor enables risk prediction and stratification, risk profile characterization, and risk mitigation guidance for patients and clinicians that can **reduce** the occurrence of prescription opioid overdoses. A **15% reduction in risk score can prevent more than 500 prescription opioid overdoses**. The result is more than **400 fewer emergency department visits** and more than **120 fewer hospitalizations**, with a reduction of more than **\$2,000,000 in treatment costs**. By understanding patient-specific risk and modifying the treatment plan accordingly, thousands of overdoses can be avoided, thereby saving millions of dollars in health care expenses and, above all, a significant number of patient lives.

Venebio Opioid Advisor can help health care systems and clinicians:

- **Prevent more than 400 ED visits**
- **Avoid over 120 hospitalizations**
- **Reduce costs by over \$2 Million**

(per 100,000 patients receiving opioid therapy per year)

To learn more about Venebio Opioid Advisor and implementation options, please contact Mark Tripodi:

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Appendix A: Analytical Methods

To estimate the clinical and economic impact of Venebio Opioid Advisor we modelled the overdose risk for 100,000 opioid-treated patients. We used a combination of Monte Carlo and Agent-based simulation to model the clinical and economic impact of risk score reduction. The simulation design is described below.

Step 1: Generate simulation population

We generated 100,000 patient profiles with demographic profiles based on national averages or distributions for race, gender, and age. The initial distribution of patients across risk classes shown in Table 1 was based on the distribution of risk scores calculated in a sample of a large population of commercially insured individuals receiving opioid therapy. Risk scores for each simulated patient were assumed to be uniformly distributed between the lower and upper bounds of each risk class.

Step 2: Establish expected baseline clinical outcomes and costs

Based on each patient's risk score and the corresponding likelihood of overdose predicted by Venebio Opioid Advisor, we used random number generation to associate patients with overdose events. Each overdose event resulted in an emergency room visit and a proportion of ED patients required inpatient treatment. We conservatively used a 40% emergency department-to-inpatient treatment conversion rate, which is below rates reported in some studies which have found inpatient treatment was needed in approximately one half of opioid overdoses admitted to an ED.

Step 3: Apply risk score reductions

Individual risk scores generated during Step 1 were reduced by the potential risk score reduction shown in Table 1 (replicated here for convenience).

Risk Class	VOA Risk score range and (mean) as measured in points	Average predicted probability of overdose (during the next 6 months)	Baseline proportion of population in risk class	Impact of 15% average reduction in risk score as measured in points
1	< 5 (0.0)	1.9%	79.8%	0.0
2	5 – 7 (6.0)	4.8%	9.5%	-0.9
3	8 – 9 (8.5)	6.8%	4.6%	-1.3
4	10 – 17 (13.5)	15.1%	2.6%	-2.0
5	18 – 25 (21.5)	29.8%	1.5%	-3.2
6	26 – 41 (33.5)	55.1%	0.9%	-5.0
7	≥ 42 (66.0)	83.4%	1.1%	-9.9

Table A1: Baseline population risk classification and risk reduction potential by risk class

Step 4: Reclassify population based on risk score reduction

Based on the lower risk scores derived from Step 3, patients were reclassified across the seven risk classes. While the reductions did not change the risk classification of all patients, many shifted into lower risk classes. Table A2 shows the distribution of opioid recipients across risk classes after a 15% reduction in risk score.

Risk Class	VOA Risk score range and (mean) as measured in points	Average predicted probability of overdose (during the next 6 months)	Baseline proportion of population in risk class	Post-VOA proportion of patients in risk class
1	< 5 (0.0)	1.9%	79.8%	83.0%
2	5 – 7 (6.0)	4.8%	9.5%	8.6%
3	8 – 9 (8.5)	6.8%	4.6%	3.0%
4	10 – 17 (13.5)	15.1%	2.6%	2.4%
5	18 – 25 (21.5)	29.8%	1.5%	1.3%
6	26 – 41 (33.5)	55.1%	0.9%	0.7%
7	≥ 42 (66.0)	83.4%	1.1%	1.0%

Table A2: Post-VOA distribution of opioid recipients across risk classes

Step 5: Calculate potential reductions in overdoses and costs based on new risk classifications

Based on each patient’s revised risk score, subsequent reclassification and the likelihood of overdose obtained from Venebio Opioid Advisor, we again used random number generation to associate patients with overdose events. The process of assigning patients experiencing overdose to either emergency department treatment alone or subsequent inpatient treatment was identical to the process outlined in Step 2.

The simulation was executed 500 times and the results presented in the paper reflect the average values across all simulation runs. Simulation cost parameters were based on publicly available data.

Upon request, Venebio will conduct customized analyses incorporating client-specific parameter values at no cost.

Appendix B: Impact of 30% and 50% reductions in risk score

Many of the published studies evaluating the impact of clinical decision support systems mentioned earlier have reported improvements in outcomes that are significantly greater than the 15% risk score reduction used as the baseline for this analysis. To illustrate the impact of a greater reduction in risk score, Table B1 presents the results from an analysis utilizing a reduction of 30%.

Risk Class	VOA Risk score range and (mean) as measured in points	Average predicted probability of overdose (during the next 6 months)	Baseline proportion of population in risk class	Impact of 30% average reduction in risk score as measured in points
1	< 5 (0.0)	1.9%	79.8%	0.0
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4	10 – 17 (13.5)	15.1%	2.6%	-4.1
5	18 – 25 (21.5)	29.8%	1.5%	-6.5
6	26 – 41 (33.5)	55.1%	0.9%	-10.1
7	≥ 42 (66.0)	83.4%	1.1%	-19.8

Table B1: Baseline population risk classification and risk reduction potential with a 30% reduction in risk score.

The greater reduction in risk score would magnify the extent to which patients shift from higher risk classes to lower risk classes. Rather than transitioning to the next lower risk class, more patients would experience more pronounced shifts, *e.g.*, from Risk Class 6 to Risk Class 4. Figure B1 shows the corresponding impact on prescription opioid overdoses and Figure B2 presents the impact on corresponding cost of treatment.

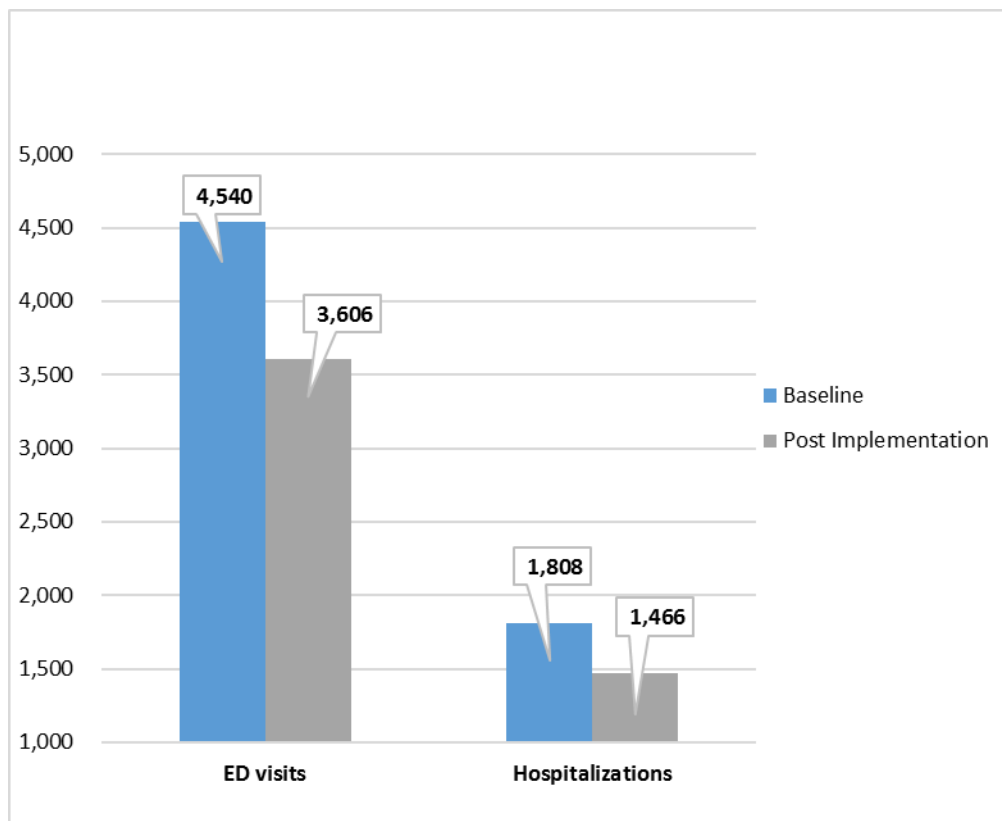


Figure B1: Impact of a 30% reduction in risk score on number of emergency department visits and hospitalizations.

Reducing risk scores by 30% on average can prevent approximately 1,300 prescription opioid overdoses per 100,000 patients every six months. This translates into almost 1,000 fewer emergency department visits and more than 300 fewer hospitalizations. While quality of care and patient safety are clearly the most important considerations, Figure B2 shows that as patient safety is improved, associated cost reductions are substantial.

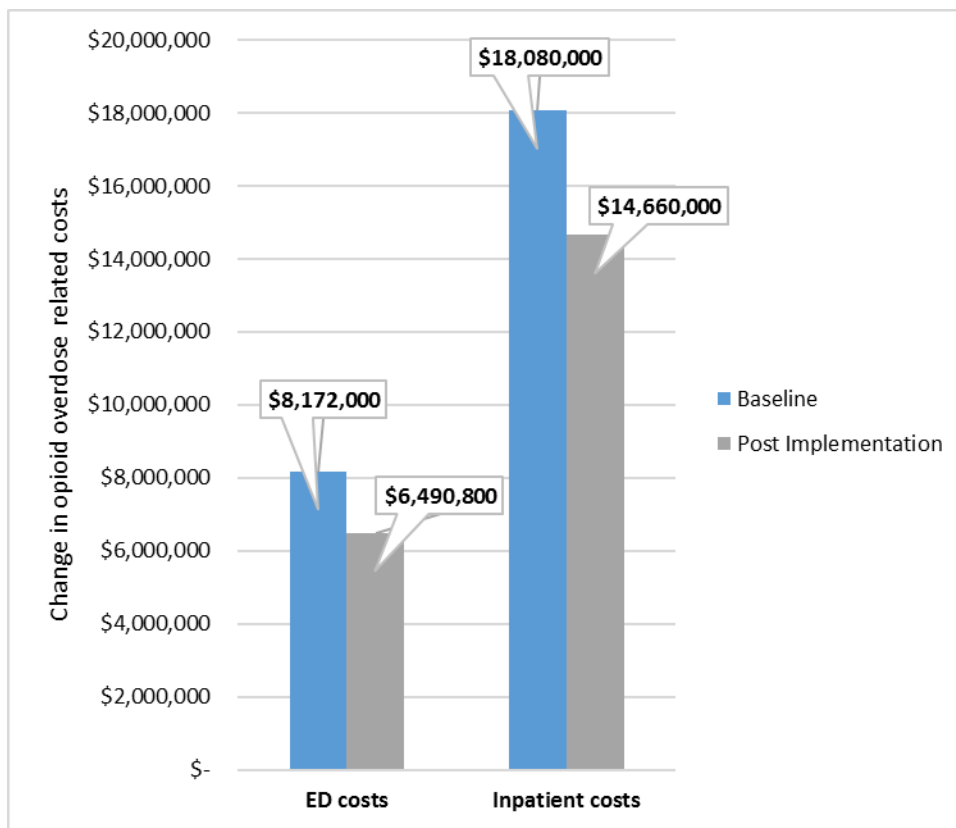


Figure B2: Reducing risk score by 30% results in even more significant savings.

Considering all point values from all the risk factors identified in our research, approximately 50% of the risk of overdoses is attributable to modifiable risk factors (medications). However, this number varies by patient, with some patients having no modifiable risk (*i.e.*, either all chronic comorbidity risk factors and/or medication risk factors that cannot be changed) and other patients having 100% modifiable risk (*i.e.*, all risk factors represent medications that can be changed). As a result, maximally effective management of modifiable risk would yield an average risk score reductions of 50%. Table B2 presents the resulting impact on the average risk score for each risk class.

Risk Class	VOA Risk score range and (mean) as measured in points	Average predicted probability of overdose (during the next 6 months)	Baseline proportion of population in risk class	Impact of 50% average reduction in risk score as measured in points
1	< 5 (0.0)	1.9%	79.8%	0.0
2	5 – 7 (6.0)	4.8%	9.5%	-3.0
3	8 – 9 (8.5)	6.8%	4.6%	-4.3
4	10 – 17 (13.5)	15.1%	2.6%	-6.8
5	18 – 25 (21.5)	29.8%	1.5%	-10.8
6	26 – 41 (33.5)	55.1%	0.9%	-16.8
7	≥ 42 (66.0)	83.4%	1.1%	-33.0

Table B2: Baseline population risk classification and risk reduction potential with a 50% reduction in risk score.

Figures B3 and B4 illustrate the impact of 50% reductions in risk score achieved through the management of modifiable risk.

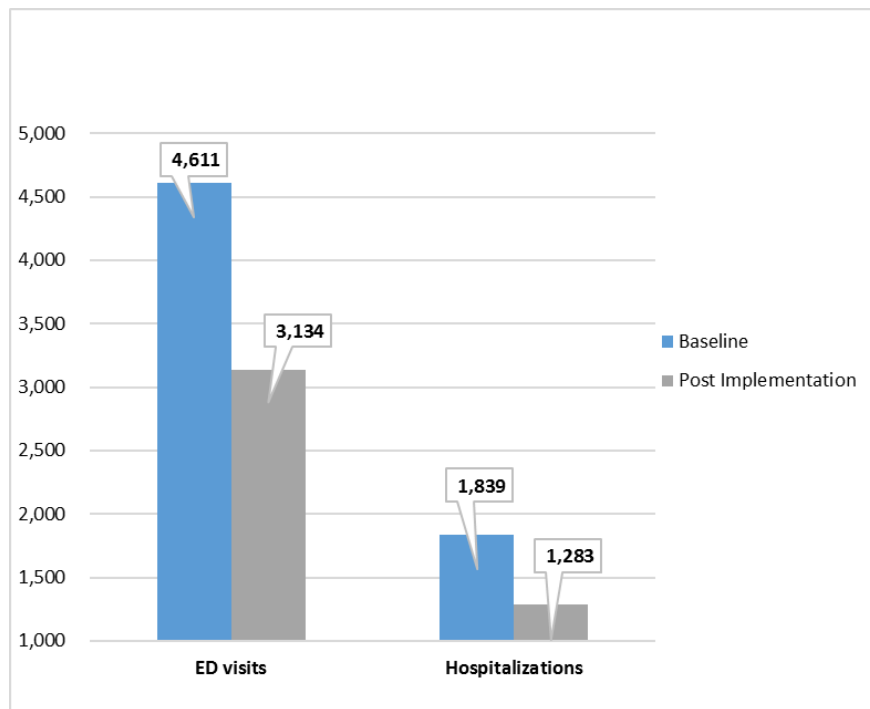


Figure B3: Eliminating modifiable risk factors can avoid thousands of prescription opioid overdoses.

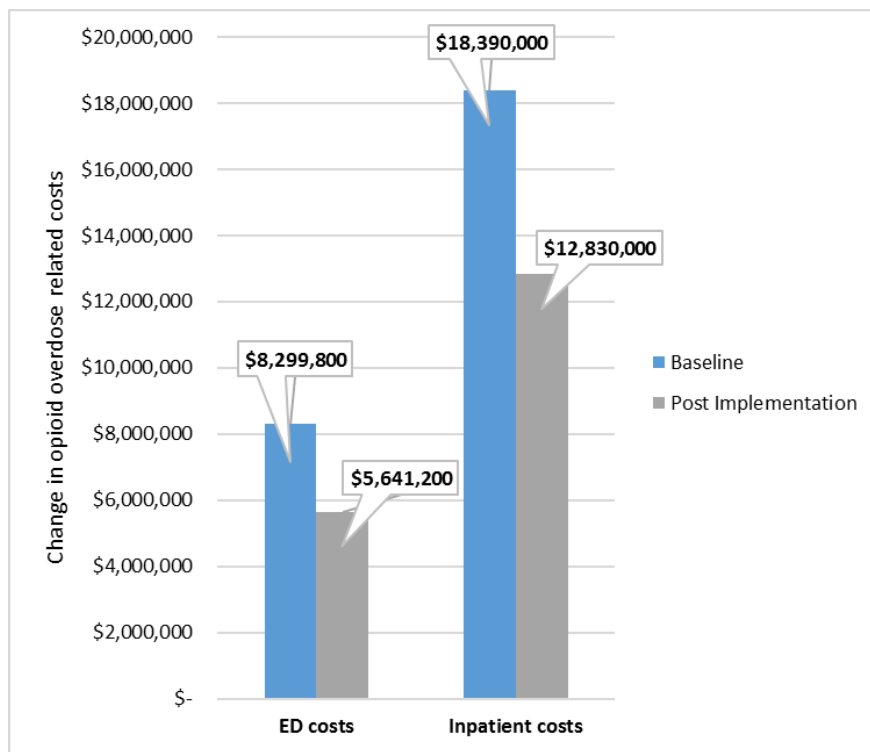


Figure B4: Reducing risk score by 50% can reduce opioid overdose-related treatment costs by more than \$7,000,000 per 100,000 opioid recipients.

While the results shown in Figures B3 and B4 represent optimistic levels of improvement, they also illustrate the potential opportunity for health care systems and clinicians to significantly reduce prescription opioid overdose.