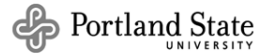


A System Dynamics Model of Pharmaceutical Opioids: Medical Use, Diversion, and Nonmedical Use



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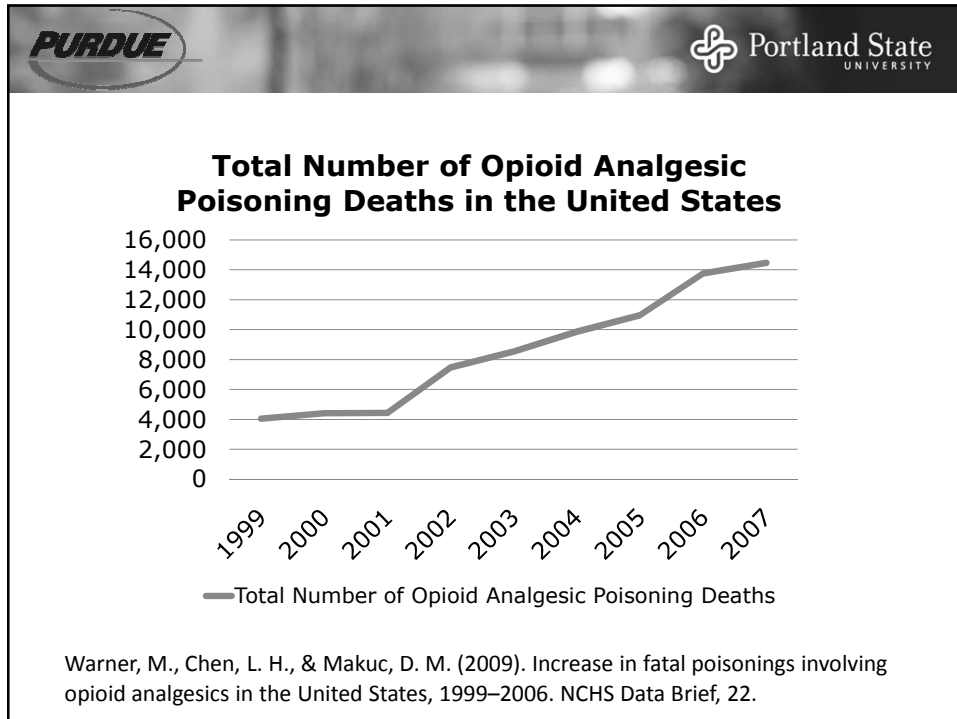
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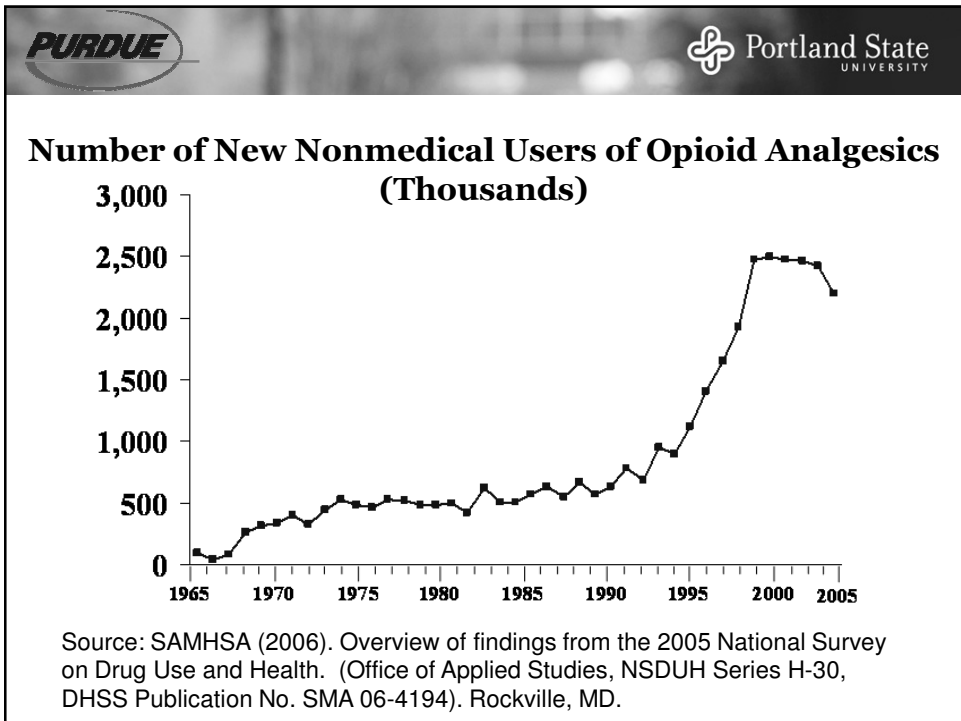
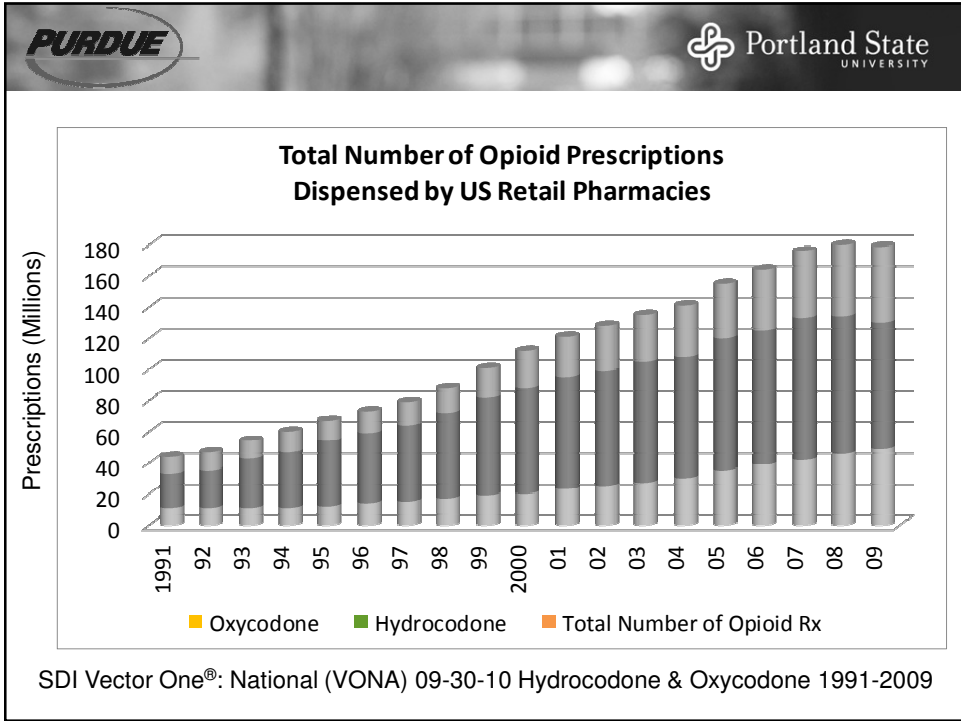
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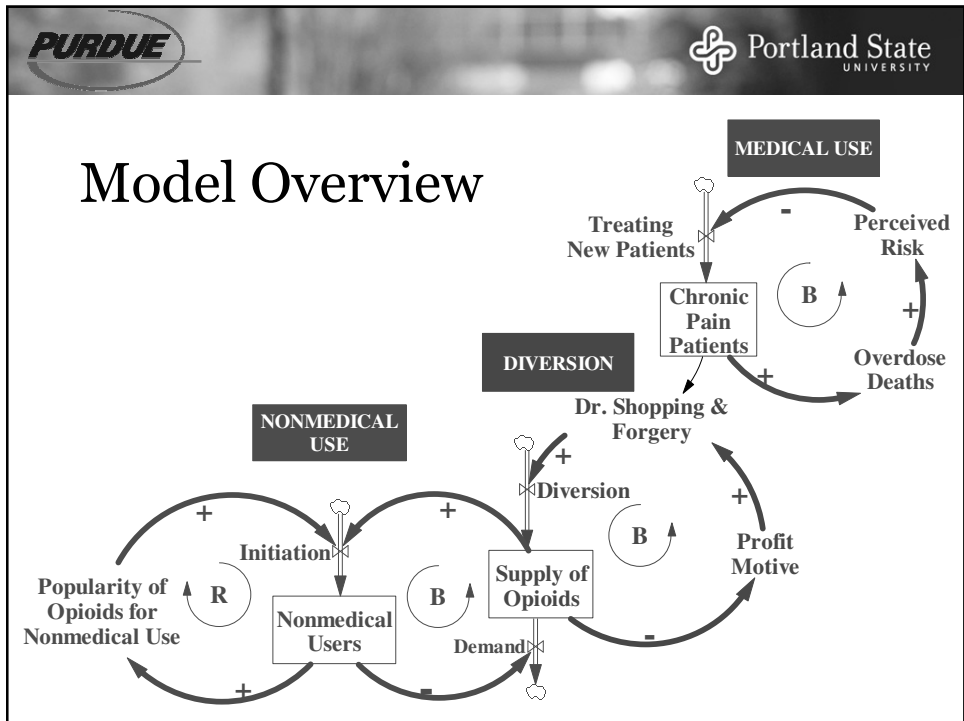
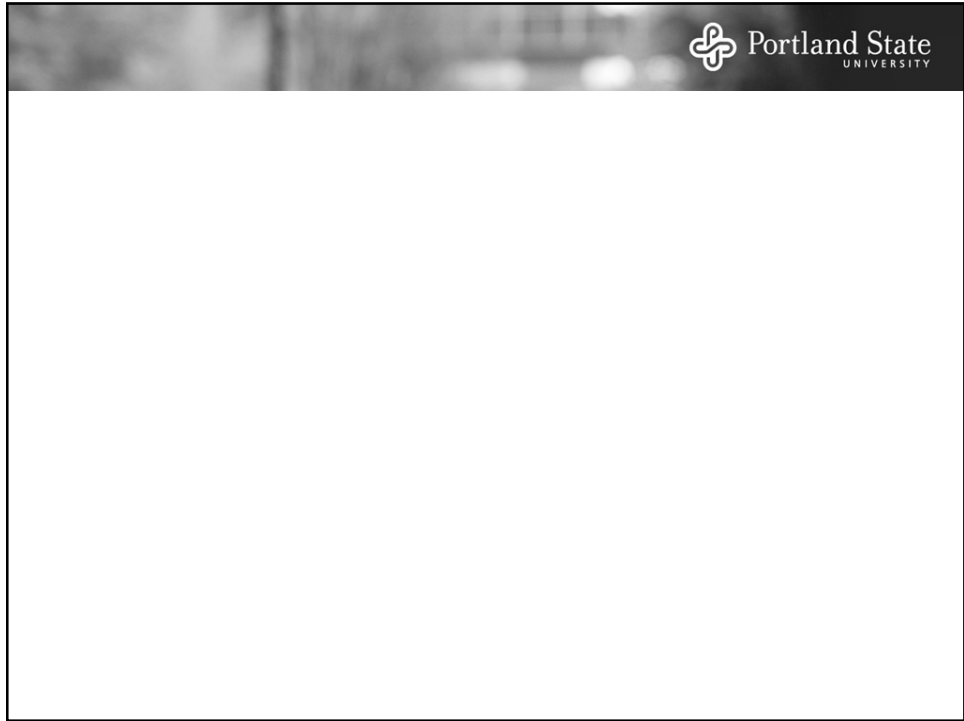


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Pharmaceutical Opioids

- Immediate-release (“short-acting”)
 - Single-entity (opioid is only active ingredient)
 - Combinations (opioid + nonopioid analgesic)
- Long-acting & Extended-release (LA/ER)
 - Pharmacologically Long-acting
 - methadone
 - Pharmaceutically Long-acting
 - Single-entity opioids in formulations that retard release of the active ingredient





Parameter	Support		
	DIRECT	INDIRECT	PANEL
MEDICAL USE SECTOR			
1 All Cause Mortality Rate for Patients on Long-acting Opioids		■	
2 All Cause Mortality Rate for Patients on Short-acting Opioids		■	
3 All Cause Mortality Rate for Patients with Abuse/Addiction		■	
4 Average Long-acting Treatment Duration (in years)			■
5 Average Short-acting Treatment Duration (in years)			■
6 Base Level of Abuse Potential for Pharmaceutical Opioids			■
7 Base Rate for Adding or Switching (to Long-acting)		■	
8 Base Rate of Treatment		■	
9 Base Risk Factor (Tx reduced in '95 due to perceived risk)			■
10 Diagnosis Rate for Chronic Pain		■	
11 Overdose Mortality Rate for Patients Abusing Opioids		■	
12 Overdose Mortality Rate for Patients on Long-acting	■		
13 Overdose Mortality Rate for Patients on Short-acting	■		
14 Rate of Addiction for Patients on Long-acting	■		
15 Rate of Addiction for Patients on Short-acting	■		
16 Table Function ¹ for Short-acting Bias (function of perceived risk)			■
17 Tamper Resistance (baseline value)			■

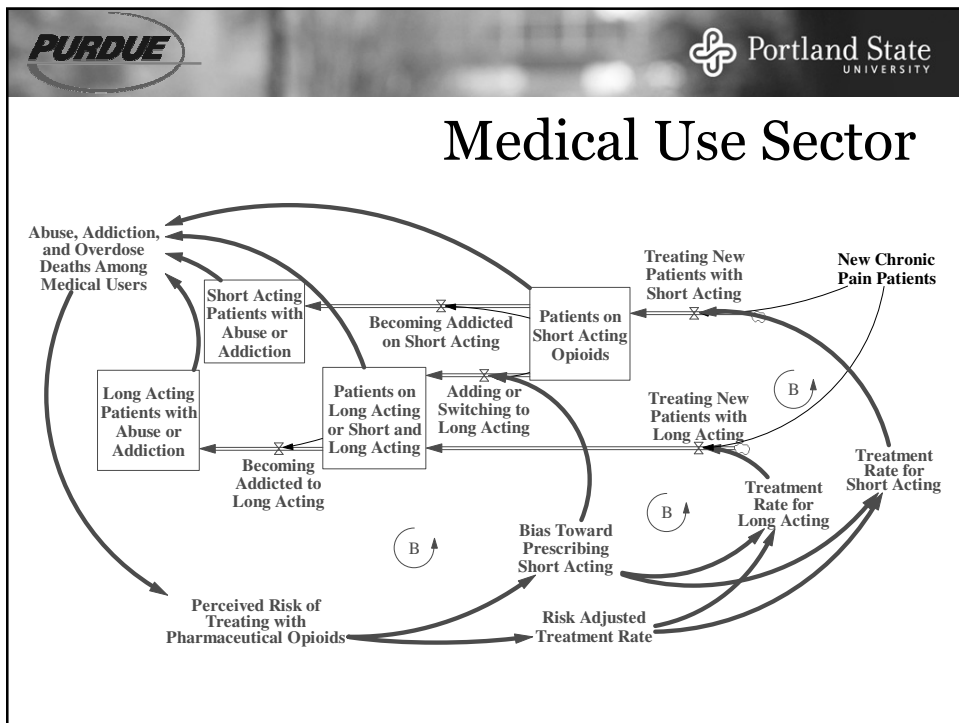
¹ A Table Function is a series of XY coordinates representing a relationship (usually nonlinear) between two variables

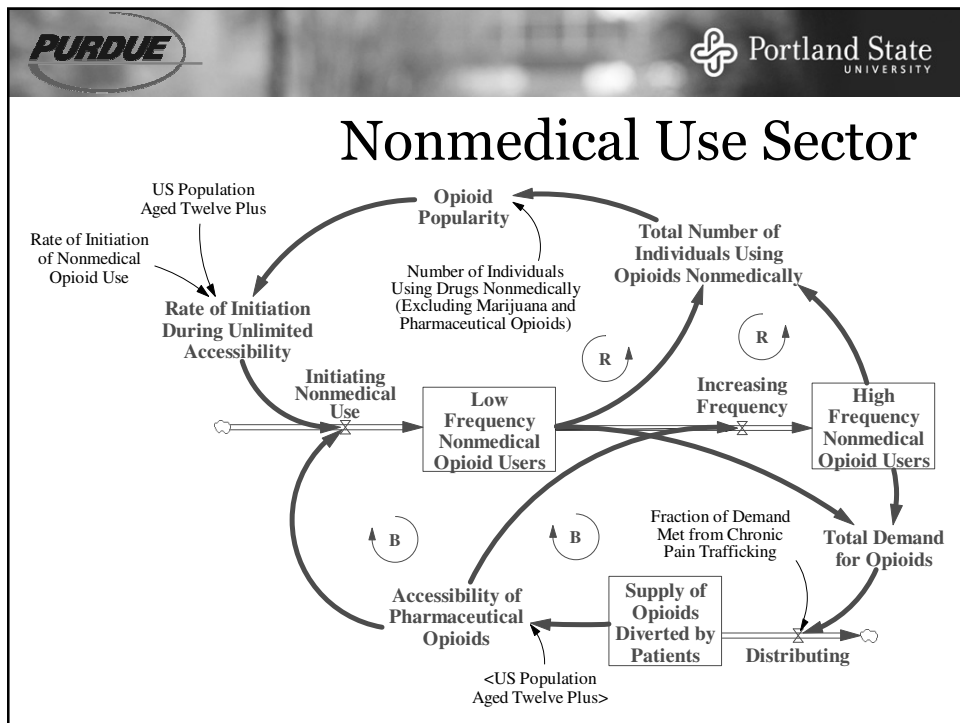
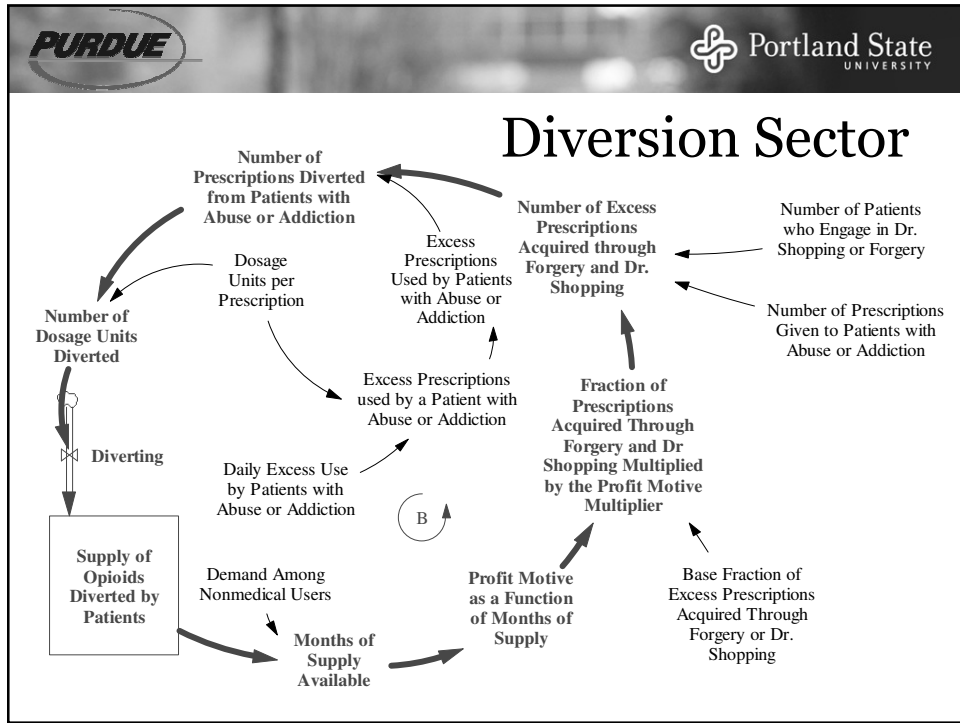
Parameter	Support		
	DIRECT	INDIRECT	PANEL
DIVERSION SECTOR			
1 Average Number of Dosage Units Per Opioid Prescription		■	
2 Average Number of Extra Dosage Units taken per Day Among Patients with Abuse or Addiction			■
3 Average Number of Prescriptions Prescribed to Patients with Abuse or Addiction		■	
4 Base Fraction of Excess Prescriptions Acquired Through Dr Shopping			■
5 Base Fraction of Excess Prescriptions Acquired Through Forgery			■
6 Fraction of Patients with Abuse/Addict who Engage in Dr Shopping	■		
7 Fraction of Patients with Abuse/Addict who Engage in Forgery	■		
8 Largest Possible Motive Multiplier			■
9 Number of Days of Extra Opioid Usage Among Patients with Abuse/Addiction	■		
10 Table Function ¹ for Profit Motive			■

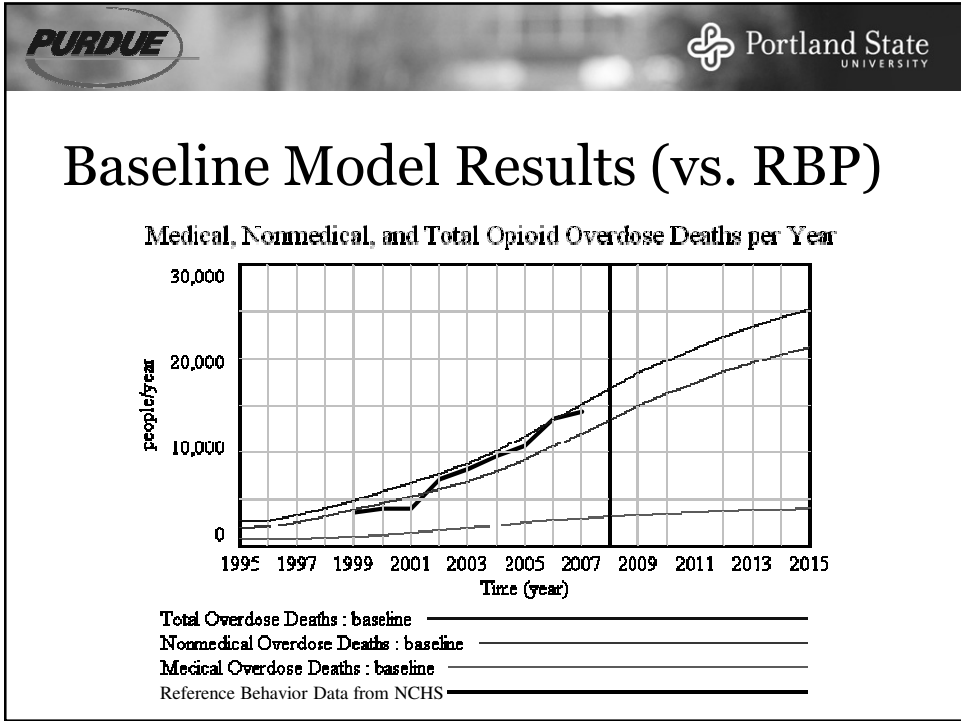
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Parameter	Support		
	DIRECT	INDIRECT	PANEL
NONMEDICAL USE SECTOR			
1 Base Level of Abuse Potential of Pharmaceutical Opioids			■
2 Fraction of Demand Met from Chronic Pain Trafficking		■	
3 Fraction of Low Freq Users who switch to High Freq		■	
4 High Frequency User All-Cause Mortality Rate		■	
5 High Frequency User Cessation Rate	■		
6 Low Frequency User All-Cause Mortality Rate		■	
7 Low Frequency User Cessation Rate	■		
8 Number of Days of Nonmedical Use Among High Freq Users		■	
9 Number of Days of Nonmedical Use Among Low Freq Users		■	
10 Number of Dosage Units Taken per Day			■
11 Overdose Mortality Rate for High Freq Nonmedical Users		■	
12 Overdose Mortality Rate for Low Freq Nonmedical Users		■	
13 Rate of Initiation of Nonmedical Opioid Use	■		
14 Table Function for the Impact of Limited Accessibility			■
15 Table Function ¹ for the Number of Individuals Using Illicit Drugs Excluding Marijuana and Pharmaceutical Opioids	■		
17 US Population Ages 12 and Older			

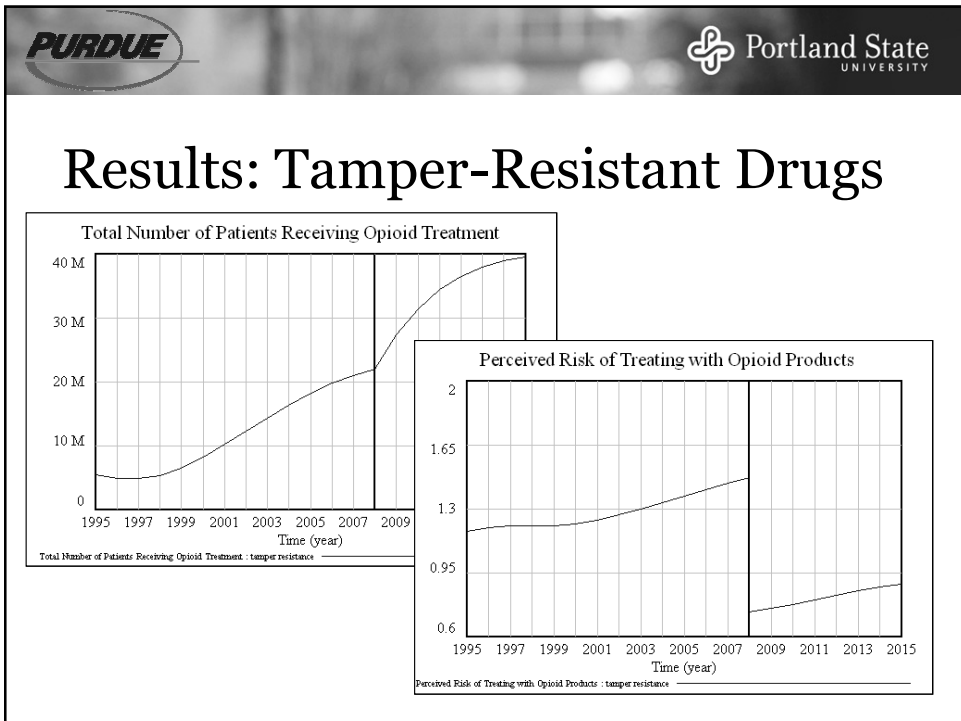
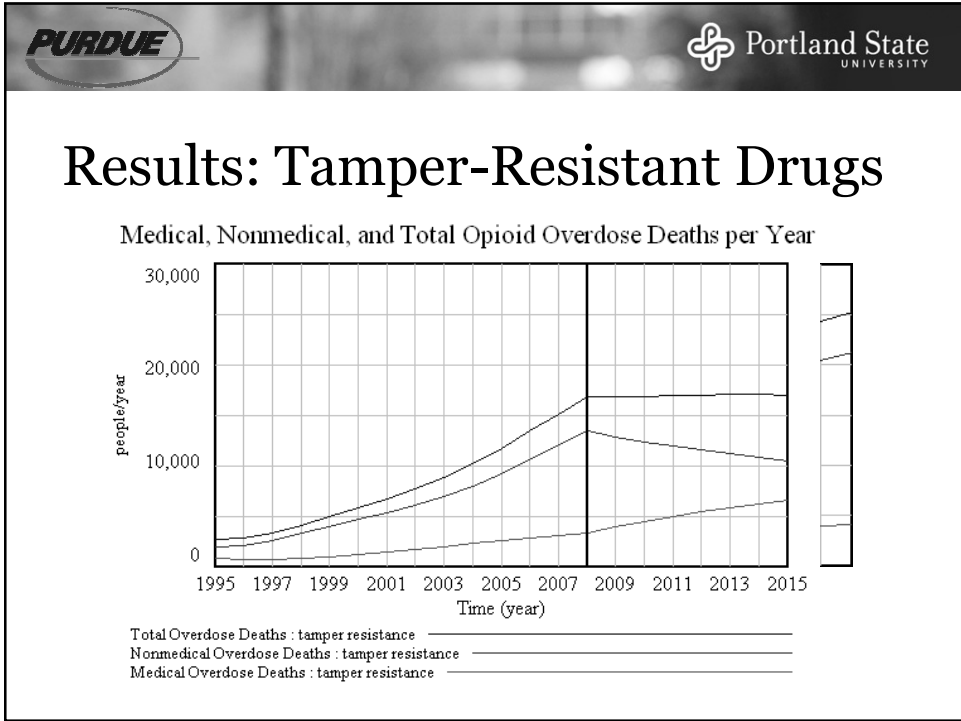
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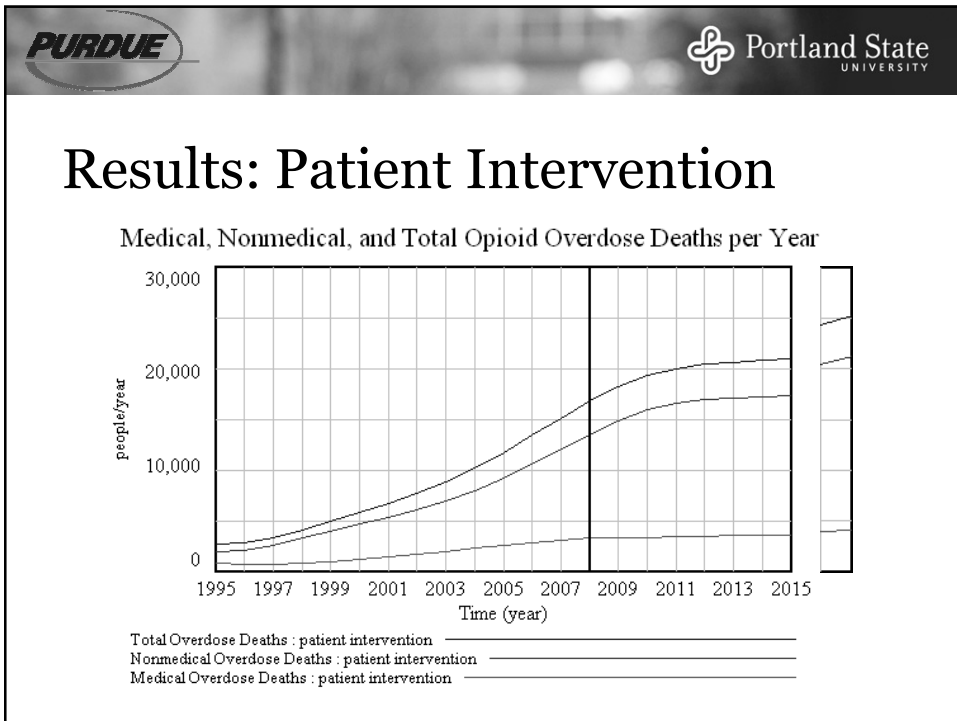
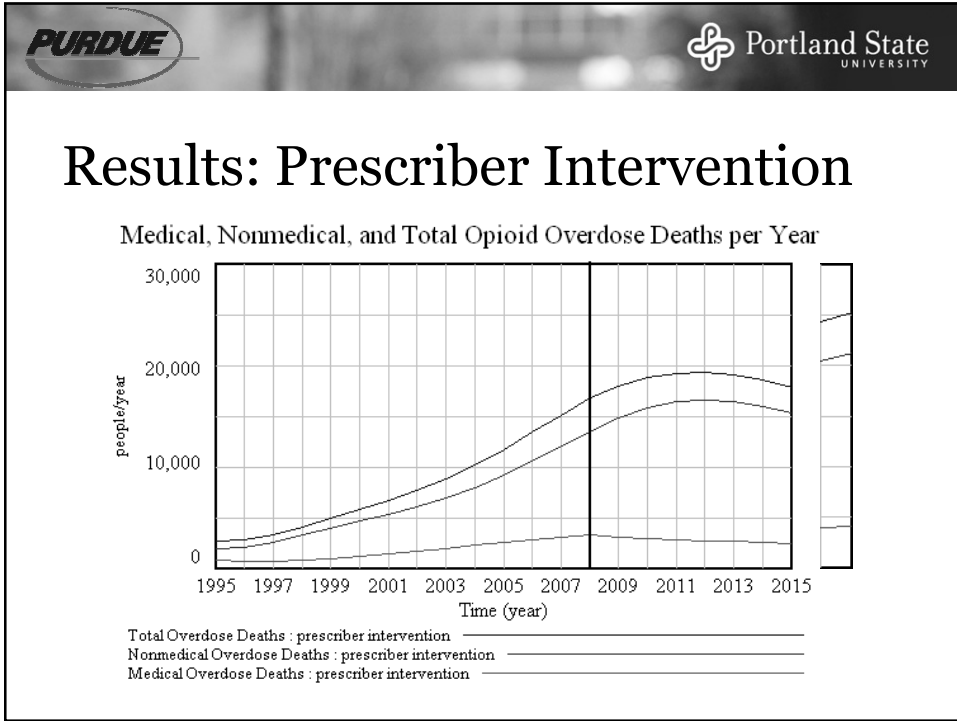


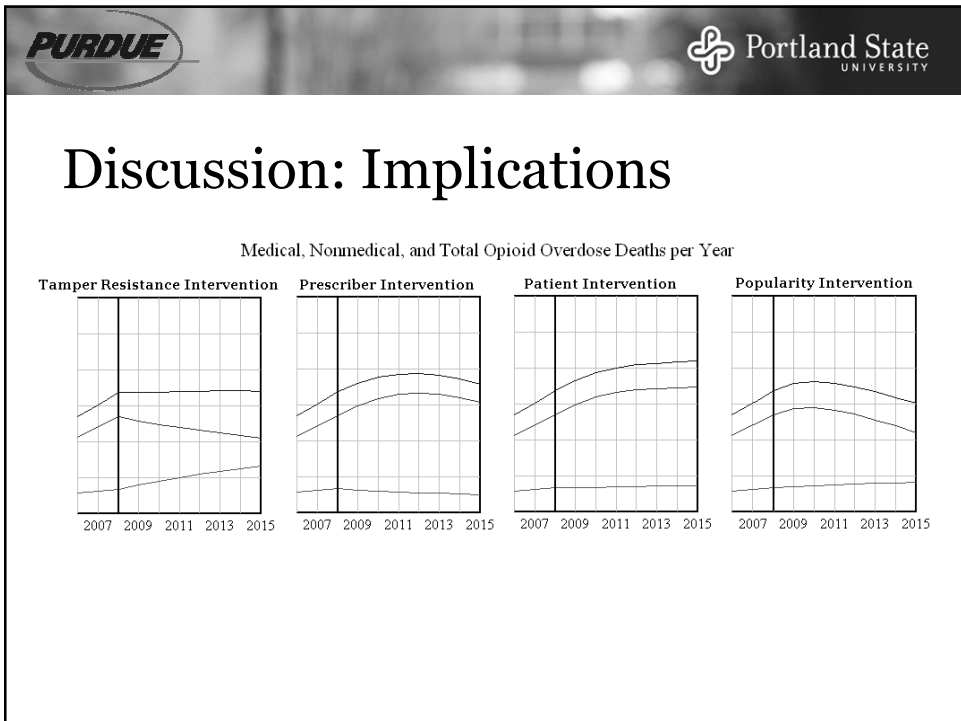
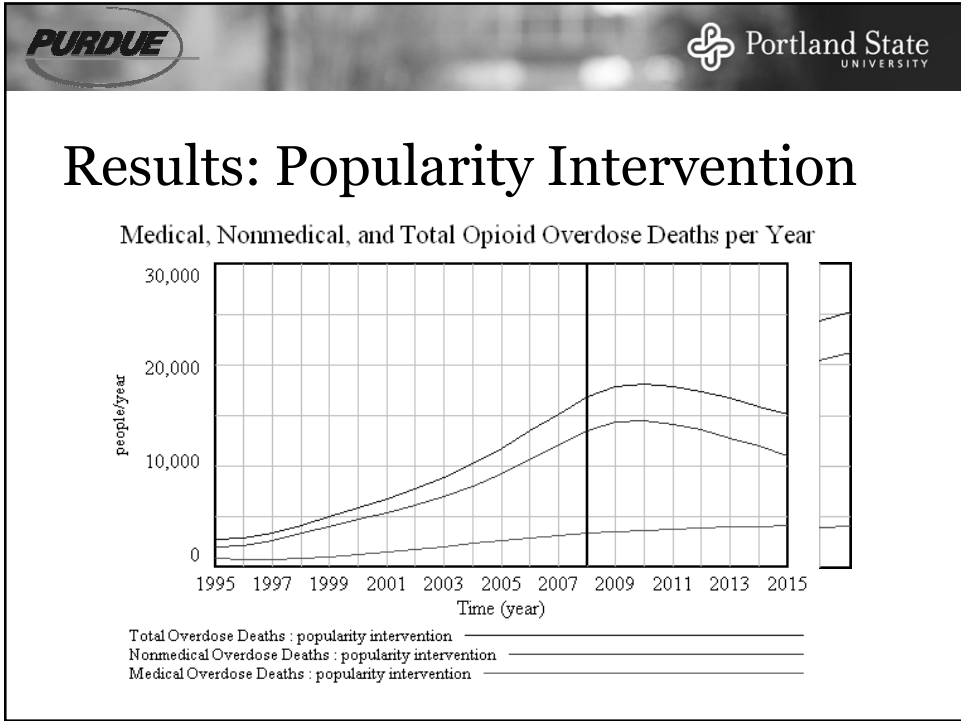






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- ## Interventions
- Tamper-Resistant Drug Formulations
 - Prescriber Intervention
 - Patient Intervention
 - Popularity Intervention





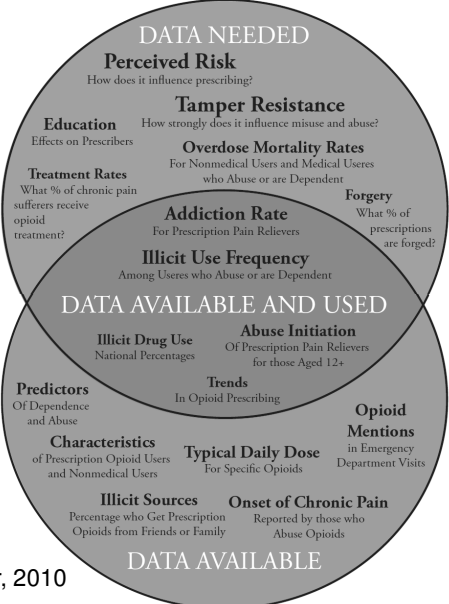


Discussion: Limitations

Key Data Gaps

- Treatment Rates
- Perceived Risk
- Profit Motive
- Forgery Fraction
- Nonmedical Dosage
- Intervention Effects



DATA NEEDED


- Perceived Risk**
How does it influence prescribing?
- Tamper Resistance**
How strongly does it influence misuse and abuse?
- Overdose Mortality Rates**
For Nonmedical Users and Medical Users who Abuse or are Dependent
- Forgery**
What % of prescriptions are forged?
- Addiction Rate**
For Prescription Pain Relievers
- Illicit Use Frequency**
Among Users who Abuse or are Dependent
- Abuse Initiation**
Of Prescription Pain Relievers for those Aged 12+
- Typical Daily Dose**
For Specific Opioids
- Opioid Mentions**
in Emergency Department Visits
- Onset of Chronic Pain**
Reported by those who Abuse Opioids

DATA AVAILABLE AND USED

- Illicit Drug Use**
National Percentages
- Trends**
In Opioid Prescribing
- Characteristics**
of Prescription Opioid Users and Nonmedical Users
- Illicit Sources**
Percentage who Get Prescription Opioids from Friends or Family
- Predictors**
Of Dependence and Abuse
- Abuse Initiation**
Of Prescription Pain Relievers for those Aged 12+
- Typical Daily Dose**
For Specific Opioids
- Opioid Mentions**
in Emergency Department Visits
- Onset of Chronic Pain**
Reported by those who Abuse Opioids

DATA AVAILABLE

Wakeland et al. CPDD Poster, 2010



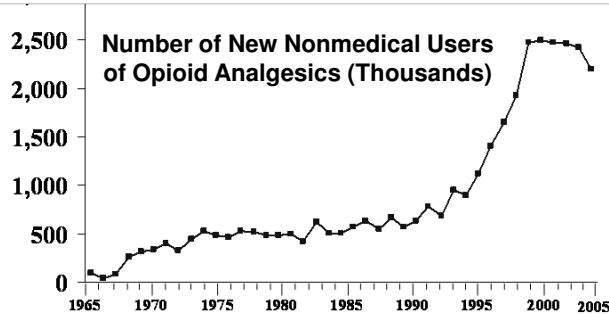

Discussion: Limitations

Boundary Exclusions

- Acute Pain Medications
- Alternative Treatments and Insurance
- Alternative Routes of Diversion
- Balloon Effects and Poly-Drug Abuse

Discussion: Future Research

- Data Gaps (see Wakeland et al. CPDD Poster, 2010)
- Verification and Validation
- Expansion to Address Boundary Exclusions



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