THE PHYSIOLOGY OF ADDICTION

Effects of Drug-Taking Behavior on the Brain

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Medical Director, Pioneer Valley Regional School District
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Co-Chair – Healthcare Solutions of the Opioid Taskforce

Thanks to Tess Jurgensen and the OTF of Franklin County
and North Quabbin for organizing these forums
Eat, Drink, Have Sex, Use Drugs
Dopamine Pathways
- Reward (motivation)
- Pleasure, euphoria
- Motor function
  (fine tuning)
- Compulsion
- Perseveration

Serotonin Pathways
- Mood
- Memory processing
- Sleep
- Cognition
How Cocaine Works

How Heroin Works
Newton’s 3rd Law of ‘Drug Abuse’

“For every action there is an equal and opposite reaction”
Sir Isaac Newton

Neurobiologic Advances from the Brain Disease Model of Addiction
Nora D. Volkow, M.D., George F. Koob, Ph.D., and A. Thomas McLellan, Ph.D.
January 28, 2016
**Functionally…**

**Dopamine D2 Receptors are Decreased by Addiction**

Genetics  
Early Use  
Trauma  

Poor Mental Health
Genetics Account for 50% of Risk of Addiction

Addiction is a Developmental Pediatric Disease

Source: NIAAA National Epidemiologic Survey on Alcohol and Related Conditions, 2003
Teen Alcohol Use Wires The Brain For Addiction

40% of kids who begin drinking at age 15 will become alcoholics.

Only 7% of those who begin drinking at age 21 become alcoholics.

* Photo courtesy of NIAAA and NASSO

How Much Do Americans Drink?
There's a wide range.

- TOP DICE: 73.85 DRINKS/WEEK
- NINTH DICE: 15.28 DRINKS
- EIGHTH DICE: 6.25 DRINKS
- SEVENTH DICE: 2.17 DRINKS
- SIXTH DICE: 0.63 DRINKS
- FIFTH DICE: 0.14 DRINKS
- FOURTH DICE: 0.02 DRINKS
- THIRD DICE: 0 DRINKS
- SECOND DICE: 0 DRINKS
- BOTTOM DICE: 0 DRINKS

Average number of drinks consumed per week.
SOURCE: WASHINGTONPOSTCHEMICLOG “PAINING THE TAP” BY PHILIP L. DOOH
Alcohol 'more harmful than heroin or crack'

Sacked government drugs adviser David Nutt publishes investigation in Lancet reopening debate on classification.

Alcohol is the most dangerous drug in the UK by a considerable margin, beating heroin and crack cocaine into second and third place, according to an authoritative study published today which will reopen calls for the drugs classification system to be scrapped and a concerted campaign launched against drink.
Adverse Childhood Experiences

Emotional Neglect
Abuse

Household Dysfunction

Source: "Drug harm in the UK", by David Nutt et al., The Lancet
Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults
The Adverse Childhood Experiences (ACE) Study

Vivian J. Felitti, MD, FACP; Robert F. Anda, MD, MD; Dale N. Nordenberg, MD; David F. Williamson, MS, PhD; Mimi M. Spitz, MD, MPH; Victoria Edwards, BS; Mary P. Browne, MD; James S. Anda, MD, MPH

Background:
The relationship of health risk behavior and disease in adulthood to the breadth of exposure to childhood emotional, physical, or sexual abuse, and household dysfunction during childhood has not previously been investigated.

Methods:
A questionnaire about adverse childhood experiences was mailed to 17,645 adults who had completed a standardized medical evaluation at a large (N = 9,401) veterans hospital. Respondents were categorized as having never been married, married, or married at least once. Analysis was performed on respondents who had experienced sexual abuse, emotional abuse, or physical abuse. Analyses also included respondents who had experienced a household death, physical abuse, or sexual abuse.

Results:
More than half of respondents reported at least one, and two-thirds reported two or more categories of childhood exposure. We found a graded relationship between the number of categories of childhood exposure and each of 18 adult health risk behaviors and diseases that were studied (P < 0.05). Persons who had experienced four or more categories of childhood exposure, compared to those who had experienced none, had 4- to 6-fold increased health risk for alcoholism, drug abuse, depression, and suicide attempt. In addition, 11 to 21 years after exposure, the rate of chronic diseases diagnosed and treated was significantly higher in adults with childhood exposure to emotional abuse and sexual abuse. The number of categories of adverse childhood experiences showed a graded relationship to the presence of adult diseases including leukemia, heart disease, cancer, chronic lung disease, skeletal fractures, and food disease. The severest categories of adverse childhood experiences were strongly associated and persons with multiple categories of childhood exposure were likely to have multiple health risk factors in life.

Conclusion:
We found a strong graded relationship between the breadth of exposure to abuse or household dysfunction during childhood and multiple risk factors for the survival of the leading causes of death and disability in adults.

American Journal of Preventive Medicine

Finding Your ACE Score

While you were growing up, during your first 18 years of life:

1. Did a parent or other adult in your household ever...?
   - Swear at you?
   - Call you a name that made you feel afraid that you might be physically hurt?
   - Tell you that you might be physically hurt?
   - Make you feel that you might be physically hurt?
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Since 1990, the number of Americans who have died every year from **car accidents**...
Since 1990, the number of Americans who have died every year from **guns**...

Since 1990, the number of Americans who have died every year from **H.I.V.**...
The number who die each year from...

- Drug overdoses: 52,404
- Car accidents: 37,757
- Guns: 35,763
- H.I.V.: 6,465

(U) Map 2. Percentage of 2015 NDTS Respondents Reporting Heroin as Greatest Drug Threat, by OCDETF Region
Opioid pain reliever prescribing rates vary by state

Some states have more painkiller prescriptions per person than others.

CDC Vital Signs, July 2014. Rates per 100 people in 2012

6. A large part of the problem has been the rise of painkillers and heroin, especially in the Northeast.

(Map shows the drug most commonly cited in drug treatment admissions in each state)
Today, Florida’s incarceration rates stand out internationally

**INCARCERATION RATES COMPARING FLORIDA AND FOUNDING NATO COUNTRIES**

<table>
<thead>
<tr>
<th>Country</th>
<th>Incarceration Rate per 100,000 Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida</td>
<td>853</td>
</tr>
<tr>
<td>United States</td>
<td>698</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>439</td>
</tr>
<tr>
<td>Portugal</td>
<td>199</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>155</td>
</tr>
<tr>
<td>Canada</td>
<td>114</td>
</tr>
<tr>
<td>France</td>
<td>103</td>
</tr>
<tr>
<td>Italy</td>
<td>96</td>
</tr>
<tr>
<td>Belgium</td>
<td>94</td>
</tr>
<tr>
<td>Norway</td>
<td>58</td>
</tr>
<tr>
<td>Netherlands</td>
<td>52</td>
</tr>
<tr>
<td>Denmark</td>
<td>59</td>
</tr>
<tr>
<td>Iceland</td>
<td>26</td>
</tr>
</tbody>
</table>

Source: https://www.prisonpolicy.org/global/2018.html

In the U.S., incarceration extends beyond prisons and local jails to include other systems of confinement. The U.S. and state incarceration rates in this graph include people held by those other parts of the justice system, so they may be slightly higher than the commonly reported incarceration rates that only include prisons and jails. Details on the data are available in States of Incarceration: The Global Context. We also have a version of this graph focusing on the incarceration of women.
**Substance Use & Incarceration**

- 48% of federal prisoners incarcerated for drug offenses
- 85% substance-involved
  - 1.5 million meet DSM criteria for substance use disorder
  - 456,000 history of SUD, under the influence, or crime committed to obtain money to buy drugs
- In 2006, alcohol and other drugs were involved in:
  - 78% of violent crimes
  - 83% of property crimes
  - 77% of public order, immigration or weapons offenses and probation/parole violations

---

**The New England Journal of Medicine**

**Special Article**

**Release from Prison — A High Risk of Death for Former Inmates**

Ingrid A. Bresnahan, M.D., Marc F. Stern, M.D., Richard A. Deyo, M.D.,
Patrick J. Heagerty, Ph.D., Allen Chaffin, Ph.D., Joann G. Elmore, M.D.,
and Thomas D. Koppel, M.D.

**Abstract**

The U.S. population of former prison inmates is large and growing. The period immediately after release may be challenging for former inmates and may involve substantial health risks. We studied the risk of death among former inmates soon after their release from Washington state prisons.

**Methods**

We conducted a retrospective cohort study of all inmates released from the Washington State Department of Corrections from July 1999 through December 2005. Prison records were linked to the National Death Index. Data for comparison with Washington state residents were obtained from the Wide-ranging OnLine Data for Epidemiologic Research system of the Centers for Disease Control and Prevention. Mortality rates among former inmates were compared with those among other state residents with the use of indirect standardization and adjustment for age, sex, and race.

**Results**

Of 90,327 released inmates, 445 died during a mean follow-up period of 1.9 years. The overall mortality rate was 777 deaths per 100,000 person-years. The adjusted risk of death among former inmates was 3.3 times that among other state residents (95% confidence interval [CI], 2.6 to 4.0). During the first 2 weeks after release, the risk of death among former inmates was 13.7 times (95% CI, 5.2 to 35.4) times that among other state residents, with a markedly elevated relative risk of death from drug overdoses (23%-97% CI, 49 to 384). The leading causes of death among former inmates were drug overdoses, cardiovascular disease, homicide, and suicide.

**Conclusions**

Former prison inmates were at high risk for death after release from prison, particularly during the first 2 weeks. Interventions are necessary to reduce the risk of death after release from prison.

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Thanks to Jennifer Clarke, MD, MPH Medical Director, RI DOC for this slide.
In early December, 26-year-old Dejah Hall, from Arizona, highlighted the harrowing effects of drug addiction by sharing her before-and-after photos on social media.

Read more: http://www.dailymail.co.uk/femail/article-4069526/Former-addicts-share-amazing-photos.html#ixzz4sEPHq7RE

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Opioid Deaths by person-years since being released from a MA state prison. 2013-2014 (121 deaths)

Deaths per 1000 person-years

Under 1 month: 437.8
1-3 months: 193.1
3-6 months: 148.5
6-12 months: 115.5
12-24 months: 69.6

Everyone else (non-former state prison inmates): 15.4 (2071 deaths)

Courtesy of Dr. Thomas Lincoln

Thanks to Jennifer Clarke, MD, MPH, Medical Director, RI-DOC for this slide.
Thanks to Jennifer Clarke, MD, MPH—Medical Director, RI-DOC for this slide.

The Swedish methadone maintenance program: a controlled study. 
Gunne LM, Grönbladh L.
The Swedish methadone maintenance program: a controlled study.

Gunne LM, Grönbladh L

Thanks to Jennifer Clarke, MD, MPH Medical Director, RI-DOC for this slide

The Swedish methadone maintenance program: a controlled study.

Jennifer Clarke, MD, MPH Medical Director, RI-DOC for this slide

The Swedish methadone maintenance program: a controlled study.

Gunne LM, Grönbladh L
What actually works?

What are the costs?

(OAT = Opioid Agonist Treatment)
# Which treatment is best?

**The One That Works!**

<table>
<thead>
<tr>
<th>General guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methadone</strong></td>
</tr>
<tr>
<td>Long history of use, high opioid tolerance, unstable life needing lots of structure and support</td>
</tr>
<tr>
<td><strong>Buprenorphine</strong></td>
</tr>
<tr>
<td>Mild-to-moderate dependence, greater life stability, more potential for abuse</td>
</tr>
<tr>
<td><strong>Naltrexone</strong></td>
</tr>
<tr>
<td>Mild-to-moderate dependence, greater life stability, greater risk of relapse and overdose</td>
</tr>
</tbody>
</table>

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**THE LANCET**


Articles

Comparative effectiveness of extended-release naltrexone versus buprenorphine-naloxone for opioid relapse prevention (X:BOT): a multicentre, open-label, randomised controlled trial

Dr Joshua D Lee MD a,b, Edward V Nunes Jr MD c, Patricia Novo MPH d, Ken Bachrach PhD d, Genie L Bailey MD a,b, Snehal Bhatt MD a, Sarah Farkas MA a, Marc Fishman MD a,b, Phoebe Gauthier MPH b, Candace C Hodgkins PhD a, Jacquie King MS b, Robert Lindblad MD k, David Liu MD a, Abigail G Matthews PhD k, Jeanine May PhD k, K Michelle Peavy PhD k, Stephen Ross MD b, Dagmar Salazar MS k, … John Rotrosen MD b

Show more
**Findings**

Between Jan 30, 2014, and May 25, 2016, we randomly assigned 570 participants to receive XR-NTX (n=283) or BUP-NX (n=287). The last follow-up visit was Jan 31, 2017. As expected, XR-NTX had a substantial induction hurdle: fewer participants successfully initiated XR-NTX (204 [72%] of 283) than BUP-NX (270 [94%] of 287; p=0.0001). Among all participants who were randomly assigned (intention-to-treat population, n=570) 24 week relapse events were greater for XR-NTX (185 [65%] of 283) than for BUP-NX (163 [57%] of 287; hazard ratio [HR] 1.36, 95% CI 1.10–1.68), most or all of this difference accounted for by early relapse in nearly all (70 [89%] of 79) XR-NTX induction failures. Among participants successfully induced (per-protocol population, n=474), 24 week relapse events were similar across study groups (p=0.44). Opioid-negative urine samples (p=0.0001) and opioid-abstinent days (p=0.0001) favoured BUP-NX compared with XR-NTX among the intention-to-treat population, but were similar across study groups among the per-protocol population. Self-reported opioid craving was initially less with XR-NTX than with BUP-NX (p=0.0012), then converged by week 24 (p=0.20). With the exception of mild-to-moderate XR-NTX injection site reactions, treatment-emergent adverse events including overdose did not differ between treatment groups. Five fatal overdoses occurred (two in the XR-NTX group and three in the BUP-NX group).

**Interpretation**

In this population it is more difficult to initiate patients to XR-NTX than BUP-NX, and this negatively affected overall relapse. However, once initiated, both medications were equally safe and effective. Future work should focus on facilitating induction to XR-NTX and on improving treatment retention for both medications.
Jail Ordered to Give Inmate Methadone for Opioid Addiction in Far-Reaching Ruling

An inmate received methadone treatment at the New Haven Correctional Center in Connecticut last year. Most jails and prisons around the country do not give inmates access to methadone.

By Kate Taylor
Nov. 26, 2016

BOSTON — In a ruling that could have tremendous consequences for the country's correctional system, a federal judge said this week that a Massachusetts man facing a jail sentence could not be denied access to treatment for his opioid addiction.

(1) Map 2: Percentage of 2015 NDTS Respondents Reporting Heroin as Greatest Drug Threat, by OCDETF Region

Source: 2015 National Drug Threat Survey
Figure 34. Heroin Threat in the DEA Field Divisions.

Source: DEA Field Division Reporting

The map below shows the amount of retail opioid prescriptions dispensed per 100 people in 2016.

Note: Counties with insufficient data are left blank.
The 2017 DCI finds that **54.3 million Americans live in economically distressed communities**— the one-fifth of zip codes that score worst on the DCI. That represents one in six Americans, or 17 percent of the U.S. population.

By comparison, **84.8 million Americans live in prosperous communities**— the one-fifth of zip codes that score best on the DCI. These top-performing zip codes contain 27 percent of the country’s population, a far greater share than any other tier.

Underlying indicators of well-being vary drastically across the different tiers of U.S. communities.

**Performance across the seven component metrics of the DCI**

<table>
<thead>
<tr>
<th>Category</th>
<th>Adults without a High School Diploma</th>
<th>Poverty Rate</th>
<th>Prime-Age Adults Not in Work</th>
<th>Housing Vacancy Rate</th>
<th>Median Income Ratio</th>
<th>Change in Employment</th>
<th>Change in Establishments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosperous</td>
<td>5.7%</td>
<td>6.2%</td>
<td>20.8%</td>
<td>4.9%</td>
<td>145.9%</td>
<td>24.5%</td>
<td>12.6%</td>
</tr>
<tr>
<td>Comfortable</td>
<td>9.3%</td>
<td>10.0%</td>
<td>24.6%</td>
<td>7.1%</td>
<td>111.3%</td>
<td>15.2%</td>
<td>6.8%</td>
</tr>
<tr>
<td>Mid-tier</td>
<td>12.6%</td>
<td>13.8%</td>
<td>28.6%</td>
<td>8.3%</td>
<td>94.8%</td>
<td>10.9%</td>
<td>4.1%</td>
</tr>
<tr>
<td>At risk</td>
<td>16.8%</td>
<td>18.6%</td>
<td>34.0%</td>
<td>10.8%</td>
<td>82.8%</td>
<td>7.6%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Distressed</td>
<td>22.5%</td>
<td>26.7%</td>
<td>41.8%</td>
<td>14.4%</td>
<td>68.6%</td>
<td>-6.0%</td>
<td>-5.3%</td>
</tr>
<tr>
<td>United States</td>
<td>13.3%</td>
<td>15.5%</td>
<td>28.2%</td>
<td>8.3%</td>
<td>100.0%</td>
<td>9.4%</td>
<td>4.2%</td>
</tr>
</tbody>
</table>