Neurobiology of Addiction

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Disclosures
I have no competing interests in this presentation.

Learning Objectives
• 1. Identify the origins and current state of the opioid crisis in America.
• 2. Describe the basic elements of drive and cognition in the neurobiology of addiction.
• 3. Understand the structure and pathways associated with changes in the brain
• 4. Discuss the clinical use of psychotherapy and psychosocial interventions in the treatment of substance abuse disorders.
Slide 7

A Biopsychosocial Illness

- Biological
- Psychological
- Social
- Use

Addiction

Brain Switch

Slide 8

Addiction Involves Multiple Factors

- Biology/Genes
- Environment

DRUGS

Brain Mechanisms

Addiction

Slide 9

Addiction

Medical

DRUGS

Social

Economic

Mental/Physical

Healthcare/Disability

Arrests

Mental Health
Slide 13

1999-2009
Primary non-heroin opioid admission rates (per 100,000)

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Slide 14

From Pills to Heroin

Compton, New England Journal of Medicine, 2016

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Slide 15

From Heroin to Fentanyl

Overdose Deaths Involving Opioids, by Type of Opioid, United States, 2000-2016

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Addiction Changes in the Brain

- Over Time Addiction causes changes in the brain.
- **Brain Structure**
  - Prefrontal Cortex, limbic system
  - Brain Pathways (neural connections)
    - Dopamine pathway, serotonin pathway
- **Brain Chemicals**
  - Dopamine, serotonin, endorphin, glutamate

Brain Structures (prefrontal and limbic systems)

Brain Regions

**CEREBRUM**
- Speech, vision, hearing, speech, reasoning, emotions, learning & the control of movements

**CEREBELLUM**
- Motor control, movement, sensation, posture, and balance

**BRAIN STEM**
- Helps control breathing, heart rate, blood pressure, temperature, and other important functions
Slide 25

**Brain Regions and their Functions**

- [Image of brain regions and their functions]

Slide 26

**Pleasure – Rewards Pathways**

- [Image of pleasure pathways]

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**Addiction Changes in the Brain**

- Brain Pathways (neural connections)
- Dopamine pathway, serotonin pathway

[Diagram with brain regions and pathways highlighted]
Addiction Changes in the Brain

- Brain Chemicals
  - Dopamine, serotonin, endorphin, glutamate, and GABA

Brain Chemicals

- Dopamine – a feel-good chemical
- Serotonin – the happy, anti-worry, flexibility chemical
- GABA – an inhibitory neurotransmitter that helps calm or relax the brain
- Endorphins – the brain's own natural pleasure and pain killing chemical
- Glutamate – locks the pleasurable experience into memory
**The Addiction Cycle & the 4 C’s**

- Loss of Control (damage to the prefrontal cortex, right & wrong)
- Continued Use Despite Consequences - further damage to prefrontal cortex (interferes with judgment)
- Compulsion (low serotonin levels)
- Craving (dopamine; brain is hard wired to crave rewards)

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**Common medications used to treat drug addiction and withdrawal**

- **Opioid**
  - Methadone
  - Buprenorphine
  - Extended-release naltrexone
- **Nicotine**
  - Nicotine replacement therapies (available as a patch, inhaler, or gum)
  - Bupropion
  - Varenicline
- **Alcohol**
  - Naltrexone
  - Disulfiram
  - Acamprosate

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**New Neurobiological Concepts**
Three Novel Areas

- Motivational Circuitry
- Anti-reward Pathways
- Interoception

Lencz, Journal of Medical Toxicology, 2016

Motivation: The Stinking – Thinking Part

How the Brain Decides

- movement
- sensations
- vision
- judgment
- reward
- memory
- attention
Motivation: The Stinking – Thinking Part

Anti-Reward Pathways

Rewards

…or $12 a month from now:

"$10 now…?"
Slide 43

**Human Nature**

- People avoid risks to ensure gains (even small gains)
- People take risks (even big risks) to avoid definite losses
- Psychology trumps probability

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Slide 44

**Reward and Anti-Reward Systems**

Gardner, Chronic Pain and Addiction, 2011

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**Insula is in the anterior cingulate cortex (ACC)**
Slide 46

The Stop-Go Model

Volkow ND and Baler RD, Neuropharmacology, 2013

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4 Treatments

Slide 48

First Wave: Psychoanalysis

Levounis, Journal of Medical Toxicology, 2016
2nd Wave: Boot Camps

3rd Wave: The Current Approach

✓ Medications
✓ Counseling and Psychotherapy
✓ Mutual Help

Renner, Levounis, and LaRose. Office-Based Buprenorphine Treatment of Opioid Use Disorder. 2nd Ed. 2018.

Medications
Agonists
Partial Agonists
Antagonists
Counseling and Psychotherapy

1. Cognitive-Behavior Therapy
   - Functional analysis
   - Skills Training to identify, avoid & cope with thoughts & cravings

2. The Kitchen Sink approach
   - Family Therapy
   - Relapse Prevention
   - 12 Step Facilitation (AA)
   - Primary Care
   - Mental Health Services
   - Aftercare

Mutual Help

Motivational Interviewing

MI is about arranging conversations so people talk themselves into change, based on their values and their interests.
• Alcoholics Anonymous (AA) is an international mutual aid fellowship with the stated purpose of enabling its members to “stay sober and help other alcoholics achieve sobriety.”

• AA is nonprofessional, self-supporting, and apolitical. Its only membership requirement is a desire to stop drinking.

• The AA program of recovery is set forth in the Twelve Steps.

• Narcotics Anonymous uses the same principles.
Psychodynamics

A therapy that helps people gain insight to their lives and problems by:

• Recognizing recurring patterns to avoid distress & develop coping mechanisms in an effort to produce change in these patterns or habits.

• Evaluating life factors of thoughts, emotions, early life experiences and beliefs.

• Developed as a simpler, goal oriented, less lengthy alternative to psychoanalysis.

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Conclusions

1. A medical mistake, a greedy industry, and a tricky brain are primarily responsible for the opioid epidemic.
2. Addiction is the war between the hijacked pleasure/reward pathways of the brain and the frontal lobes.
3. Motivational circuitry, the anti-reward pathways, and interception complete the STOP-BO model of addiction.
4. Partial agonists, Motivational Interviewing, and 12-step work are the first line interventions in 2018.
5. Mindfulness and a return to psychodynamic psychotherapy are next frontiers in the psychosocial treatment of addiction.
Thank You