Pre-Medical Honors Program 2018
Wednesday, October 17, 2018 - Session # 3
Agenda:

4:00 PM – 5:15 PM
University Hospital Emergency Department Tour
Bleeding Control Workshop

5:30 PM – 6:45 PM
Medical Student Seminar Discussion Groups: Neurology/Mental Health

Formal Lectures
7:00 PM – 8:00 PM

The Ever Changing Landscape of Hospital Emergency Preparedness
by
Michael R. Feravolo, RN, B.A., B.S.N., HSEP
Coordinator, Emergency Management
Center for Emergency Preparedness and Response
University Hospital

8:00 PM – 9:00 PM
Biological and Chemical Weapons: What We Need To Know
by
Nancy D. Connell, Ph.D.
Professor Emerita
Division of Infectious Diseases
Department of Medicine
Rutgers-New Jersey Medical School
Senior Scholar
Johns Hopkins Center for Health Security
Johns Hopkins University

Rutgers-New Jersey Medical School

ANNOUNCEMENTS

1. **There will be a Pathology 101 class offered on Wednesday, October 24th from 4:00 PM til 5:15 PM. The students will meet inside room B 552, second year lecture. The sign-up sheet will be posted on Google Docs.**

2. **The first University Hospital Emergency Department Tour will take place today on Wednesday. Background information regarding this tour may be found by accessing information from the following site: https://en.wikipedia.org/wiki/Emergency_medicine**

3. **The two Basic Life Support Sessions are scheduled for Saturday, October 27th from 9 am til 1 pm and Sunday, November 18th from 1 pm til 5 pm. Those who register online for this class and successfully complete it will receive a certification card through the American Heart Association. Certification will last for two years. In order to participate in this class, students must matriculate through prior online registration. The cost of the Basic Life Support course remains at $ 50.00 by typing in the Promo code: "Minimed". Students may register for either class, using the individual link specific for the BLS session:**

   October 27, 2018: https://uhnj.enrollware.com/enroll?id=2494636
   November 18, 2018: https://uhnj.enrollware.com/enroll?id=2494637

   Students must pay ONLY through either credit or debit card online. NO CASH PAYMENT IS ALLOWED. No walk-in students will be accepted without prior registration and confirmation. For further information or for on-line registration difficulties, please call Mr. Dennis Boos or Mr. John Cruz at the Community Training Center: 973.972.4373 from 8 am til 4 pm.

4. **Any student who still owes tuition money for our program must submit payment by check or money order as soon as possible. Failure to do so may result in not receiving a graduation certificate at the end of the program. If you have any questions regarding this matter or any other matter, please direct questions or concerns to Mr. Michael Grabow, Program Administrator at grabowmi@njms.rutgers.edu or by phone: 973.972.1269.**

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Neurology & Mental Health

Mini-Med Fall 2018

Central vs Peripheral Nervous System

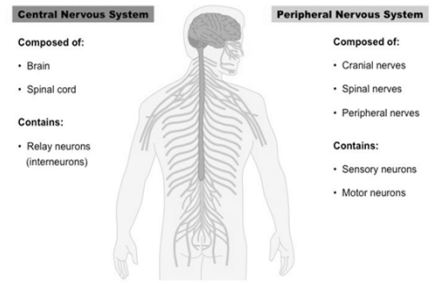
CENTRAL:

- Divided into two parts: the brain and the spinal cord
- The brain lies protected inside the skull and from there controls all the body functions by sending and receiving messages through nerves.

PERIPHERAL:

- Divided into two parts: the somatic nervous system and the autonomic nervous system
- **Somatic nervous system** consists nerve fibers that send sensory information to the central nervous system AND motor nerve fibers that go into skeletal muscle.
- **Autonomic nervous system** controls smooth muscle of the viscera (internal organs) and glands.

What makes up the nervous system?



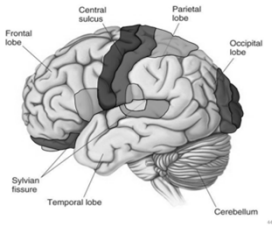
http://ib.bioninja.com.au/_Media/cns-vs-pns_med.jpeg

What is the Nervous System?

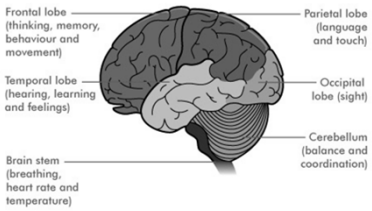
- Brain, spinal cord, and nerves
- Composed of the Central Nervous System and Peripheral Nervous System
- Carries information throughout the body
  - Coordinates sensory and motor information
  - Tells the body "what to do"

The Brain

- The brain is the center of the nervous system
- Cells in the brain are grouped into neurons and glia
  - Neurons are the functional units
  - Glia is a term for a broad class of supporting cells
- The lobes of the brain: Frontal, Parietal, Occipital, and Temporal
- Neurons are connected by synapses which allow them to communicate with each other



Lobes of the Brain



Stroke

- Someone in the US has a stroke every 40 seconds → **every 4 minutes, someone dies of stroke**
- **5th leading cause of death in US**
- 87% of strokes are ischemic
- The risk of having a stroke varies with race and ethnicity.
  - Risk of having a first stroke is nearly twice as high for blacks as for whites
  - Though stroke death rates have declined for decades among all race/ethnicities, Hispanics have seen an increase in death rates since 2013
- Risk factors for stroke include:
  - **High blood pressure, high cholesterol, smoking, obesity, and diabetes**
  - 1 in 3 US adults has at least one of these conditions or habits

https://www.youtube.com/watch?v=pRFXSjkpKWA

There are two types of stroke:

ISCHEMIC STROKE

- Acute blockage of vessels in brain → disruption of blood flow
- Three types
  - Thrombotic – clot at site of infarct
  - Embolic – embolus from another part of body
  - Hypoxic – hypoxemia or low perfusion
- Irreversible damage begins after **5 minutes**
- Treatment:
  - "Clot Buster" - Tissue Plasminogen Activator
  - Do NOT give if any risk of hemorrhage
  - Can break up clot and restore blood flow to brain

HEMORRHAGIC STROKE

- Emergency condition
- Ruptured vessel leads to bleeding in the brain
- Aneurysm – weakened, ballooned vessel
  - Risk of rupture = hemorrhagic stroke
- Pressure on the brain
- Loss of blood to surrounding areas of the brain
- Treatment:
  - Surgical intervention to stop the bleeding
  - Can use a metal clip to clamp down bleeding artery

What happens if your brain loses blood supply?

Signs of a Stroke

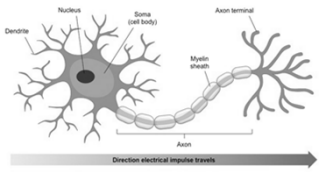
- Sudden **numbness** or weakness in the face, arm, or leg,
- **Confusion**, trouble speaking
- **Trouble seeing** in one or both eyes
- **Trouble walking**, dizziness, loss of balance, or lack of coordination
- Sudden **severe headache** with no known cause

Post-Stroke Complications

- Increased muscle tone (**spasticity**) can be due to damage to the brain that interrupts the messages between the muscles and brain.
  - Hands can be stuck in a tight fist, elbow permanently bent, pointed foot
- **Emotional changes**: pseudobulbar affect (PBA)
  - Outbursts of uncontrollable crying or laughing
- **Cognitive changes:** memory loss, vascular dementia, aphasia
  - Aphasia: difficulty speaking, understanding speech, reading, writing
  - Vascular dementia: problems with reasoning, judgement, and thought processes

The Neuron

- **Dendrites and soma (cell body)** receive chemical information from neighboring neuronal **axons**
- The chemical information is converted to **electrical currents** which travel toward and converge on the soma
- A **major impulse** is produced (the action potential) and travels down the axon toward the terminal

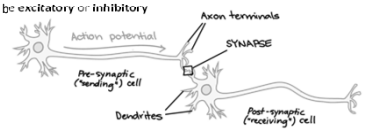


Stroke Prevention

- **Healthy Diet**
  - Eat plenty of fresh fruits and vegetables
  - Eat foods low in saturated fat, trans fat, and cholesterol
  - Limit salt to lower blood pressure
- **Healthy Weight**
  - Being overweight increases risk for stroke
- **Physical Activity**
  - 2 hours and 30 minutes of moderate-intensity exercise each week
- **No Smoking**

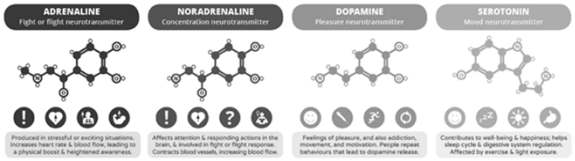
The Synapse

- The action potential traveling down the axon starts a series of events at the terminal that results in vesicles containing a **neurotransmitter** to become exocytosed into the **synaptic cleft**
- Once inside the synaptic cleft, the neurotransmitters can bind to specific proteins called **receptors** on the membrane of a neighboring neuron
- Occupation of receptors by neurotransmitters causes various actions in the cell
  - Activation or inhibition of enzymes
  - Entry or exit of certain ions
- These actions can be **excitatory** or **inhibitory**



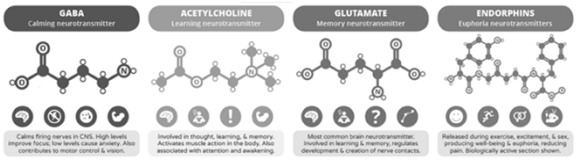
What is a neuron?

What are some examples of neurotransmitters?



Mental Health In America

- 1 in every 5 adults in America experience mental Illness
  - Nearly 1 in 24 adults live with a serious mental illness
- **Depression** is the leading cause of disability worldwide and a major contributor to the global burden of disease
- 90% of those who die by suicide have an underlying mental illness



Depression

Signs and Symptoms - "SIG-E-CAPS'

- **S**leep disturbance (increased or decreased)
- **I**nterest reduced (not enjoying anything)
- **G**uilt sensation and worthlessness
- **E**nergy loss and fatigue
- **C**oncentration problems
- **A**ppetite problem (increased or decreased)
- **P**sychomotor agitation or retardation
- **S**uicidality

Risk Factors

- **Sex** - women are at greater risk
- **Age** - 18-44 years of age have the greatest risk
- **Family history** - genetic factors account for 40% of developing depression
- **Early parental death**
- **Low confidence**
- **Chronic exposure to stress**

What are some diseases that are caused by issues with neurotransmitters?

What happens in the brain during depression?

- A complex relationship seems to lie between **norepinephrine**, **serotonin**, and **dopamine**, all which must exist in a balance
  - For example, lower levels of **serotonin** have been observed, and low levels of a serotonin byproduct have been linked to a **higher risk for suicide**
  - Increased release of **norepinephrine** can trigger feelings of **anxiety** and have been linked with **some types of depression**
- Changes have also been studied in the brain's structures
  - Loss of **hippocampal mass** (responsible for **processing long-term memory**) is affected by high levels of stress
  - Over-activation of the **amygdala**, (emotions like fear, joy, and anger) **stays high even after long-term recovery from depression**

Depression: Myths and Misconceptions

Myth #1: Depression and sadness are the same.

- While an overwhelming sense of sadness is often a symptom of depression, they are not one and the same. Sadness is fleeting and temporary, but depression is a severe and persistent medical illness that interferes with one's ability to work, sleep, study, eat, and enjoy life.

Myth #2: Depression is a sign of mental weakness.

- This stigma is one of the main reasons why many people resort to suffer in silence rather than to seek help. No one chooses to develop depression. Would you think someone who suffers from Alzheimer's disease, a broken bone, asthma, diabetes, heart disease or osteoporosis as 'weak'?

What to do if *you are depressed*

- **Individual therapy** can help you explore and understand your thoughts, feelings, and behaviors, build coping skills, and learn how to manage your depression in healthy ways.
- **Group therapy** has the same goals and benefits as individual therapy. And many people find connecting with other people who are experiencing depression to be extremely powerful.
- **Medications** like antidepressants and mood stabilizers can't cure depression, but they do help some people manage their symptoms. Taking medication is a personal choice you make with your doctor.
- **Peer-to-peer support groups** like provide safe, confidential spaces for people to learn, share, and grow together. They also foster a sense of community and connection — which can help remind people living with depression that they're not alone.
- **Healthy lifestyle changes** like eating healthier and exercising more can help some people find relief from mild to moderate symptoms of depression.

Depression: Myths and Misconceptions, cont.

Myth #3: Depression isn't a real medical illness.

- While its symptoms may be difficult to examine, people with depression actually have physical differences in their brain and neurotransmitter imbalances that directly determine their condition.

Myth #4: Depression "goes away by itself."

- Like any medical condition, the longer one goes without treatment, the harder it often is for the individual to recover. Depression requires ongoing treatment and support and will not go away by itself.

Generalized Anxiety Disorder

- **Generalized anxiety disorder (GAD)** is characterized by excessive, poorly controlled anxiety and worry on a majority of days, lasting for **at least 6 months** and adversely affecting the patient's life.
- Accompanying features include restlessness, fatigue, difficulty concentrating, irritability, increased muscle tension, and sleep disturbance

What to do if *someone tells you they are depressed*

- **Learn about depression**
  - Take time to find out about depression and how it can be treated.
- **Listen with an open mind**
  - When someone tells you they're depressed, one of the most meaningful things you can do is listen without judgement. Don't try to give advice — just help them feel heard, understood, and accepted.
- **Help them get help**
  - Let them know that depression is common — and that help is available. Encourage them to reach out to a doctor or therapist, and offer to help them do that if you think it's appropriate.
- **Stay connected**
  - Check in often with the person you're supporting. You may want to ask them how they're doing, invite them to spend time with you, or offer to help with everyday tasks. The important thing is to show up, listen, and show that you care.

GAD Signs

Signs and Symptoms

- Restlessness
- Difficulty concentrating
- Fatigue
- Irritability
- Impatience
- Easily distracted
- Muscle tension
- Trouble falling asleep or staying asleep
- Excessive sweating
- Stomach ache
- Headache
- Diarrhea

Risk Factors

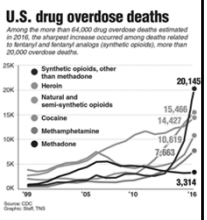
- ***Age:*** Most GAD diagnosis occur in someone's 20s
- ***Gender:*** GAD is approximately twice as common in women than in men
- ***Genetics:*** Approximately 25% of first-degree relatives of people with GAD are also affected
- ***Physical illness***: GAD occurs in 14% of patients with diabetes.
- ***Stress***: Stress may cause or exacerbate GAD.
- ***Substance abuse:*** Cocaine, other stimulating substances, nicotine, or cannabis usage may predispose to GAD.

Generalized Anxiety Disorder: Complications

- **Suicide:** People with GAD are 1.5x as likely to commit suicide.
- **Substance abuse:** Patients have a more than threefold risk of dependence on alcohol or drugs of abuse.
- **Work and interpersonal difficulties:** Patients may have a high rate of disruption and conflict at work and may need special support measures. GAD can severely disrupt interpersonal and marital relationships

America's Opioid Epidemic

- The misuse of and addiction to opioids—including prescription pain relievers, heroin, and synthetic opioids such as fentanyl—is a serious national crisis.
- New Jersey has the **2nd lowest opioid prescription rate** but h**igher than average death rate**. Why?
- Devastating consequences include:
  - Increases in **opioid misuse** and related **overdoses.**
  - Rising incidence of **neonatal abstinence syndrome** due to opioid use and misuse during pregnancy.
  - Increase in injection drug use contributing to the spread of infectious diseases including **HIV and hepatitis C**.



GAD: Myths and Misconceptions

Myth # 1: Anxiety is not a "real" illness.

- Everyone feels anxious or worried at times. Anxiety helps you respond appropriately to real danger, and it can help motivate you to excel at work and at home.
- However some individuals feel very anxious without reason and these worries may disrupt their daily life. Generalized anxiety disorder causes excessive or unrealistic anxiety and worry — well beyond what's appropriate for a situation.

Myth #2: Someone with anxiety should avoid situations that cause stress.

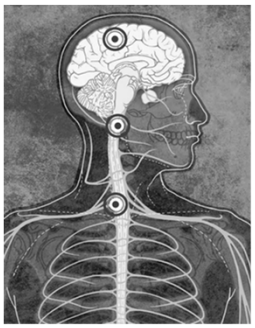
- Life is full of stressful unexpected situations. Developing the habit of avoiding things that you know cause anxiety - like crowds of people, open spaces, or spiders - just reinforces the anxiety disorder. Effective anxiety treatment involves gradually and safely exposing you to the source of your anxiety so that you can learn to cope with it, not avoid it.

https://www.youtube.com/watch?v=oHlaz0kQjRE *Note 115 people die daily in 2018…not 90"

What to do if *you have GAD*

Treatment with **medication** combined with **cognitive behavioral therapy (CBT)** may offer the best chance of remission!

- **Psychotherapy**
- **Medications**
  - Anti-anxiety (benzodiazepines)
  - Antidepressants
- **Coping Skills**
  - Join an anxiety support group
  - Breaking the cycle – when you feel anxious take a brisk walk or other activity to keep your mind off your worries
  - Socializing
  - **Don't dwell on past concerns**



OPIOIDS IN THE BODY

Opioid receptors are located in the brain, brain stem, spinal cord, intestines, and other organs. When endorphins, our body's naturally made opioids, are released or when opioid drugs, including medications, are taken, they bind to opioid receptors in the brain and body to regulate functions including pain, pleasure, breathing, and digestion.

BRAIN: There are opioid receptors throughout the brain, including in the cerebral cortex, cerebellum, nucleus accumbens, ventral tegmental area, substantia nigra, and hypothalamus of the brain. These areas are involved in pain perception, emotion, and reward (pleasure). The activation of the reward center is the primary reason opioids can lead to addiction.

BRAIN STEM: When opioids bind to receptors in the brain stem, breathing slows down, which creates a feeling of relaxation. This reaction to opioids is the reason an overdose can cause a person's breathing to stop.

SPINAL CORD: The opioid receptors in the spinal cord reduce pain signals from an injury, sickness, or surgery. This interference in pain perception is the intended function of prescription opioids.

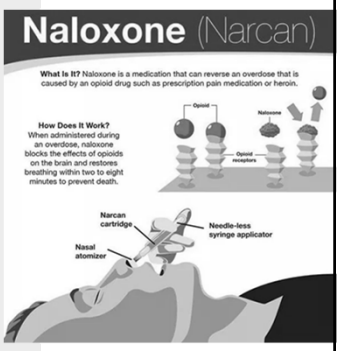
Possible Presenting Signs and Symptoms

- Fade in and out wakefulness
- Flushing of skin
- Dry mouth
- Slowed breathing
- Constricted pupils
- "Heavy" extremities
- Nod off suddenly
- Unclear thinking
- Itching
- Vomiting
- Nausea
- Constipation

The major risk is **depression of breathing** which can lead to death.

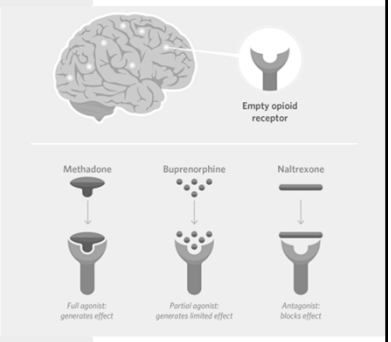
What are some things that may help fight against the opioid epidemic?

Emergency Opioid Treatments



Questions?

Opioid Treatments



References

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- Project, T. G. (2016, June 08). This Is How You Teach Kids About Consent. Retrieved February 18, 2018, from https://www.huffingtonpost.com/good-men-project/this-is-how-you-teach-kids-about-consent_b_10360296.html
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NOTES

Michael R. Feravolo, RN, BA, BSN, HSEP

Michael Feravolo is the Coordinator of University Hospital's Office of Disaster Preparedness. He has an extensive background in emergency management and disaster preparedness that spans a 20 year career. His current duties include: disaster preparedness, coordination of disaster response and crisis management activities and conducting drills and exercises to evaluate policies and plans.

Past employment includes working for the Federal Emergency Management Agency (FEMA) and the New Jersey State Police Office of Emergency Management. He also held the position of Director of Emergency Management in his Morris County township for a period of 5 years. Michael has worked and coordinated numerous federally declared disasters that have occurred in the State of New Jersey and New York which included multi-million dollar recovery and mitigation projects.

Michael is a multi-disciplined instructor specializing in hazardous materials, incident command, emergency management and disaster response. He espouses the phrase: "No matter who you are or where you live; always have a plan"

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Newark, New Jersey

The Ever Changing Landscape of Hospital Emergency Preparedness

Pre-Medical Honors Program 2018
10/17/18

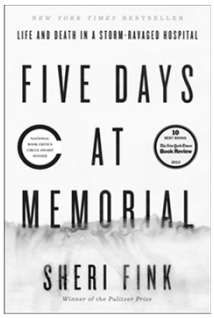
MICHAEL FERAVOLO
COORDINATOR – EMERGENCY MANAGEMENT

The ever changing Landscape of Hospital Emergency Preparedness

Defining Disaster

The term "disaster" denotes a low-probability but high-impact event that causes a large number of individuals to become ill or injured.

Hospital Emergency Preparedness



Memorial Hospital in New Orleans, commonly called Baptist Hospital; remained an island for days after Hurricane Katrina made landfall.

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Diminished Resources significantly compromised patient care and later proved tragic

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Memorials Chapel was used as a temporary morgue for which over a dozen bodies were held.

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Extreme Circumstances-Extreme Measures

When evacuations were done, 45 patients had not made it out alive. The State of Louisiana began an investigation; forensic consultants determined that 23 corpses had elevated levels of morphine and other drugs, and decided that 20 were victims of homicide.

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New Jersey's Response to Katrina

- NJ Urban Search and Rescue
- University Hospital EMS Special Operations
- Numerous Law Enforcement Agencies
- Regional Red Cross

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What did we learn in the aftermath of Katrina?

- The local government was unprepared
- Lack of Strategic Planning resulted in delayed rescue efforts
- Logistical issues resulted in scarce resources
- State and Federal aid delayed due to poor intelligence, communication and coordination
- Many of the patients at Memorial were disproportionally old and acutely ill with some nearing end of life

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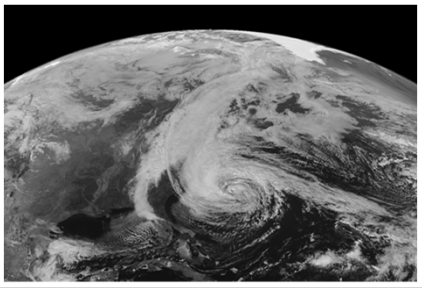
GOES Weather Satellite Imagery of Hurricane Sandy



Lessons Learned

Hospitals cannot due it alone!

Improvements in Preparation, Response and Recovery to Super Storm Sandy

- Improvements in hospital emergency preparedness and continuity of operations plans
- Enhanced coordination between the federal government, state and local authorities
- Strategic deployment of resources
- Improved communication and coordination with hospital staff
- Future grant funding to support response and recovery missions in the wake of disasters

"I can't even imagine what the state would be like without the Task Force in hurricane Sandy," said John Grembowiec, chairman of the NJEMSTF. "I would challenge anyone to say we haven't used our grant funds wisely."

Mission of the New Jersey EMS Task Force

"To provide New Jersey and the region with a highly trained, equipped and specialized EMS resource to support operations at major incidents and preplanned events using a well coordinated, robust all hazards approach through the State's Emergency Management System."

- Incident Advance Team
- Planning Team
- Staging and Accountability Team
- Mass Care Specialists
- Communication and Technology Specialists
- Safety
- Physician Response Team

Mobile Ambulance Buses were used to evacuate many patients from affected facilities

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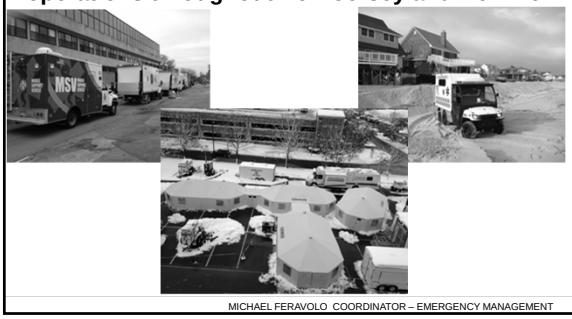
NJ EMS Task Force Assets Supported operations throughout New Jersey and New York



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Hurricane Harvey

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Emptying even a modest-sized hospital during a disaster often requires a vast logistical effort and the cooperation of ambulance teams and other hospitals."

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Additional Challenges now and in the future

- Resuming healthcare systems functionality
- Transferring digital medical records to receiving hospitals
- Surge capabilities and expanded treatment areas
- Supplies and resources
- Dealing with the emotional and psychological impact
- Financial recovery
- Increased illness in the community

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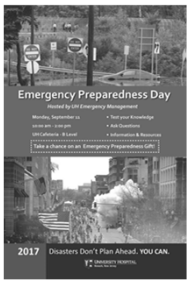
What is UH doing to improve preparedness?



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Constant Vigilance

- Review Emergency Operations Plans
- Conduct periodic Hazard Vulnerability Analysis
- Test and evaluate current plans
- Maintain resources
- Partnership with local, county, state agencies and hospital coalitions

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Questions & Comments

NOTES

Nancy D. Connell, Ph.D.

Dr. Nancy Connell had served for a number of years as Professor and Vice Chair in the Department of Medicine at Rutgers- New Jersey Medical School, as well as the Director of the Center for Emerging and Re-emerging Pathogens. She received her B.A. degree in music and the classics from Middlebury College. She later earned her Ph.D. in bacterial genetics at Harvard University where she studied gene expression during the stationary phase of growth in Escherichia coli. She then held a post-doctoral position at the Albert Einstein College of Medicine of Yeshiva University in the laboratory of Dr. Barry Bloom where she developed live recombinant vaccines.

In 1992, Dr. Connell joined the Department of Microbiology and Molecular Genetics at UMDNJ-New Jersey Medical School. Dr. Connell's major research focus has focused on the interaction between respiratory infectious agents and the macrophage. Using genetic and cell biological approaches, her laboratory focuses on intracellular metabolism of Mycobacterium tuberculosis. She has a joint appointment in the Department of Medicine. In addition to mycobacterial metabolism, her laboratory has been examining the molecular basis of resistance in multi-drug resistant strains of Mycobacterium tuberculosis. She is also Director of the Biosafety Level Three (BSLIII) Facility of the Rutgers-Center for the Study of Emerging and Re-emerging Pathogens and chairs the University's Institutional Biosafety Committee. Dr. Connell's interest in biological

weapons research and policy issues began in the 1980s, when she chaired the Biological Weapons subcommittee of the Council on responsible Genetics. She has served on a number of committees of the National Academy of Sciences, including the Committee on “Advances in Technology and the Prevention of their Application to Next Generation Bio-warfare Agents” (2004) and the “Review of the Scientific Approaches used During the FBI's Investigation of the 2001 Bacillus Anthracis Mailings” (ongoing).

Finally, Dr. Connell has been working many years in the area of the control of proliferation of biological weapons. She serves on the Federation of American Scientists Working Group on Biological and Toxic Weapons Verification and has testified before Congress and served as a contributor to the Henry L. Stimson Center’s Chemical and Biological Weapons Nonproliferation Project. Today, Dr. Connell serves as both Professor Emerita in the Division of Infectious Diseases for the Department of Medicine at Rutgers-New Jersey Medical School and as Senior Scholar at the Johns Hopkins Center for Health Safety of Johns Hopkins University. **E-mail: nancyconnell@jhu.edu**

Biological and chemical weapons: what we need to know

Rutgers New Jersey Medical School
Pre-Medical Honors Program, 2018

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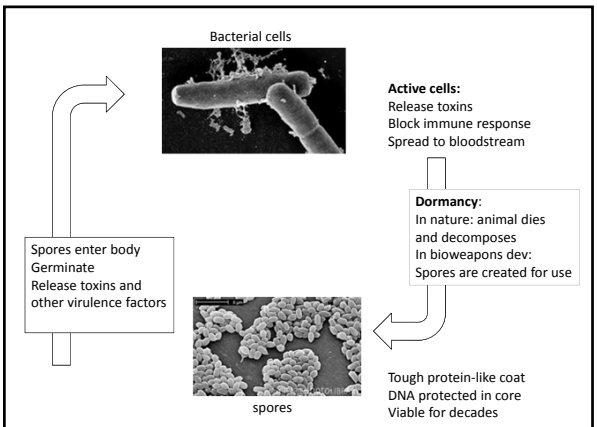


- What are biological and chemical weapons?
- Do you know any examples of their use?
- Left side of room: biological
- Right side of room: chemical

Sverdlovsk Investigation

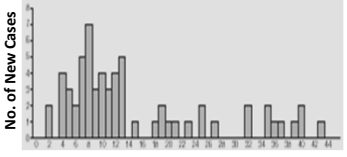
Compound 19

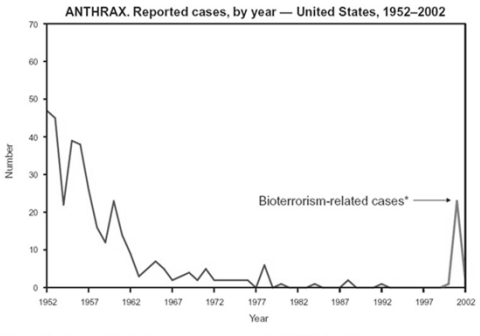
THE ANTHRAX ATTACKS OF 2001, AN UNSOLVED MYSTERY:

basic science and forensics

Sverdlovsk

Accident: April, 1979; 1 gm spores; at least 64 deaths; extensive decontamination

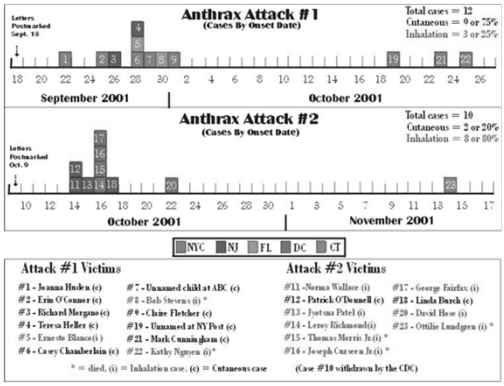


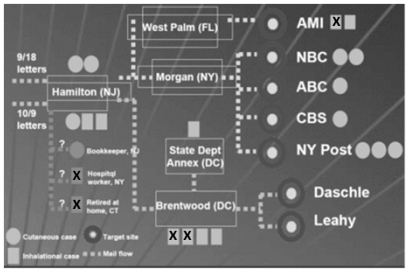


* One epizootic-associated cutaneous case was reported in 2001 from Texas.

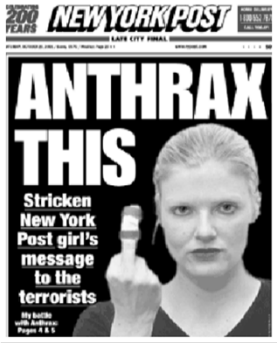
Two cases of cutaneous anthrax were reported to CDC in 2002. One case occurred in a laboratorian who had been processing environmental samples for *Bacillus anthracis* in support of investigations of the bioterrorist attacks in the United States during fall 2001. The other was a naturally occurring case in a veterinarian who was performing a necropsy of a cow.

Source: Morbidity and Mortality Weekly Report 51(53) 37, 2004.





Source: CDC. This image is a work of the CDC taken or made during the course of an employee's official duties. As a work of the U.S. Federal Government, the image is in the public domain.



09-11-01
THIS IS NEXT
TAKE PENACILIN NOW
DEATH TO AMERICA
DEATH TO ISRAEL
ALLAH IS GREAT

small discussions

- Come up with a list of all of the approaches that might be used to analyze the evidentiary material:

FBI investigation

- 7 years
- 600,000 person hours
- 17 special agents, 10 US postal inspectors
- 10,000 witness interviews, 80 searches
- 26,000 email reviews
- 4 million MB of computer memory
- 6,000 items of potential evidence
- 5,750 grand jury subpoenas
- 5,730 environmental samples from 60 sites
- More than 1,040 individuals scrutinized, 400 in-depth
- Cooperation of 29 labs (gov't, academic and commercial)

Focus of NRC committee's scientific review

- Application of of biological, physical and chemical science to:
  - Evidentiary material from four letters
    - Brokaw – some material lost when opened
    - Post – found unopened
    - Daschle – some material lost when opened
    - Leahy – found unopened
  - Collection and analysis of environmental samples
  - Analysis of flask at USAMRIID "RMR-1029"
  - Collection and analysis of samples in FBI Repository

Who were involved??

- FBI
- CBRN Science Unit
- USAMRIID
- Los Alamos Nat'l Labs
- Lawrence Livermore Nat'l Labs
- Sandia Nat'l Labs
- Pacific Northwest Nat'l Labs
- Battelle Memorial Institute
- CDC
- Armed Forces Institute of Pathology
- Edgewood Chemical Biological Center
- National Bioforensic Analysis Center
- National Center for Agricultural Utilization Research
- Dugway Proving Ground
- The Institute for Genomic Research
- Northern Arizona University
- Commonwealth Biotechnologies Inc
- IIT Research Institute
- Midwest Research Institute
- Woods Hole Oceanographic Institute
- University of Maryland
- University of Utah
- University of Cincinnati
- Applied Biosystems
- Novozymes Biotech, Inc

Physical and chemical analyses

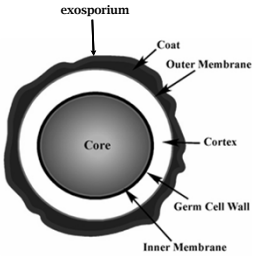
- 1. spore preparation and purification
- 2. surrogate preparation and purification
- *3. size and granularity of letter material*
- 4. silicon and other elements
- *5. silicon in spore coat*
- 6. elemental analysis

Physical and chemical analyses

- 7. bacterial growth conditions
- 8. media component analysis
- 9. volatile organic compounds
- *10. radiocarbon dating*
- *11. stable isotope analysis*
- 12. water samples
- 13. envelope measurements

Silicon in spore coat

- High resolution SEM-EDX of Leahy and NY Post gave similar results: Si was present in spore coat but not in the exosporium (outermost layer) where a dispersant would reside
- Bulk elemental analysis by ICP-OES of 10 of 36 surrogate preps with no dispersant: Si was found to be in range of wt percent, mostly 2-5 %

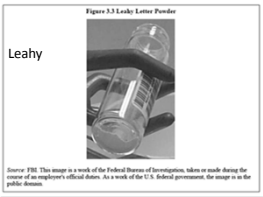


Esther Angert

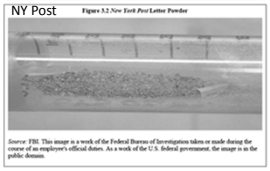
http://www.micro.cornell.edu/cals/micro/research/labs/angert-lab/index.cfm

Size and granularity

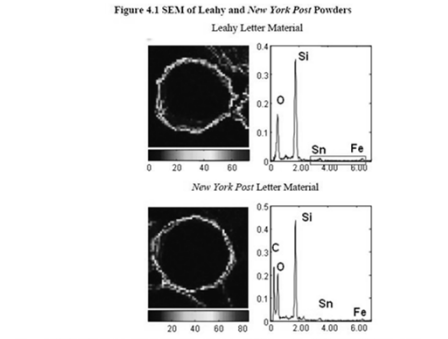
Leahy



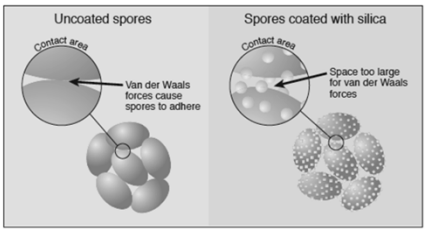
NY Post



- SEM analysis of letter material: single spores and clump
- Commercial instruments to measure particle size, weight and ability to "float" (aerodynamic properties)
- Daschle and Leahy: bimodal size distribution(1.5 um ~1% of total)
- Surrogates: similar to letter material in size, granularity and aerodynamic properties*
- *Consistent with notion that silicon/additive not required to make good spores



Source: SNL. This figure is the work of Sandia National Laboratories, taken or made during the course of an employee's official duties. As a work of the U.S. Federal Government, the image is in th public domain.



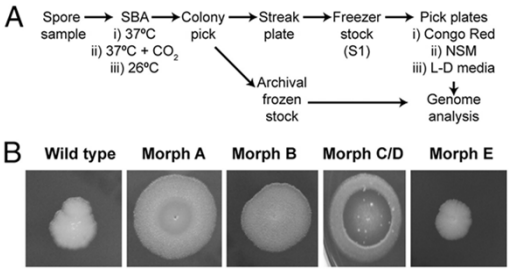
Spacers. U.S. and Soviet bioweapons specialists discovered that adding silica particles to germ powders made them easier to disperse.

Matsumoto, Science 2003

Determining when the material was produced: radiocarbon dating of Leahy material

- Two institutions
  - LLNL Center for Accelerator Mass Spectrometry
  - National Ocean Sciences AMS facility (Woods Hole)
- Assignment of actual calendar dates is complicated by incorporation of fossil fuels
- Both analyses agreed: *the Leahy sample was produced between 1998 and 2001*

Microbiological identification of morphological variants of *B. anthracis* Ames



Rasko D A et al. PNAS 2011;108:5027-5032

PNAS

Distribution results in the 947 samples

A1	A3	MRI-D	E	count
positive	positive	positive	positive	8
positive	positive	positive	-	2
positive	positive	-	-	2
positive	-	positive	-	4
-	positive	-	positive	3
-	-	positive	positive	2
positive	-	-	-	11
-	positive	-	-	1
-	-	positive	-	35
-	-	-	positive	3
-	-	-	-	876
			Total	**947**

- means negative result

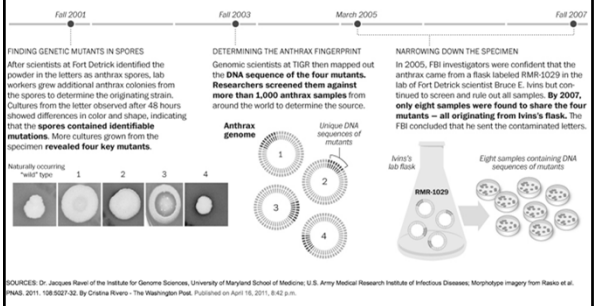
•Individuals colonies were expanded and sequenced in entirety to identify specific genetic mutations

Distribution of the morphotypes in letter material:

letter	A1	A3	D	E
Leahy	+	+	+	+
Daschle	+	+	NT	+
NY Post	+	+	NT	+
Brokaw	NT	NT	NT	NT

Determining the source of the anthrax letters

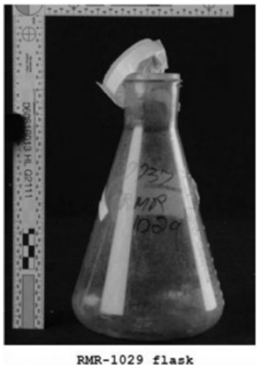
Scientists and researchers at Fort Detrick and the Institute for Genomic Research (TIGR) worked collaboratively to determine the origin of anthrax sent in letter attacks during the fall of 2001. Based on sample analysis conducted in their labs, investigators with the Federal Bureau of Investigation concluded that Fort Detrick researcher Bruce E. Ivins was the culprit. Some critics question whether the FBI's search was exhaustive enough to rule out other labs that might have had access to the anthrax.



SOURCES: Dr. Jacques Ravel of the Institute for Genome Sciences, University of Maryland School of Medicine; U.S. Army Medical Research Institute of Infectious Diseases; Morphotype imagery from Rasko et al. PNAS. 2011. 108:5027-32. By Cristina Rivero - The Washington Post. Published on April 16, 2011, 8:42 p.m.

Creation of the FBI Repository

- At time of the mailings, there was no record of what labs possessed anthrax - just transfer
- FBI sent out subpoenas Feb 2002
- 20 labs (15 domestic, 2 foreign, USAMRIID, DPG and BMI)
  - Consent searches at USAMRIID, Dugway and Battelle
- Of 1,070 samples, 1,059 were viable



RMR-1029 flask

http://www.justice.gov/amerithrax/ exhibit E

- The results of the repository screening were *consistent* with the finding that the spores in the attack letters were derived from RMR-1029, but the analyses did not *definitively* demonstrate such a relationship

Summary of investigative evidence implicating Dr. Ivins

- Opportunity (RMR1029; alone in lab)
- Motive (failing vaccine program; personal revenge)
- Mental health struggle ("homicidal" "sociopath")
- Proximity to source of envelopes (local batch)
- Language used in the letters (emails)
- Guilty conscious (emails, trash, shifting blame)
- History of disguising identity (pseudonyms)
- Obsessive behavior (KKG sorority)
- Inability to describe/explain his own behavior

Estimated Casualties From Gas during WWI

Country	Total Casualties	Death
Austria-Hungary	100,000	3,000
British Empire	188,706	8,109
France	190,000	8,000
Germany	200,000	9,000
Italy	60,000	4,627
Russia	419,340	56,000
USA	72,807	1,462
Others	10,000	1,000

Source: ICRC

Previous uses of biological agents in warfare

- Pre-Geneva Convention:
  - Tatars
  - Lord Jeffrey Amherst
  - WWI
- Post-Geneva Convention
  - WWII offensive programs
  - Domestic/terrorism

Programs during World War II

- Mass-produced, battle-ready biological weapons in the form of agents that cause: anthrax, tularemia, brucellosis, Q-fever, VEE, botulism, and SEB
- Attempted weaponization: smallpox, EEE and WEE, AHF, Hantavirus, BHF, Lassa fever, glanders, melioidosis, plague, yellow fever, psittacosis, typhus, dengue fever, Rift Valley fever (RVF), CHIKV, late blight of potato, rinderpest, Newcastle disease, bird flu, and the toxin ricin.

Source: Croddy, Eric C. and Hart, C. Perez-Armendariz J.2002.

International actions to limit or prevent biological weapons before WWI

- **1899 and 1907 Hague Conventions**
- **Geneva Protocol, 1925: "no first-use"**

U.S. Program:

Testing BW agents on unsuspecting populations

- **San Francisco, 1950**
  - ***Bacillus globigii* and *Serratia marcescens***
- **Minneapolis and St. Louis 1952-1953:**
  - **zinc cadmium sulfide**
- **NYC subway system, 1966:**
  - ***Bacillus subtilis***
    - **Clouds of Secrecy: The Army's Germ Warfare Tests over Populated Areas, by L. A. Cole**

U.S. renounces BW program

- Nixon ordered review of entire BW program
- concluded that BW were tactically inadequate:
  - latency between exposure and onset
  - difficulty in confining effects to target area
  - increasing antiwar sentiment
- November 1969: unconditional, unilateral renouncement of biological weapons
- February 1970: extended to include toxin agents

Article I of the Biological Weapons Convention

Each State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:

(1) Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;

(2) Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.

The Articles

i. No microbial or other biological agents, or toxins that have no justification for prophylactic, protective or other peaceful purposes

ii. Destroy or divert to peaceful purposes all agents in its possession or under its jurisdiction or control

iii. Not to transfer, assist, encourage or induce to acquire any of these agents

iv. Take all necessary measures to prohibit and prevent the development, production, stockpiling, acquisition, or retention of the agents under its jurisdiction and control anywhere

v. Parties to the Convention must consult one another and cooperate in solving any problems which may arise in relation to the objectives of the Convention

vi. Any party which finds that any other party is acting in breach of obligations to the provisions of the Convention may lodge a complaint with the UN Security Council

vii. Each party undertakes to provide or support assistance if the Security Council decides that a party has been exposed to danger as a result of the violation of the Convention

viii. Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any Party under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous, or Other Gases, and Bacteriological Methods of Warfare (Geneva, 1925)

ix. Each Party affirms the recognized objective of effective prohibition of chemical weapons and undertakes to continue negotiations in good faith

x. All Parties undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological agents and toxins for peaceful purposes

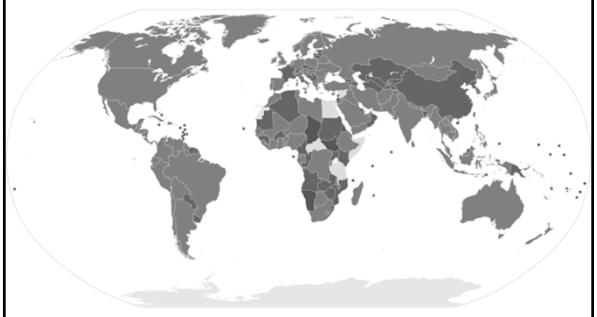
xi. Parties may propose amendments to this Convention

xii. Five years after the entry into force of this Convention, or earlier if requested, a conference of States Parties to the Convention shall be held in Geneva to review the operation of the Convention. Such review shall take into account any new scientific and technological developments.

xiii. This Convention shall be of unlimited duration and every Party has the right to withdraw if it decides that extraordinary events, related to the subject matter of the Convention, have jeopardized the supreme interests of its country

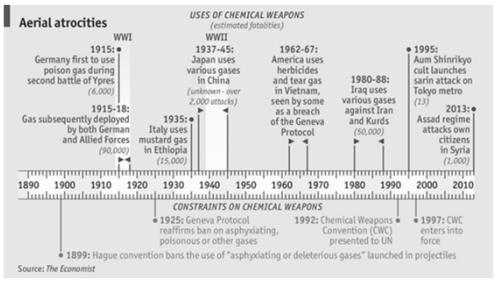
The Biological Weapons Convention

- **Drafted 1972**
- **Signed 1972**
- **Effective 1975**
- **# of parties: 178**
  - **Non-signatories: Chad, Comoros, Djibouti, Eritrea, Israel, Kiribati, Micronesia, Namibia, Niue, Samoa, South Sudan, Tuvalu**



Chemical Weapons Convention

- **Drafted 1992**
- **Signed 1993**
- **Effective 1997**
- **# of parties: 192**
  - **Non-signatories: Egypt, Israel, North Korea and South Sudan.**



Parameters	Chemical Weapons	Biological Weapons	Implications for BWC Monitoring
Agent types	Man-made toxic chemicals that do not exist in the natural environment.	Pathogenic microbes and toxins produced by living bacteria, plants, and animals.	Disease agents can be cultivated for legitimate purposes, such as vaccine production, complicating the process of BWC compliance monitoring.
Range of agents potentially suitable for military use	Relatively few chemicals have the necessary toxicity and physical properties, but the development of novel agents is possible.	The range of potential agents is nearly unlimited because of the occasional emergence of natural diseases and the potential for genetic manipulation of microorganisms and toxins.	The broad, purpose-based coverage of the prohibitions in Article I of the BWC (the "general-purpose criterion") must be preserved.
Militarily significant quantity of agent	80 to 1,000 metric tons of chemical agent, depending on type and lethality.	Kilograms to tens of kilograms of agent, depending on type and lethality.	Militarily significant production of biological and toxin agents in small-scale facilities may elude detection. Stockpiles may also be small enough to permit easy concealment.
Stockpiling requirement	Must be stockpiled in multi-ton quantities in stabilized or binary form, or produced in large volume prior to use.	Militarily significant quantities of agent can be produced to order in a few days or weeks, obviating the need for long-term storage.	Dual-use production facilities such as vaccine plants may have a "latent" capacity to produce biological agents in wartime.
Peaceful medical applications of agents and materials	Very small quantities of some Schedule 1 chemicals (e.g., nitrogen mustard, saxitoxin, ricin) are used in biomedical research and medical therapeutics.	Microbial pathogens may be grown in large quantities for the production of vaccines. Also, natural toxins such as botulinum and ricin are increasingly used in medical therapeutics.	Production of microbial pathogens and toxins for legitimate medical uses may serve as a cover for acquiring a biological-weapons capability.

Jonathan tucker

"The next epidemic could originate on the computer screen of a terrorist intent on using genetic engineering to create a synthetic version of the smallpox virus ... or a super contagious and deadly strain of the flu."

Bill Gates, Feb 17, 2017

Conclusions

- Chemical and Biological weapons remain a threat
- We are all responsible for supporting the existing treaties that were designed to prevent use of these weapons
- Understanding science and how it can be used for *good* – not *evil* – is our responsibility as doctors and scientists around the world

NOTES

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