

**Understanding the Impact of Concussions:
From Injury through Recovery**

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Outline

- Concussions
 - Brief history
 - Definition
 - Pathophysiology
 - Signs and symptoms
- Management
 - Acute
 - Clinical evaluation
 - Behavioral Management
- Risk Factors
 - Post-traumatic and premonitory
- When to ask for help

A brief history of concussion

3000 bce 415 bce 1600s ce 18th century

1700 bce 1st century 1700s-1800s present

What is a concussion?

According to the CDC:

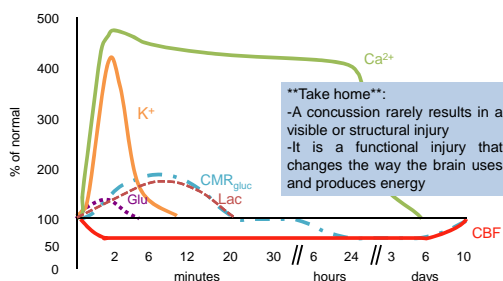
- A **complex pathophysiological process affecting the brain**, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head. Disturbance of brain function is related to **neurometabolic dysfunction**, rather than structural brain injury, and is typically associated with normal structural imaging findings (CT Scan, MRI).



- Concussion may or may not involve a loss of consciousness.
- **Concussion results in a constellation of physical, cognitive, emotional, and sleep-related symptoms.** Recovery is a sequential process and symptoms may last from several minutes to days, weeks, months, or even longer in some cases."

Neurometabolic Cascade

The "Complex Pathophysiological Process"



****Take home**:**
 -A concussion rarely results in a visible or structural injury
 -It is a functional injury that changes the way the brain uses and produces energy

(Giza & Hovda, 2001)

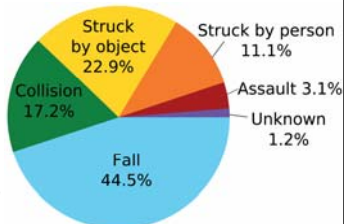
What is a concussion?

• Epidemiology

- 100-300/100,000 worldwide based on ER admissions only

- Total estimates are 600/100,000
 • Holm et al., 2005


- More likely in those who have already been concussed*
 • Quigley, 1945; Thorndike, 1952



Kozlowski et al., 2007

Signs

- Immediate markers (signs)
 - Loss of Consciousness
 - Retrograde Amnesia
 - Anterograde Amnesia
 - Disorientation/ Confusion



Symptoms

Factor Analysis, Post-Concussion Symptom Scale (Kontos et al., 2012; Pardini et al. 2004)

NEUROPSYCHIATRIC

- Increased lability
- Sadness
- Nervousness/Anxiety
- Irritability

COGNITIVE SYMPTOMS

- Attention Problems
- Memory dysfunction
- "Fogginess"
- Fatigue
- Cognitive slowing

MIGRAINE (PHYSICAL SX)

- Headaches
- Visual Problems
- Dizziness
- Noise/Light Sensitivity
- Nausea

SLEEP DISTURBANCE

- Difficulty falling asleep
- Sleeping less than usual

N=15,000 High School and University Athletes within 24-72 hours of concussion
 N=327, High School and University Athletes Within 7 Days of Concussion

Commonly Reported Symptoms

High School and College Athletes (within 3 days of injury)

#1	Headache	71%
#2	Feeling Slowed Down	58%
#3	Difficulty concentrating	57%
#4	Dizziness	55%
#5	Fogginess	53%
#6	Fatigue	50%
#7	Visual Changes (double/blurring)	49%
#8	Light Sensitivity	47%
#9	Memory Dysfunction	43%
#10	Balance Problems	43%

Lovell, Collins et al., 2004; N = 215

Why should mental health care practitioners care?

- Summary of Mental Health Sequelae of TBI
 - Patients with TBI have higher rates of depression, substance abuse, aggression, and impulsivity prior to injury.
 - TBI associated with 2-4 increased risk for suicide attempts, suicide, and psychiatric disorder
 - Highest risk for suicide and attempt in those with both TBI and psychiatric disorder
 - Role of worthlessness, hopelessness, belonging, support, perception of functional impairment
 - Inter-relationship of sleep, HA, depression, PTSD, and suicidality
 - Multiple concussions increase risk for depression and suicidality
 - Associated with neurocognitive impairment in memory, executive function, inhibition

Why should mental health care practitioners care?

- mTBI + adolescence = the perfect storm?
 - **Distress:** headache, depression, reaction to school difficulties, and loss of activity
 - **Disinhibition:** difficulty with prefrontal cortical activity to inhibition action, negative emotion
 - **Development:** On top of developmentally immature brain with increase drive for reward relative to capacity to inhibit

Now What?

HOW TO HELP THE CONCUSSED ADOLESCENT

Concussion Management

<p>The old mentality:</p> <ul style="list-style-type: none"> • Rest is the best treatment <ul style="list-style-type: none"> – Symptom provocation is a sign of continued impairment – Symptoms are treated with rest: <ul style="list-style-type: none"> • Physical: complete rest • Cognitive: no/minimal school 	<p>Why the change?</p> <ul style="list-style-type: none"> • Rest seems to work initially (first 3-5 days) post-injury <ul style="list-style-type: none"> – The effects thereafter plateau – Patients with <i>either</i> very low or very high levels of activity have more persistent symptoms <ul style="list-style-type: none"> • Majerske et al., 2008 – Total rest is actually harmful <ul style="list-style-type: none"> • de Kruijk et al., 2002 • Allen et al., 1999
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Concussion Management

- Symptom Management
 - Symptoms are a part of recovery
 - Managing symptoms is crucial to recovery
 - When is it okay to push and when is it time to rest?
 - Using a pain scale

10
9
8
7
6
5
4
3
2
1
0

"Setback/slowing recovery"
"Doing too much"
"Time to rest"
"Functional Symptoms"

Concussion Management

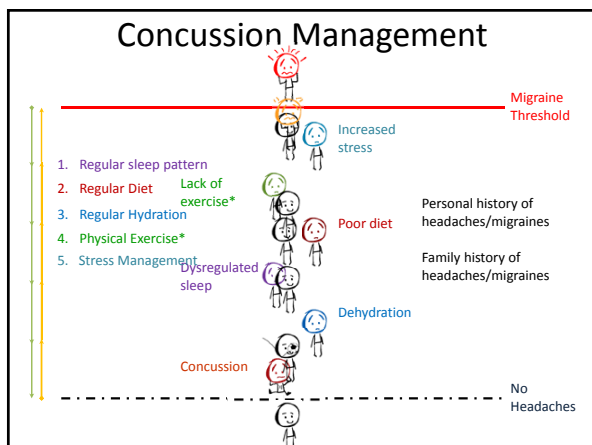
- Over-stimulation has the most profound effect in the acute-subacute post-injury phase
- Little/No stimulation does not bode well for neuropsychological recovery either
- Balance between symptom provocation and rest is difficult, and necessary

10
9
8
7
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5
4
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2
1
0

"Setback/slowing recovery"
"Doing too much"
"Time to rest"
"Functional Symptoms"

Concussion Management

<p>Treatment Model</p> <ul style="list-style-type: none"> • What treatments work in other pathologies? <ul style="list-style-type: none"> – Graded exposure works <ul style="list-style-type: none"> • Anxiety • Chronic pain • Migraine – Approach-Confront strategies are effective in symptom management and treatment <ul style="list-style-type: none"> – Martin, 2010 	<p>In mTBI?</p> <ul style="list-style-type: none"> • The research is limited, but... <ul style="list-style-type: none"> – Modified CBT protocols works in chronic cases (adult samples) <ul style="list-style-type: none"> • Potter & Brown, 2012 • Ferguson & Mittenberg, 1996 • Miller & Mittenberg, 1998 • Leonard & Tucker, 2004 – Physical activity is also beneficial <ul style="list-style-type: none"> • Silverberg & Iverson, 2012 • Iverson et al., 2012 • Leddy et al., 2012
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Influencing recovery:

RISK FACTORS

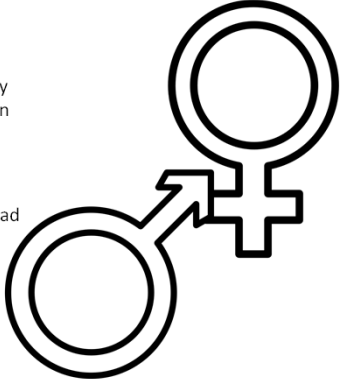
Risk Factors: Incidence

- Injury History
 - The single largest factor in recovery and future incidence
 - Those with prior injuries are more like to be injured in the future
 - Lowered threshold?
 - Personality factors?



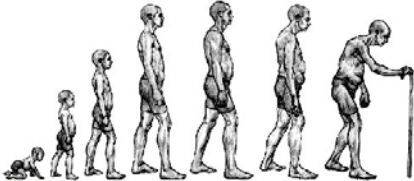
Risk Factors: Incidence

- Gender
 - Females are more likely to sustain injuries when looking at equivalent activities
 - Males sustain more head injuries overall
 - Risk taking behaviors
 - Sports



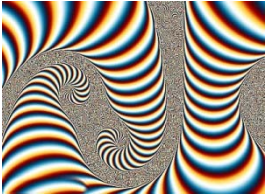
Risk Factors: Incidence

- Age
 - More common in males, teenagers and young adults
 - Children and adolescents make up a larger portion of ER visits
 - Ultimately, the data is inconclusive



Risk Factors: Prolonged Recovery

- Signs/Symptoms
 - Post-traumatic amnesia
 - On field dizziness
 - Subacute “fogginess”
 - Initial impaired neurocognitive performance
 - More severe symptom report
 - LoC is *not* predictive of prolonged recovery



Risk Factors: Prolonged Recovery

- Premorbid Conditions
 - Migraines
 - High overlap between
 - Gordon et al., 2006
 - ADHD/Learning Disability
 - Alosco et al., 2014
 - Hutchinson et al., 2014
 - Depression/Anxiety
 - Hutchinson et al., 2014
- Demographic Factors
 - Age
 - Younger take longer
 - Gender
 - Females take longer

Involving other disciplines:

WHEN TO ASK FOR HELP

Coordinating Care

- Not every patient recovers with time and proper management alone
- Depending on the presenting symptoms, consider adjunct therapies
 - Medications
 - Physical Therapies
 - Psychotherapy

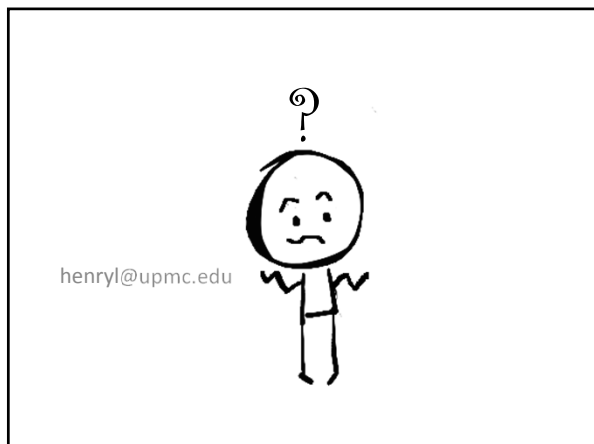


Summary

- Concussions are a neurometabolic injury
 - Energy production and use is impaired
- Presentation and intensity varies
 - HUGE individual differences
 - Incidence and Recovery times are influenced by several factors
- Balance between rest and exposure
 - Over- *and* under-stimulation can be harmful
- In cases of protracted recovery, coordinating care across professionals is necessary

Concussion Resources: CDC Tool Kit

- Three kits with information for physicians, parents, and coaches
- Information on High School and Youth Management of Concussion
- Link to order tool kit:
<http://wwwn.cdc.gov/pubs/ncipc.aspx>



Clinical Management
ANXIETY CASE

Anxiety Case

- 15 year old male
 - Hockey player
 - Struck occipital region to ice subsequent to body check
 - Initial signs
 - disorientation/confusion
 - Initial symptoms
 - Headache
 - Dizziness
 - Mental fogginess
- Biopsychosocial History
 - 1 prior concussions
 - 2 year prior
 - No other relevant history
 - Above average academically
- No treatment for 5 months
 - Academic decline
 - Worsening sleep
 - Panic attacks
 - Diagnosed with migraines and anxiety by pediatrician
 - Maxalt
 - MRI (-)
 - Prism glasses

Anxiety Case

- Presenting Symptoms
 - Headache
 - Photo/phonosensitivity
 - Blurred vision
 - Nausea
 - Numbness & tingling
 - Mentally foggy
 - Memory & attention dysfunction
 - Anxious
 - Mood symptoms

- Treatment recommendations
 - Homebound instruction
 - Vestibular and Vision Therapies
 - Behavioral management
 - Referred for medications
 - Behavioral management
 - Sleep was much improved

Composite Scores	Percentile scores if available are listed in small type.	
Memory composite (verbal)	74	22%
Memory composite (visual)	77	57%
Visual motor speed composite	42.22	85%
Reaction time composite	0.5	92%
Impulse control composite	12	
Total Symptom Score	52	

- Vestibular exam was highly provocative for symptoms
- Near point convergence measured at 29 cm

Anxiety Case

Follow-up #1

- Presenting Symptoms
 - Headache
 - Photo/phonosensitivity
 - Dizziness
 - Dysregulated sleep
 - Difficulty falling and staying asleep
 - Memory & attention dysfunction
 - Anxiety
 - Mood symptoms

- Treatment Recommendations
 - Return to school
 - Modified schedule
 - Continue vestibular therapy
 - Placed on Klonopin & Zoloft
 - Light physical activity

Composite Scores	Percentile scores if available are listed in small type.			
Memory composite (verbal)	74	22%	78	32%
Memory composite (visual)	77	57%	76	54%
Visual motor speed composite	42.22	85%	42.35	85%
Reaction time composite	0.5	92%	0.52	87%
Impulse control composite	12		5	
Total Symptom Score	52		62	

- Vestibular exam was still provocative for symptoms
- Near point convergence measured at 12 cm

Anxiety Case

Follow-up #2

- Presenting Symptoms
 - Headache
 - Photo/phonosensitivity
 - Dizziness
 - Numbness & tingling
 - Memory & attention dysfunction
 - Anxiety
 - Mood

**symptoms reduced with physical activity

- Treatment Recommendations
 - Continued modified school schedule
 - Discharged from vestibular therapy
 - PT's progress notes indicated large functional gains despite symptom report
 - Increase physical activity
 - Psychotherapy

Composite Scores	Percentile scores if available are listed in small type.					
Memory composite (verbal)	74	22%	78	32%	91	80%
Memory composite (visual)	77	57%	76	54%	78	60%
Visual motor speed composite	42.22	85%	42.35	85%	43.43	88%
Reaction time composite	0.5	92%	0.52	87%	0.51	90%
Impulse control composite	12		5		9	
Total Symptom Score	52		62		58	

- Vestibular exam was mildly provocative for symptoms
- Near point convergence measured at 6 cm

Anxiety Case

Follow-up #3

- Presenting Symptoms
 - Headache
 - Photo/phonosensitivity
 - Dizziness
 - Numbness & tingling
 - Memory & attention dysfunction
 - Anxiety
 - Hypervigilance, ruminating
 - Mood
- Treatment Recommendations
 - Continued modified schedule
 - Extremely resistant to full return
 - Increase physical activity
 - Psychotherapy

Composite Scores	Percentile scores if available are listed in small type.								
Memory composite (verbal)	74	22%	78	32%	91	80%	74	22%	
Memory composite (visual)	77	57%	76	54%	78	60%	83	75%	
Visual motor speed composite	42.22	85%	42.35	85%	43.43	88%	48.8	99%	
Reaction time composite	0.5	92%	0.52	87%	0.51	90%	0.46	98%	
Impulse control composite	12		5		9		8		
Total Symptom Score	52		62		58		56		

Anxiety Case

Follow-up #4

- Presenting Symptoms
 - Headache
 - Photo/phonosensitivity
 - Dizziness
 - Numbness & tingling
 - Memory & attention dysfunction
 - Anxiety
 - Hypervigilance, ruminating
 - "something wrong"
 - Mood
- Treatment Recommendations
 - Full days at school
 - Discharged from vestibular therapy
 - Therapist progress notes indicated large functional gains despite symptom report
 - All other therapies/evaluations successfully completed/passed
 - Psychotherapy

Composite Scores	Percentile scores if available are listed in small type.								
Memory composite (verbal)	74	22%	78	32%	91	80%	74	22%	86 64%
Memory composite (visual)	77	57%	76	54%	78	60%	83	75%	64 21%
Visual motor speed composite	42.22	85%	42.35	85%	43.43	88%	48.8	99%	45.15 92%
Reaction time composite	0.5	92%	0.52	87%	0.51	90%	0.46	98%	0.47 97%
Impulse control composite	12		5		9		8		18
Total Symptom Score	52		62		58		56		70

Anxiety Case

Headache	5	3	5	5	2	4	1	1	4	3
Nausea	2	0	2	2	0	0	0	0	2	0
Vomiting	0	0	0	0	0	0	0	0	0	0
Balance Problems	1	0	2	3	9	0	0	0	1	0
Dizziness	4	2	1	1	2	1	0	0	1	0
Fatigue	2	1	3	3	2	3	2	2	1	1
Trouble falling asleep	5	N/A	2	N/A	3	N/A	3	N/A	4	N/A
Sleeping more than usual	3	N/A	3	N/A	0	N/A	2	N/A	4	N/A
Sleeping less than usual	3	N/A	1	N/A	3	N/A	3	N/A	2	N/A
Drowsiness	2	1	4	3	3	3	2	3	3	3
Sensitivity to light	2	2	4	4	5	4	3	4	3	5
Sensitivity to noise	3	1	4	3	1	1	1	0	1	1
Irritability	2	1	3	3	4	4	4	3	4	3
Sadness	2	1	2	4	3	2	3	3	4	3
Nervousness	2	0	2	2	3	2	4	3	3	3
Feeling more emotional	1	0	1	1	1	2	3	2	4	2
Numbness or tingling	1	1	2	3	4	2	3	1	4	3
Feeling slowed down	2	2	5	5	4	6	4	6	4	6
Feeling mentally foggy	2	2	5	4	6	4	6	4	6	4
Difficulty concentrating	3	2	4	5	5	5	5	5	6	5
Difficulty remembering	2	1	4	4	3	3	4	2	4	3
Visual problems	3	2	3	4	4	4	3	4	5	5
Total Symptom Score	52	22	62	58	58	90	56	43	70	50

Anxiety Case #2

- 17 year old female
 - Soccer player
 - Fell and struck back of head to the ground
 - Initial signs
 - Anterograde amnesia
 - Disorientation/confusion
 - Initial symptoms
 - Headache
 - Nausea
 - Dizziness
 - Mental foginess
- Biopsychosocial History
 - Psychotherapy for “adjustment disorder” after parents’ divorce
 - No other relevant history
 - Above average academically
- Seen 1 week after injury
 - Struggling academically
 - Panic attacks
 - PCP referred to concussion clinic

Anxiety Case #2

- Presenting Symptoms
 - Headache
 - Photo/phonosensitivity
 - Blurred vision
 - Nausea
 - Mentally foggy
 - Memory & attention dysfunction
 - Denied feeling anxious
 - Denied mood change
- Treatment recommendations
 - Modified Academic Schedule
 - Vestibular Therapy
 - Behavioral management
 - Referred for medications
 - Behavioral management
 - Sleep was much improved

Composite Scores	Percentile scores if available are listed in small type.	
Memory composite (verbal)	82	35%
Memory composite (visual)	67	31%
Visual motor speed composite	28.58	1%
Reaction time composite	0.68	8%
Impulse control composite	0	
Total Symptom Score	60	

- Vestibular exam was highly provocative for symptoms
- Near point convergence measured at 2 cm

Anxiety Case #2

Follow-up #1

- Presenting Symptoms
 - Headache
 - Dizziness
 - Dysregulated sleep
 - Difficulty falling and staying asleep
 - Memory & attention dysfunction
 - Anxiety was increasing
 - Attributed to school stress
 - Denied mood symptoms
- Treatment Recommendations
 - Continued modified schedule, but increased hours
 - Continued vestibular therapy
 - Light physical activity
 - Recommended psychotherapy

Composite Scores	Percentile scores if available are listed			
Memory composite (verbal)	82	35%	88	51%
Memory composite (visual)	67	31%	75	54%
Visual motor speed composite	28.58	1%	30.65	7%
Reaction time composite	0.68	8%	0.57	44%
Impulse control composite	0		0	
Total Symptom Score	60		74	

- Vestibular exam was still provocative for symptoms
- Near point convergence measured at 2 cm

Anxiety Case #2

Follow-up #2

- Presenting Symptoms
 - Headache
 - Photo/phonosensitivity
 - Dizziness
 - Memory & attention dysfunction
 - Anxiety
 - Mood
- Treatment Recommendations
 - Return to full school schedule
 - Discharged from vestibular therapy
 - Increase physical activity
 - Psychotherapy

Composite Scores	Percentile scores if available are listed in small type.							
Memory composite (verbal)	82	35%	88	51%	85	44%	78	63%
Memory composite (visual)	67	31%	75	54%	30.65	7%	36.95	36%
Visual motor speed composite	0.68	8%	0.57	44%	0.57	44%	0.54	63%
Reaction time composite	0		0		5		0	
Impulse control composite	0		0		5		0	
Total Symptom Score	60		74		69		26	

• Vestibular exam was nonprovocative

Anxiety Case #2

Follow-up #3

- Presenting Symptoms
 - Moderate Headache
 - Mild Photo/phonosensitivity
 - Mild Dizziness
 - Memory & attention dysfunction
 - Anxiety
 - Improving
 - Mood
 - Improving
- Treatment Recommendations
 - Continued full schedule
 - Increase physical activity
 - Psychotherapy

Composite Scores	Percentile scores if available are listed in small type.									
Memory composite (verbal)	82	35%	88	51%	85	44%	96	86%	78	63%
Memory composite (visual)	67	31%	75	54%	30.65	7%	36.95	36%	38.7	42%
Visual motor speed composite	0.68	8%	0.57	44%	0.57	44%	0.54	63%	0.5	85%
Reaction time composite	0		0		5		0		1	
Impulse control composite	0		0		5		0		1	
Total Symptom Score	60		74		69		26		2	

Anxiety Case #2

Follow-up #4

- Presenting Symptoms
 - Denying all symptoms
- Treatment Recommendations
 - Full days at school
 - Psychotherapy
 - Discharged

Composite Scores	Percentile scores if available are listed in small type.									
Memory composite (verbal)	82	35%	88	51%	85	44%	96	86%	95	80%
Memory composite (visual)	67	31%	75	54%	30.65	7%	36.95	36%	40.22	49%
Visual motor speed composite	0.68	8%	0.57	44%	0.57	44%	0.54	63%	0.5	85%
Reaction time composite	0		0		5		0		1	
Impulse control composite	0		0		5		0		1	
Total Symptom Score	60		74		69		26		2	

Anxiety Case #2

Headache	5	5	4	4	5	2	2	0	0
Nausea	3	5	5	2	2	0	0	0	0
Tinnitus	0	0	2	0	0	0	0	0	0
Balance Problems	2	3	3	1	1	0	0	0	0
Dizziness	3	5	5	5	5	1	1	0	0
Fatigue	5	4	3	4	3	1	0	0	0
Trouble falling asleep	5	N/A	4	6	N/A	3	N/A	0	N/A
Sleeping more than usual	2	N/A	3	0	N/A	0	N/A	0	N/A
Sleeping less than usual	4	N/A	4	5	N/A	2	N/A	0	N/A
Drowsiness	3	3	3	4	3	0	0	0	0
Sensitivity to light	4	6	6	3	5	0	0	0	0
Sensitivity to noise	3	3	5	5	3	0	0	0	0
Irritability	0	0	2	5	5	1	1	1	0
Sadness	2	0	3	5	6	5	3	0	0
Nervousness	0	2	3	6	5	3	5	0	0
Feeling more emotional	4	5	4	5	6	5	4	1	1
Numbness or tingling	0	0	0	0	0	0	0	0	0
Feeling slowed down	4	4	3	2	4	0	1	0	0
Feeling mentally foggy	4	3	5	3	2	1	0	0	0
Difficulty concentrating	4	3	5	5	3	2	1	0	0
Difficulty remembering	2	1	4	2	2	0	0	0	0
Visual problems	2	2	3	2	1	0	0	0	0
Total Symptom Score	60	54	74	69	60	20	15	2	1

Anxiety Cases

- Summary
 - Treating psychiatric cases is challenging in patients set on “medicalizing” the problem
 - Patients who are willing to address the issues directly fair better
 - Symptoms get better with treatment
 - Psychotherapy can be a useful adjunct in psychiatric cases (mood or anxiety disorders)
