Chemical Eric:
A Clicker Case
About the
Complexity of
Hormonal
Control

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A Promising Start

He was, his mother always said, the cutest little boy ever, and she had always adored him. So strong, so sturdy, confidently charging through life. At 10, he joined a Little League baseball team and made the All-Star team in his first year. It wasn’t until quite some time later that she realized something was very wrong.
Little League

Looking back, probably the first symptom appeared when he was 11. Promoted up to the next division in Little League, he mostly sat on the bench. His coordination was not as good as it had been, and he seemed to have lost his hustle. Of course, it was probably just that he was being expected to do too much, and it was easy to overlook. And he began to grow.
Growing Pains

Soon he began to notice girls, but after an initial girlfriend or two, he retreated. Too shy, probably. They moved to a different town, and moved again to another state, and his grades slipped. He became more introverted. Troubled teen? Doing drugs? His mother found no evidence, but worried. And he grew.

He turned 15, and he grew. He was getting close to 6' tall now, and was wearing size 13 shoes. He was skinny, weighing only 150 lbs. His right knee began to swell, and he developed mysterious ulcerated sores on his lower left leg that refused to heal. He began to complain of odd feelings of being sick and came home from school frequently. Never anything seriously wrong, but he just didn’t feel good.
Checkup

They revisited the doctor, who picked up on the description of large hands and feet and decided to check blood levels of some hormones. The results showed that the boy’s thyroid hormone levels were down, his cortisone levels low, his testosterone levels low, and his growth hormone levels high. Taps of his right knee removed up to 500 cc of fluid, but no evidence of anything specifically wrong inside his knee, just that it was being damaged. He looked gaunt and unhealthy. Then he fell and broke his left hip.
Problem:

- What hormonal problem could be causing these symptoms?
- When you think you know the answer, discuss it with someone sitting near you. Try to find an answer you both think is right.
- Note: You MUST work with someone else to finish this problem!
CQ#1: What hormonal problem could be causing these symptoms?

A. Thyroid gland isn’t working.
B. Pituitary gland has problems.
C. Testes didn’t mature.
D. Adrenal glands are cancerous.
The Pituitary

The pituitary is about the size of a small olive, located at the base of the brain where the optic chiasma cross. It is connected to the hypothalamus, and is an important connection between the brain and the endocrine glands.
The Pituitary

- hypothalamus
- sella turcica (bone)
- pituitary gland
- optic chiasm
Posterior and Anterior Pituitary
CQ#2: Based on the diagram in Slide 10:

A. The anterior pituitary probably collects hormones made by the hypothalamus, and the posterior pituitary probably makes hormones under the direction of the hypothalamus.

B. The posterior pituitary probably collects hormones made by the hypothalamus, and the anterior pituitary probably makes hormones under the direction of the hypothalamus.
Pituitary Hormones

Look in your textbook or the handout. The posterior pituitary stores and releases several hormones, including oxytocin and antidiuretic hormone. The anterior pituitary manufactures and releases a wide variety of hormones, including growth hormones, prolactin, endorphins, and hormones to control the thyroid and adrenal glands.
Irradiation

It was, Dr. Kidd thought, a most unusual case. The symptoms all indicated that a benign pituitary tumor had put pressure on the pituitary and disrupted its functions. It was an unusual condition, and this was the first case he had ever seen. The boy had been referred to Madison, where they used irradiation (aiming from the left, the right, and the front) to kill the pituitary and any tumor associated with it. They had also had to do a cartilage operation on his knee, and put metal pins in both hips to hold the ball and socket jointing together.
Success?

The good news was that everything seemed to be working. The patient was 6'4" now, and had put on muscle, so he now weighed over 220 lbs. X-rays of the skull showed that the bone saddle the pituitary rested in, which had been pitted, was now healing over, which indicated that the tumor was no longer putting pressure on the bone and therefore had probably been destroyed. His hormone levels had stabilized. Of course, he would need replacement hormones for the rest of his life, especially cortisone, thyroid, and testosterone, and they had used a growth hormone suppressant for a year, but overall Dr. Kidd was happy with his progress.
Quandry

All of which led to Dr. Kidd’s present quandary. His patient, now 25, was sitting in his office and had just told Dr. Kidd that he was getting married. It had never occurred to Dr. Kidd to discuss it before, but normally patients with these syndromes were sterile, and Eric had little body hair and had told him he never shaved. What should Dr.
CQ#3: Should Dr. Kidd tell Eric that he is probably sterile?

A. Yes
B. No
C. Ask him if he wants to know
Problem:

What treatment could Dr. Kidd try?

*Hint: Look at your list of hormones. Discuss it with your small group.*
CQ#4: What treatment to reverse Eric’s sterility could Dr. Kidd try?

A. Growth Hormone
B. Luteinizing Hormone
C. Follicle-Stimulating Hormone
D. Prolactin
Why FSH and LH?

Because luteinizing hormone and follicle-stimulating hormones are hormones released by the pituitary that trigger a variety of events in the testes, including production of testosterone and production of sperm. Testosterone is made by the testes, and has a role in sperm production.
Three Years Later

He was 28 now, and growing a beard. They had injected human chorionic gonadotropin (hCG) for two years in an attempt to get sperm to be produced, but it hadn’t worked. He was big, 6'6", and weighed 275 lbs. His hands and feet were especially large; he wore 2x gloves and size 18 shoes.
Jaw Surgery

Eric couldn’t wait to get the wires out of his mouth. His jaw had been hurting, especially the joint on the left side. The dentist thought he might have TMJ (temporal mandibular joint dysfunction), and referred him to a dental surgeon. The surgeon had expanded his upper jaw by splitting it into five pieces, pulling the pieces into place, and screwing in small metal plates to hold it all together. The wires were there to let everything heal. Ten weeks with a mouth wired shut had been more difficult than he had thought. However, he was happy to be rid of the frequent headaches.
Group Problems:

• Why didn’t Eric have a beard when he got testosterone injections, but he is growing a beard now?

• Why did he need jaw surgery?
Answers:

• hCG acts like FSH and LH and triggers a variety of secondary sexual characteristics, including facial hair.

• Having too much growth hormone in childhood produces gigantism, but too much growth hormone later in adolescence produces acromegaly.
Acromegaly

Acromegaly is marked by differential growth: bones that have already fused do not grow, but other parts of the body can grow.

Typically acromegaly is most pronounced in areas such as the hands, the feet, and the jaw. Thus, Eric’s lower jaw grew, but his upper jaw did not, causing a misalignment.
Dr. Lee sat down at her desk with a weary sigh and rubbed her stiff neck. She picked up a fat folder full of lab tests, notes from office visits, and other documents. Ah yes, this was one of her challenging patients. The guy’s hormones were seriously out of balance. Trying to keep them in balance while dealing with his high blood pressure was a bit like juggling china plates while riding a unicycle.
Odd …

As if that wasn’t enough, he kept coming up with odd things. One morning his right eye stopped working, which led to the diagnosis of an aneurysm in an artery immediately beneath the pituitary. The aneurysm was probably due to radiation damage to the blood vessel walls in the area of the tumor. They had gone in and surgically wrapped the aneurysm to hold it together, but his recovery had taken months. Fourteen months later his right eye began to work again.
Stroke

A stroke he had two years later may have been due to radiation or high blood pressure or the surgery, but meant frustratingly long months of physical rehab.
Complications
And, of course, just to make things interesting, he had to have the stroke while he was in a jungle somewhere in Costa Rica. He came home from China testing positive for tuberculosis, from the Marshall Islands with beaver fever, and from Costa Rica with parasitic botflies burrowing under his
Good Night?
Well, back to work. Let’s see...her patient was 45 years old, 6'6", 310 lbs. Now Eric’s wife was complaining he wasn’t sleeping enough. Eventually they had figured out that his sleep was getting seriously disrupted by frequent nighttime trips to the bathroom.
Frequent Trips

It’s quite normal for a 45-year-old male to make one nighttime visit to the bathroom and void 350 cc of urine, but she’d asked him to record the frequency of his visits and the quantity of urine produced. Her nurse had attached the chart he had just sent. She looked it over.
<table>
<thead>
<tr>
<th>Nighttime Urination Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monday</strong></td>
</tr>
<tr>
<td>11pm: 450 cc</td>
</tr>
<tr>
<td>12am: 600 cc</td>
</tr>
<tr>
<td>1:30am: 550 cc</td>
</tr>
<tr>
<td>4am: 400 cc</td>
</tr>
<tr>
<td>7am: 500 cc</td>
</tr>
</tbody>
</table>
Diagnosis

Dr. Lee mentally gave herself a high five. Finally she had a problem she could solve; this was what she spent all of those years of training to do. The diabetes insipidus was so obvious when you looked at this data. All she had to do was to write one prescription!
Problem:
Why are his kidneys so active at night? Note: diabetes insipidus is NOT diabetes mellitus, so the answer is not high blood sugar levels or an insulin deficiency. Diabetes merely means high urine production. Look for a specific hormonal problem involving the pituitary.
CQ#5: His kidneys are so active at night because...

A. He drinks too much because he is unhappy.
B. He doesn’t make enough cortisone, which is a stress response manager.
C. He doesn’t make enough antidiuretic hormone.
D. His blood sugar levels are too high.
Problem:

If the pituitary is so important and Eric is not getting replacements of hormones the pituitary makes (except for ADH), why isn’t he dead? To answer this question, think through the cascade of events from hypothalamus to effect.
CQ#6: Can you live without a pituitary?

A. No.

B. Yes, if you get replacement signals from the hypothalamus.

C. Yes, if you get replacement pituitary hormones (like FSH and TSH).

D. Yes, if you get replacement end-stage hormones (like thyroid and testosterone).

E. C or D would both work.
Postscript

I hope you learned from this case. When I teach it, my students want to know the end of the story.

I’m 52 years old (2010). Things are going ok right now for me medically, although I’ve also just been diagnosed with Type II diabetes mellitus. I have two lovely adopted daughters, and I teach plant ecology and introductory biology.

(I’m pointing at a plant that I am studying – a prickly pear!)