Hydrocephalus:

An Owner's Manual

Edison McDaniels, MD

Hydrocephalus:
An Owner's Manual

Edison P. McDaniels II, MD
Board Certified in the Practice of Neurosurgery
by the
American Board of Neurological Surgeons

HYDROCEPHALUS: An Owner's Manual

Edition 1, March 2013

Disclaimer

This is a work of nonfiction. It is not an exhaustive treatment of hydrocephalus, but rather is a useful companion to the shunted patient. It is meant to be informational only. It cannot and should not replace appropriate consultation with a medical professional in general or a neurosurgeon in particular.

What You Won't Find Here

You will not find a bunch of charts and diagrams here. This is a very straight forward monograph, my attempt to pare hydrocephalus to the bones and make it as understandable as possible to the greatest number of folks. There are plenty of books out there that will show the anatomy and the various products we use to treat this unfortunate condition. What is here are the simple and most basic definitions and explanations of hydrocephalus—enough, I hope, to demystify it for the average patient and his/her family.

The reader is invited to seek out more info if desired.

WHY I WROTE THIS MONOGRAPH

I am a brain surgeon.

Several years ago, I was confronted with a young man in the emergency room who had earlier that morning been found unconscious by his college roommates. In fact, when I met him he was essentially comatose, that is, unresponsive in any meaningful way. Fortunately, one of his roommates recalled something about him having a *shunt*. With this piece of information, the emergency physician quickly called for a stat head CT and a diagnosis of *shunt malfunction* was made. I was called, took the patient to surgery for an emergent *shunt revision*, and he recovered and lived happily ever after.

Well almost. It turned out he was a college student and the ordeal left him rather exhausted, though *neurologically normal*, and he would spend several months recovering from his near death experience. His mother, who lived in a city 160 miles away, drove over immediately and was waiting for me when I came out of the operating room. I have seldom seen a mother so grateful as that woman—unless it be virtually every other mother I have ever dealt with as a neurosurgeon.

Largely because of their children, parents are special people.

The bond between parent and child is like no other. I have seen octogenarians break down while recalling the death of a forty-year-old son or daughter—never mind that the death occurred fifteen years before. Perhaps the only bond in all of nature that can never be fully broken, it continues beyond divorce, separation, abandonment, illness, and even death. At its best, the parent-child bond drives us to be our best, to meet our full potential. Even when it is missing, entire lives are predicated, even formulated, on the basis of such a loss.

Almost without exception, the parents I meet would gladly exchange places with their child in these moments of extreme stress. These parents feel helpless and at the mercy of the situation. I am often asked *What could I have done?* Or *Is there anything I can do to prevent this from happening again?*

I know the feeling.

I am a brain surgeon. I am also a parent. Several years ago, my oldest son died suddenly. In my years on this earth I have lost people close to me—a brother, a half-brother, both parents, several close friends—but all of their deaths paled in comparison to losing a child of my own. It was and remains the single most difficult event of my life, the defining moment if you will.

A bond which cannot be broken.

Which brings me to this monograph.

Hydrocephalus—loosely defined as a build-up of fluid in the brain—is a life-threatening, fairly common, and relatively easily treated condition. Unfortunately, with existing medical technology, the treatment requires a lifelong diligence on the part of loved ones as well as the patient himself/herself. But that being said, the treatment is not onerous on a daily basis and the benefits are dramatic. Most patients with hydrocephalus live normal lives in virtually every respect. They play sports (even extreme ones), marry, have regular jobs, carry babies through labor and delivery, and die as an old man or woman (or at least we expect they will—the technology is only fifty or so years old and thus people shunted as young children are only now reaching late middle age). With the possible exception of the more remote parts of Alaska, if you live in the United States you almost certainly have at least one friend, acquaintance, student, or co-worker with a *vp shunt*—though you may not know it.

So why this monograph?

Because, to put it in the simplest terms possible, failure to recognize a shunt malfunction can be fatal. The boy I took care of above had failed to get out of bed for class one morning. When his roommates returned home for lunch, they found him unresponsive and still in bed. They called an ambulance and he was taken to my hospital, where a CT of the brain showed the problem. He received prompt medical attention—but only belatedly and it nearly cost him his life.

Had his roommates known the gravity of his failure to arise that morning, his brush with death would likely have been avoided. His mother recognized this fact. She knew how close to the edge he had come. She was one of those who asked *What could I have done? Is there anything I can do to prevent this from happening again?*

The advice I gave her became this monograph.

NEUROSURGERY 101

Loosely speaking, hydrocephalus is an abnormal build-up of spinal fluid within the head. This can happen for a number of different reasons. I will define hydrocephalus more fully in a moment, and we will look at a number of different ways it can come about, but first a quick look inside the box.

The skull is, for all its complexity, essentially nothing more than a container, a closed box. Clinically speaking, that is looking at it from the neurosurgeon's point of view, it has only three important openings: the paired openings for the eyes and a third opening through which the spinal cord exits at the base of the skull.

The two openings for the eyes allow the optic nerves to pass thru the skull to the eyeballs themselves. The optic nerves are actually not nerves at all, but true extensions of the brain itself—which makes them the only part of the brain visible from outside the body under normal circumstances. Every time you go to the doctor and he looks in your eyes with that bright light (an ophthalmoscope), you are having your brain examined. What he or she is actually looking for is the shape and color of the optic nerve head, that is, that portion of the nerve just as it enters the eye. Pressure inside the head, we will talk about this below, gives the nerve head a different appearance depending on whether it is high or low, normal or abnormal, old or new, etc. That is, the pressure inside the head is propagated along the nerve and causes visible changes in the eye when that pressure is abnormal.

So, the skull is, for our purposes, a closed box. One important caveat: a closed box has a fixed volume (think of your dishwasher—you can only fit so much inside it). The skull cannot expand. That is, there is only a certain amount of space inside the skull.

As far as the neurosurgeon is concerned, there are only three things inside the skull that matter and take up any space: the brain itself, the blood (which normally flows through the brain in blood vessels but sometimes hemorrhages and then is found outside the blood vessels, where it takes up space needed by the brain), and cerebral spinal fluid (CSF).

Brain, blood, and CSF.

Each of these substances takes up a certain amount of space. The key thing to remember is this: *an increase in any one of these substances requires a decrease in the other two.*

Why?

Because the skull is a closed box. And a closed box has a fixed volume.

Think once again of your dishwasher. Say it holds plates, glasses, and pots, but only a limited number of each. Of course, you can put in more glasses if you desire, but only at the expense of fewer plates and pots.

Lets do a thought experiment. You are blowing up a balloon and watching it expand. It expands for two reasons: the walls are flexible and you are increasing the pressure inside the balloon.

Now imagine the walls are not flexible but semi-rigid. But you have superhuman strength and can still blow into the balloon and expand it, though now the balloon expands only very slowly. It enlarges in an attempt to keep the pressure inside the balloon equal to that outside. It will continue to enlarge until one of three things happens: the balloon pops, you can't generate enough pressure to expand the balloon further (in this case the balloon is at equilibrium inside and out), or the walls encounter something external that is more rigid and prevents their further expansion.

Now imagine you are blowing up the balloon inside a closed box. And that box is the skull.

Now imagine the balloon to be any one or more of the three substances—brain, blood, or CSF.

You will see from this little thought experiment that the interaction of the three substances (brain, blood, CSF) inside the closed box of the skull creates a certain pressure, called the intracranial pressure (ICP). Normally, the ICP is in equilibrium across the three substances, but what happens if one of the substances grows in volume?

Well, as we have seen above, the other two must decrease. Or the pressure, the ICP, will rise.

It is this rise in the ICP under adverse conditions that is so dangerous inside the head. Why? We'll get to that.

For now, just know that as a first approximation, if the ICP rises higher than the blood pressure, blood won't be able to flow into the head and the brain will fail. This is what happens when a person suddenly faints. The two common reasons for fainting: the blood pressure suddenly falls or the ICP suddenly rises. Either way, the ICP eventually exceeds the blood pressure, blood flow to the brain fails, and the patient faints (if they are lucky, they will fall on flat ground and, with the brain and heart now level, blood flow to the brain resumes and the person wakes up).

Some causes of a sudden fall in blood pressure:

—A bad coughing fit, which actually reduces blood return to the heart and thus there is nothing to pump out to the brain;

—Sudden heart failure, such as a heart attack;

—A bad scare, in which case the blood vessels of the body sudden dilate wide open and the blood pressure falls as a result.

—Have you ever heard of micturition syncope? That's the fancy medical term for what happens when a person (usually an older man) is straining to pee and suddenly faints. Why does this happen? Because, as any man past middle age knows, the enlarged prostate gland partially obstructs the flow of urine out of the bladder. The greater the obstruction, the harder a man has to push to pee. This pushing, or straining, effectively increases the pressure inside the belly, which in turn decreases the return of blood to the heart (though only transiently). Just as with a bad coughing fit, there's nothing in the heart to pump and the brain fails. Result: a faint. Fortunately, the victim of such quickly awakens once he faints and thus stops straining to pee. Unfortunately, he may have cracked his head on the toilet...

Some causes of a sudden increase in the ICP:

—An acute obstruction to the flow of CSF, i.e., acute hydrocephalus (the usual cause of this is a shunt malfunction. A less common cause is a brain tumor);

—A spontaneous hemorrhage in the head, such as a ruptured aneurysm.

—A blow to the head, such as one might sustain from a simple fall (say, while straining to pee standing up).

The skull is a closed box.

Only three important things take up space in the box: brain, blood, and CSF.

An increase in any one of these substances requires a compensatory decrease in the other two, or...

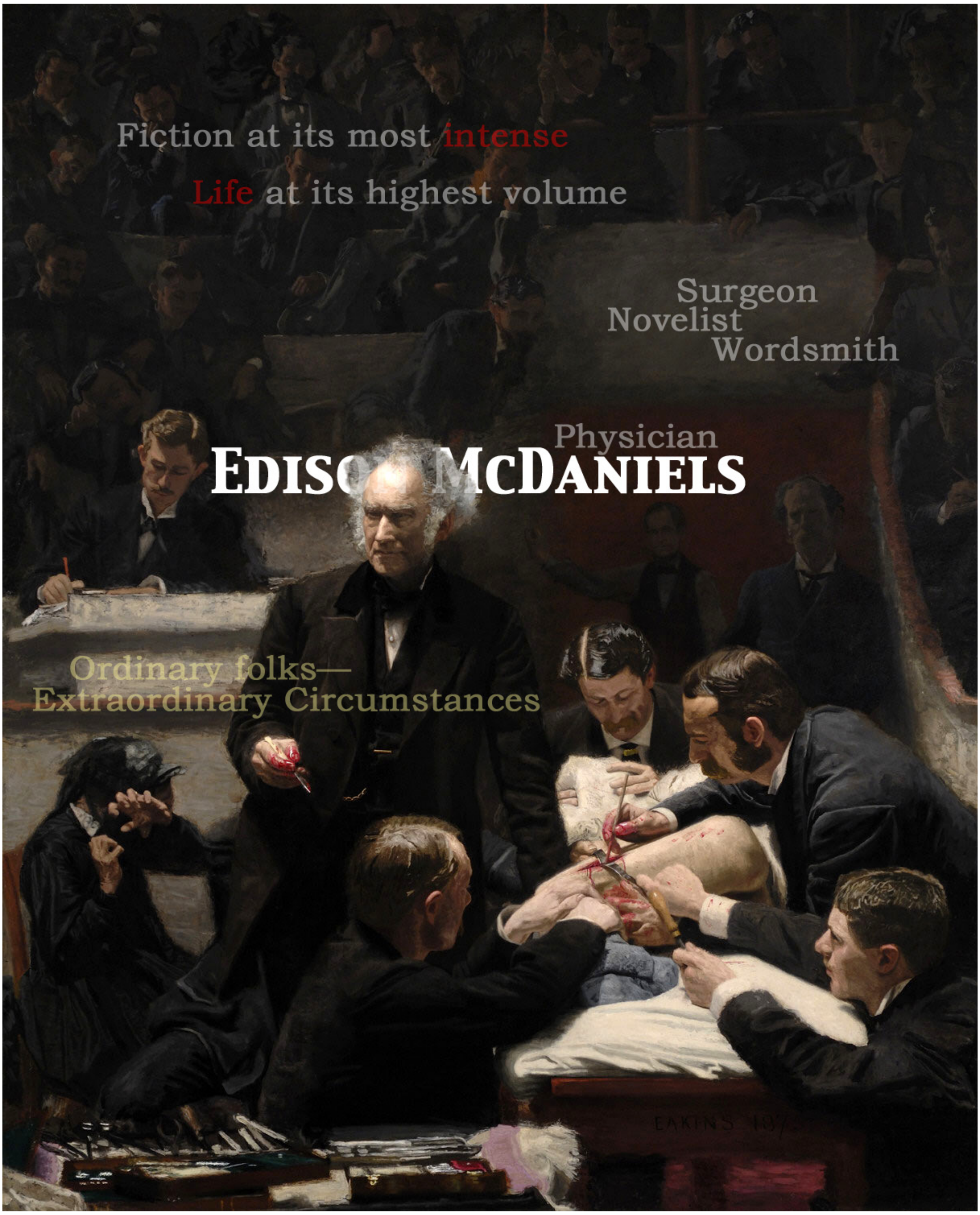
Or the ICP will rise, usually to the detriment of the patient.

****

Well, gentle reader, thanks for reading. That's the first part of *Hydrocephalus: An Owner's Manual*. If you liked what you read, there's another 5,000 words (the entire work is 7,000 words) for your immediate reading available at Amazon for the Kindle for just $2.99!

Own it today. Right now. Right this very moment.

And don't forget to check out my fiction, including the novel *Not One Among Them Whole*—A magnificently harrowing trip through the bloody horrors of the battle of Gettysburg. A group of surgeons struggle amid the chaos and carnage of a battlefield hospital in this epic tale of human grist under the grindstone of the American Civil War.


Fiction at its most intense
Life at its highest volume
Surgeon
Novelist
Wordsmith
Physician
EDISON MCDANIELS
Ordinary folks—
Extraordinary Circumstances