



Vertigo: The Basics, for Pilots

(All prior columns are at <http://www.tinyurl.com/drdanscolumns>)

The letter said:

Dear Dr. Dan,

I've had an attack of vertigo that lasted 6 weeks. I've decided to give up soaring. Is there any hope for me?

Sincerely,

Dizzy Dave

This is an intelligent and wise question, and there are no glib answers.

This is an intelligent question because this pilot recognizes that vertigo interferes with accurate perception of the in-motion aviation environment, which hinders accurate movements that depend on perception.

This is a wise question because it reflects sound judgment: a willingness to give up soaring if that's appropriate, and openness to expert advice.

This note reveals that the pilot has had vertigo for quite a long time, and he's feeling understandably discouraged about recovery. It's right to ask basic questions, and it's normal to be anxious about the future (*prognosis*, in the jargon).

Vertigo Versus Pilot in Command

There are two important issues with vertigo:

First, it's not possible to fly safely with vertigo. As one of my pilots said about his vertigo, "Fly!?! Jeez, I couldn't stand!" Even if we've recovered well enough to sit in a cockpit, the head movement necessary to see, avoid, and navigate may precipitate an attack of vertigo until complete recovery. The landing pattern

is not a good place to have our world suddenly start spinning.

Second, vertigo, even if long lasting such as this, even if not permanent, may result in some loss of fine coordination. In this regard, the important thing is to understand why the vertigo exists.

Understanding the cause reveals prognosis \pm the usual future course of the condition (now called the *disease trajectory*, especially by cancer specialists).

Who Can Best Sort This Out?

I don't want to dis general physicians like myself, as many can indeed guide this pilot to a proper investigation and diagnosis. Yet only certain specialists are *obligated* to maintain current expertise in the complete evaluation of vertigo.

The diagnostic specialty is *otoneurology* \pm the neurology of the inner ear. Go to vestibular.org to find a specialist. If you have problematic vertigo trouble with equilibrium, seek out one of these experts. (The surgical specialty is *neurotology*, with similarly refined training.)

This ends the "what to do" section \pm now we'll go ahead with the "how this works" section.

OK, What Is "Vertigo?"

We can skip the classic movie, a convoluted tragedy that happened to involve chronic vertigo. It was not a medical story.

"Vertigo" is also applied to that feeling we get when we lean past the edge of a tall structure and look down. This is a little closer to the medical meaning, but is neither abnormal nor disabling.

"Dizzy" is a vague word that means many things. When someone tells me

she's dizzy during a medical visit, it's necessary to explore all the different meanings before we can surmise what physical process might be creating this sense. It might be vertigo. (Or it might be the emotions of the 84-year-old mother, whose daughter and son-in-law invite themselves for a late dinner nearly every night, feed their dog with their fork from their plates, watch TV until bedtime, and then decamp without helping with the dishes. That'd make *me* woozy with high blood pressure, too!)

In medicine, vertigo specifically denotes a false sensation of rotation, either of self or the world. The spinning we sense while on the playground merry-go-round is *not* vertigo; the spinning we sense after it stops *is* vertigo.

We say that the vertigo is *subjective* when the person feels as though he's spinning, and *objective* when the world seems to spin around us. This difference is medically trivial, though maybe it reflects personality. Do owners of single-seat ships have more objective vertigo?

I don't know why vertigo usually seems to be horizontal \pm around the yaw axis \pm less often, a sense of tumbling. When that's the case, it's really hard not to fall down.

Why Might We Get Vertigo?

The basic reason is this: Any complex instrument, when damaged, may simply give wrong readings if damaged short of destruction. This is true for the vestibular system, which is a highly complex instrument that senses and analyzes sound and acceleration, with separate organs for rotary and linear acceleration.

An important factor in vertigo is that there are two sets of accelerometers, one within each ear, and *balanced* function is crucial to correct perception of changes of motion. Asymmetrical injury or inflammation is a very important cause of vertigo.

Vertigo resolves when either the damage is repaired (or the imbalancing cause is removed) or when the brain recalibrates the instrument. If the cause can be removed quickly, such as when a *canalith* from the utricle or saccule is caused to drift out the semicircular canal



that it's entered, the vertigo resolves dramatically.

If the injury is permanent, so is the imbalance, and the brain does recalibrate slowly over a period of weeks. After this recalibration, one's equilibrium will be less precise to the extent that damage has been done.

I include these details so that you can understand what to expect when you do have vertigo, and so you can help your doctors give sound advice, especially about piloting.

Pilots generally are willing to fly even if they're suffering, and a pilot who's never had vertigo might be mystified why we aeromedical physicians absolutely prohibit pilot duties until the vertigo is completely resolved (and hopefully its cause understood). Each time I care for a pilot who has had vertigo, I ask, "When you were dizzy, did you feel OK to fly?" Always, they say, "NO!!" emphatically.

I mean, what's going to be the outcome if you're on short final in a light, gusty crosswind, anticipating maybe ten knots of wind shear in the friction layer, you turn your head to the left to look at the aircraft on base, and suddenly the airport starts spinning rapidly? Remember the old joke about the guy with double vision, who crashed his car: "I couldn't decide which road to take, so I drove between them."

Why Does Vertigo Occur?

As we've noted in prior columns, the inner ear comprises 3 components: the cochlea, which parses sound; the semi-circular canals, which detect changes in circular motion; and the otolith apparatus, which detects accelerations (changes in linear motion). There are some nice anatomical illustrations at <http://tinyurl.com/otolith>.

The otolith apparatus and the semi-circular canals together provide equilibrium and the cochlea provides sound. The sensations from each of these components are digitized and sent along a single cable, the *acoustic nerve* or, more accurately, the *vestibulocochlear nerve*.

Perception is the conscious end result of all the neurologic processing of the entire system from the inner ear to the brain. Perception is a cartoon of

reality, the accuracy of which depends on successful integration of all the body's sensory faculties. Any malfunction degrades this accuracy. Inaccurate perception, whether we're aware of a problem or not, creates awkwardness in aircraft handling and leads to accidents.

Stages of Abnormality

Vertigo does occur when the system is normal: For example, spinning on a

turntable such as a merry-go-round, and then stopping. But there are no lazy-susan cockpits.

Vertigo will occur abnormally when any part of this system is asymmetrically impaired or damaged. (If we think about this for a moment, it would be rare for damage to be symmetric, so most abnormalities of the vestibular system lead to some flavor of vertigo.)

I say "some flavor of vertigo" because

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dysfunctions of equilibrium do not always involve a simple spinning sensation, even when the abnormality is in the semicircular canals.

Because one function of the system is to detect rotation, a defect may result in some sort of turning or tumbling sensation, or a combination of these.

Because the other equilibrium function of the inner ear is to detect linear acceleration, a defect of that part of the system results in a mysterious sense of movement. When I talk to patients about their experiences, they agree that it's similar to walking on the deck of a moving ship.

Types of Vertigo

Broadly, causes of vertigo are divided into *central*, related to defects of the brain, brainstem, or acoustic nerve (the signal-processing system) and *peripheral*, related to defects of the inner ear (the sensors).

Central vertigo is relatively rare. It tends to develop slowly and to be long-lasting. Tumors and multiple sclerosis are typical causes. For example, the pilot with a tumor on the acoustic nerve on one side (the signal path from the sensor to the CPU) is prone to vertigo, imbalance, and hearing loss. The vertigo is usually mild, and the pilot of my acquaintance with an acoustic neuroma is reported by colleagues at his field to fly patterns a bit awkwardly.

(The FAA required him to return his medical certificate, but gliders don't require medicals, do they?) Given the change in performance from ATP-level precision to new-student imprecision, we wonder if the pilot has also developed poor judgment for some reason. It's my experience that loss of judgment is the most dangerous and disruptive disease on the field.

Central causes of vertigo are related to the acoustic nerve, the brainstem, or the brain.

We don't need to make a catalog of the specific abnormalities. What *you* want to understand, when you do get vertigo, is whether this will ever end, and whether you'll actually get back to normal when it's all over. None of us wants to pilot an aircraft while having trouble knowing which way is up.

Central and peripheral vertigo behave differently. Because peripheral causes involve abnormality of the inner ear, and because the fluids of the inner ear *always* respond to motion, peripheral vertigo is always affected by movement.

Central vertigo involves structures that are *not* sensitive to movement, so vertigo that does not change with head movement is usually due to an abnormality of the acoustic nerve, midbrain, or brain. Of course, there may be a relationship to movement if the abnormality distorts signals from the inner ear.

Peripheral causes of vertigo are mostly due to degeneration, habituation ("the wobbles" in aerobic pilots), abnormal inner-ear pressure (Meniere's Disease), injury, or infection. Most such infections are viral (no pus seen behind the eardrum and a bad cold).

We doctors will usually tell the dizzy patient with a cold, "It's just a virus. You'll be fine in a couple of weeks," without any real proof, and without actually spending hundreds or thousands of your soaring dollars on tests that would more precisely sniff out the cause of a disease without treatment that will resolve soon.

If movement makes the dizziness worse, we doctors usually say, "You have benign paroxysmal positional vertigo ± BPPV" and may recommend a "canalith repositioning procedure" such as the Epley Maneuver. This is the easy diagnosis because it's commonest, most people have heard about it, and there's something to do for it, so it gets you out the door.

If head movement makes you spin (not just feel mildly dizzy), keep track of which head-turning direction causes the turning. Then, in a clear moment, search for videos of "Epley maneuver" and for written instructions. It's a simple, s-l-o-w procedure. It takes less than five minutes. Some doctors have bothered to learn how to do it, which can save time, money, and suffering.

You don't really need to have five sessions of canalith re-positioning at \$200/session at your local physical therapy shop to fix BPPV. The point here is not to deride my colleagues, but to point out that misdiagnosis does occur, even with

us brilliant diagnosticians: been wrong before, will be again.

See, we tend to label as BPPV any vertigo made worse by movement. And it's really, really difficult to coax a dizzy patient into a carefully-observed description of the experience. So there's often doubt. And since the most treatable cause of vertigo is BPPV, and the treatment is straightforward, canalith repositioning is the thing to do when the cause is unclear.

On the other hand, most vertigo, regardless of cause, is made somewhat worse with head motion because, after all, the sensory instrument is malfunctioning and possibly rather twitchy in some modes and configurations.

Because the fluids of the inner ear are viscous, they settle down quickly if we're still, so bouts of peripheral vertigo tend to be severe but brief, lasting minutes.

Because the lesions causing central vertigo are static or slowly changing, the vertigo tends to be milder but more enduring, lasting hours, days, or longer.

Causes of Peripheral Vertigo

You may have noticed that as we age, the elastic parts get stiff and the firm parts get floppy. Also, stuff like cartilage gets brittle. The otolith apparatus ± the utricle and saccule (<http://tinyurl.com/otolith>) consists of two little mounds of jelly, surmounted by tiny rocks, into which penetrate fibers that are rate-sensitive to bending.

After whacks to the head or with age, a rock or two might fall off. If one drifts into a semicircular canal, it will move back and forth with head movement, excessively stimulating the sensory hairs that line these canals. The signal to the brain is "turning!!" so we perceive rotation. This is pretty disorienting when the message from the other inner ear and the eyes is "not!" A short description is at <http://tinyurl.com/equilibrium-gone>.

This is called BPV (benign positional vertigo), and bouts of spinning last until the crystals migrate to a better position. (Or BPPV, "benign paroxysmal positional vertigo" because there are sudden episodes.)

Other causes of peripheral vertigo are caused by what amounts to static



on the telephone wire: false signals from inflamed sensors or nerves. This is called *vestibular neuronitis* (presumed to be a viral infection) and typically lasts 2-3 weeks.

Typically, the lesion involves permanent damage to the affected inner ear, the vertigo is caused by *unbalanced* sensory signals to the brain, and it takes about that long for the brain to recalibrate itself.

The Wobblies

Sometimes, on returning to ground after a bout of vigorous aerobatics, the pilot has trouble maintaining a sense of equilibrium. This is not due to damage of the inner ear, but is probably caused by the sudden cessation of continuous overstimulation. It is probably analogous to the "sea legs" of a sailor who's been on a small ship for a long while.

The wobblies seldom last for more than a few hours. Obviously, we shouldn't fly until it's completely quiet (though I've heard of competition pilots who disregarded this and survived).

The wobblies shouldn't affect glider pilots because our ships simply can't perform the sudden high-g rotations that can be done in a short-wing powered aircraft.

Dread Meniere's Disease

Meniere's disease is possibly caused by abnormal pressure in the inner ear. It involves dysfunction of all components of the inner ear, and thus causes both hearing loss and vertigo with or without disequilibrium.

A person with Meniere's disease wrote a vivid description of the experience \pm Jane Gross, in the NY Times, 8/29/14, <http://tinyurl.com/dizzying-times>. She said, "Rotational vertigo is the medically and colloquially accurate description: the room spins. The walls aren't where the walls are supposed to be. The floor is only an idea, not a reality. One minute I was lying in bed, feeling perfectly normal, and the next minute, trying to get to my feet, I was stumbling, grasping at furniture to hold myself upright. ... Along with the vertigo came nausea

and diarrhea ... I couldn't walk ... [getting to the bathroom was difficult]. Dehydration made the vertigo worse. ... I had difficulty hearing people on the telephone when the receiver was at my left, but not my right, ear.

"The only thing that everyone agrees is effective is lying perfectly still until the vertigo passes. ... the attacks last from 20 minutes to 24 hours and come in clusters." I can't imagine going to the airport, never mind flying, with such suffering.

Central Vertigo

Central vertigo is caused by any abnormality *downstream* of the inner ear \pm the auditory nerve, the brainstem, or brain. The sensors are fine, but signal processing is distorted. Causes include concussion, closed head injury, multiple sclerosis, migraine, brain tumor, or stroke. For example, the pilot who flipped his motorcycle in his neighbor's muddy back yard and KO'd himself had vertigo for 8 weeks and couldn't fly the friendly skies for 6 months (the manda-

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tory FAA “observation period” for loss of consciousness with later symptoms).

The key problem with central vertigo is that it may last a long time, up to months, and in the end we might have permanently inaccurate equilibrium or coordination. The important question to ask the specialist is, even with recovery and resolution, “Will I have normal vestibular function after the dizziness is gone?”

So, if you have vertigo or imbalance, it’s lingering along and whatever treatment is not helping, it’s worth getting the greatest available expertise. This would be a neurotologist or an otoneurologist physician. Other physicians may be able to do this, but it’s not on the label of the bottle, and these specialists are obligated to be current in knowledge and procedures. Look up The Vestibular Disorders Association ± vestibular.org ± click on “Find a Specialist,” then click on “Specialty,” and search for otoneurologist and neurotologist (you can search for both at once).

The difference in these specialty names is training: An otoneurologist completed neurology training and then did a fellowship for further training in the diseases of the ear. This is a medical specialty focused on diagnosis and begins with deep expertise in central vertigo and brain or neurologic disease.

A neurotologist is a surgical specialty. The doc first completes training in ear, nose, and throat surgery and then does a fellowship in neurology. This specialty is founded in a thor-

ough knowledge of surgically treatable disease of the ear and related areas, and adds expertise in neurology.

Both of these specialties are small. You can start with either one and get where you need to go. And of course there are many doctors with adequate knowledge, but they’re unlabeled, so finding them is a matter of luck.

What Medication Helps Vertigo?

Well, nothing, really. Sorry.

Meclizine (“Antivert”) has been around for about 60 years. It is simply a first-generation antihistamine with the usual sedation and dry mouth. It is at least as effective for vertigo as placebo, so it has a lot of admirers among the true believers. And the side effects let you know that you’ve taken something, which is reassuring.

Except that the cognitive side effects increase error rates, so your passengers may not feel safer if they know. And it’s sort of long acting, so it’s safer not to fly for a couple of days after taking it. But, of course, you’re not flying anyway because you’ve had vertigo, and you’re waiting for that to clear.

Vertigo often causes nausea and even vomiting, and there really is something that will help that. Ondansetron is reasonable selective for the “chemoreceptor trigger zone” in the brainstem, which governs vomiting. Yes, it’s mildly sedating, but at least it’s better than a placebo. It’s prescription-only, so the doctor visit is a bit of a barrier ± though most primary care docs will prescribe it after a phone call because it has no abuse potential and this is quicker. The trade name is Zofran, and when it first came out it was about \$10 per pill back when \$10 could buy a nice meal, not that you’d be eating one if you truly needed the medication. It’s been generic for a long time, and is cheap. The dose can be safely doubled or tripled if necessary.

(Which raises the point that many non-prescription drugs were originally Rx-only [“ethically promoted”]. For 70 years, when they have been displaced by something more effective, less toxic, or more convenient, doctors quit prescribing them, and the ignorant general public gets the hand-downs. The FDA has traditionally been sympathetic to the threat of corporate poverty.)

(The exceptions are cromolyn, loratadine and fexofenadine, ranitidine and famotidine, omeprazole, and dextromethorphan. Look them up if you want to know more. I’ve gone far enough off-topic already.)

What to Do?

The bottom line is that true vertigo is disabling, and as pilots, we have to keep both feet on the ground (or on the bed!). I have no glib solution except to urge you to show good judgement by staying out of the cockpit until it’s completely resolved and to diligently seek expert diagnosis, so that you understand what to expect.

Acknowledgements

Thanks to Dr. Timothy Hain for the nice images of anatomy. <http://tinyurl.com/Tim-Hain>

Find a specialist: <http://www.tinyurl.com/otoneurology> ✈



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