This article concerns one of the most common medical problems I encounter in flight crew, and recreational pilots—"ear lock" or, as it is scientifically called, barotitis media.

The first fact that must be understood is that gas expands as a person gains altitude. This is called "Boyle's Law". Gas is trapped in various body cavities, such as the intestines, which contain about 500 mL of gas. As the aircraft climbs, the trapped gas expands, causing discomfort until it escapes from the body. The inner ear also contains gas (air), between approximately 2.5 and 13 milliliters. As the aircraft climbs, this gas expands and leaks out through a small tube into your throat, called the eustachian tube (you have two— one for each ear). This tube connects the inner ear cavity with the throat. It is about 35 mm long, and the first one third of it is bone, which prevents the tube from collapsing. The last two thirds of the tube is soft tissue, and is normally collapsed. It resembles the duck whistle you might have had as a child. You remember these. You could blow out of them and the soft rubber tube would make a quacking sound, but if you try to suck back air, the tube collapsed, and effectively formed a one-way valve. Your eustachian tube is like this.

Gas usually escapes down the tube without too much difficulty on climb out, although it may be necessary to yawn or swallow or "pop" your ears. These actions activate the pharyngeal and palatine muscles that open up the tube. Normally air vents every 300 to 500 feet. The real problem begins on descent. Now the gas inside the ear starts to shrink, creating negative pressure with respect to the cabin air. This is painful if not corrected. To equalize, air must go back up the eustachian tube, but remember? The tube is collapsed.

To equalize pressure, you must open the tube by the mechanisms listed above—yawning or swallowing. If this fails, a maneuver called the Valsalva can be employed. Pinching both nostrils and closing your mouth, gently blow out a small breath. You should hear a pop or click and the pain should stop. This may be repeated several times, firmly but gently. There is a danger of damage to the hearing mechanism (blowing out the round window), if too violent Valsalvas are repeated, like a sneezing mechanism against back pressure. If you are not successful in relieving the negative pressure, the aircraft continues to descend, the eustachian tube sucks firmly shut, and extreme pain is experienced. This is a condition referred to as "ear lock", and can result in the eardrum rupturing inwards. The only action which may be taken to correct the problem is to rapidly climb the cabin (depressurizing) to unlock the ear. To make ear lock worse, often fluid (called "transudate") leaks from the body into the locked up ear, and this is a fertile liquid for bacterial growth.

If the drum (tympanic membrane) ruptures, you'll hear a loud pop, then be deaf on that side. The pain will cease instantly, because pressure equalization has occurred through the hole, but blood may come from the ear canal. You may be extremely dizzy, as your balance organs are quite near to all of the action. Although this sounds pretty serious, most pressure ruptures of the eardrum heal up just fine, with no permanent loss of hearing. This is not unlike cutting your skin. It will heal. You should, of course, get the help of a physician if this happens to you.

So why would you have difficulty equalizing pressure? The most common reason is a cold or sore throat. This has the effect of swelling the eustachian tube opening shut. Air
can leak out of the swollen tube okay, but you can't get it back in easily. Thus, climb out
is mildly difficult, but descent will be extremely painful. Even if you avoid ear lock, it is
likely that some bacteria from your throat will be trapped in the inner ear and could
cause infection (called otitis media). If you have infected ears, this is a grounding
condition, until it resolves – sometimes requiring antibiotics. Any other process that
swells the throat can cause pressure equalization problems - for example allergies,
inhaled irritants such as cigarette smoke, enlarged tonsils, chronic sinusitis, et cetera.

What can be done to prevent barotitis media? First and foremost, don't fly with a cold.
Secondly, "stay ahead of your ears". If you expect to have problems equalizing
pressure, carefully open your eustachian tubes by one of the methods we discussed,
during descent. If you allow your ears to become locked, it may be impossible to
correct. If you are not the pilot actively flying, using a medication as a preventative
sometimes works. Pseudoephedrine, as contained in Sudafed LA, is a decongestant
which may help keep the tubes open. Make sure you are taking the long-acting
preparation, as the short acting one only lasts three or four hours. Nasal decongestants
of the spray type are to be avoided, because although they are successful over the short
run, they have a nasty habit of rebounding, blocking the eustachian tubes and nose
worse than ever.

What about passengers? Handing out medical advice to passengers is always a risky
proposition, so in general I advise flight crew not to do this, but a little bit of friendly
suggestion can relieve a whole lot of misery. Children have very small eustachian tubes,
and are more likely to have a cold or other causes of obstruction, thus they are more
likely to have trouble with their ears. Have you ever noticed that, on airliners, as the
captain pressurizes the cabin, the baby's crying begins? Try to encourage parents to
have their children drinking on the way up and down, this helps open the tubes.
Sleeping is not wise, as ear lock often results. Older children can chew gum or suck
candies. Adult passengers can be shown how to use yawning or swallowing to equalize
pressure. I advise again showing them the Valsalva maneuver. It is hard to teach in the
air, and if it doesn't work, and eardrum ruptures, you may find yourself being blamed for
causing the rupture, even though we know you didn't. Don't administer any medications
without medical advice.

One last word of advice. If barotitis media happens to you, and you seek medical
attention, please explain to the physician that you are aircrew, and that an overpressure
or under pressure accident has occurred. Most ground-based physicians are not used
to examining the eardrums of aircrew. You will usually be told that "you have an ear
infection" because the doctor sees a bloody red eardrum. This in fact, is not true, as
what has happened is bleeding into the eardrum from pressure, not infection. Antibiotics
in this setting are useless, and may cause more harm than good. All that is required is
time to allow the bleeding eardrum to settle. Occasionally I will prescribe nasal steroids
such as Flonase or Nasonex for my affected aircrew. An infected eardrum, with purulent
middle ear fluid, fever, or other signs of infection, is of course, a completely different set
of circumstances, and may require antibiotics.

In terms of when to fly again, it is best to see an aviation physician who can perform a
special test called an impedance tympanogram. Generally, I allow crews to fly with
pressures between +10 and -40 decapascals. Pressures outside of these limits often
result in discomfort or, in the worst case, eardrum rupture. With a little bit of knowledge,
and some precautionary activities, ear pressure problems can be dealt with before or in
flight. Unfortunately, they will undoubtedly affect the career of every pilot or aircrew out there, so knowing what to do is essential.

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References

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