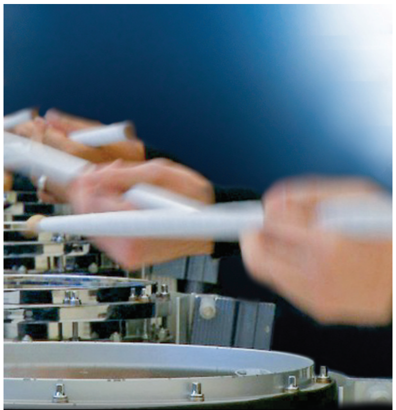

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# Percussion Musical Instruments and Hearing Loss

by Marshall Chasin, AuD

**The vast majority of noise or music exposure is the result of "steady state" noise.**
It is the almost constant level of noise or music over a prolonged period of time that results in eventual hearing loss. Research from a number of sources and "models" suggests that prolonged exposure to 85 decibels (A-weighted) for about 40 hours a week, for about a year, will result in about 6 decibels of hearing loss at 4000 Hz (near the top note on the piano keyboard). Prolonged exposures to 90 dBA will result in 11 dB, and 95 dBA exposures will result in 21 dB of hearing loss.

The above is based on "models" such as ISO R-1999. These models can have certain predictive powers that give estimates of what an expected hearing loss for a large group of workers (or musicians) will experience.

Two interesting things about these models is (1) 85 dBA is not a safe level – there will still be 6 dB of permanent hearing loss at 4000 Hz after about a year of exposure; and (2) these predicted hearing losses are only based on long-term, prolonged "steady state" noise exposure.

**But what about impulsive noises or percussion blasts from a rimshot or cymbal?**
The short answer is that we don't really know. We have fairly good models up to about 115 dBA for hearing loss due to steady state noise, but don't really have any good data for levels above that. And not only are percussion blasts of short duration, but they tend to also be of great intensity.

The longer answer to this question comes from the research of Richard Price (no relation to Vincent Price, who starred in many horror movies of the 1950s, at least I think he's not related)…. In any event, Richard Price and his colleagues in the early 1990s did some really interesting studies on how our ear responds to impulse noise exposure. Price found that when it comes to impulse noise, the motion of the basilar membrane also became a factor – it is no longer just the intensity and the duration, but now it seems to be related to the motion of the basilar membrane in the inner ear as well!

Price and his colleagues noted that "at lower sound pressure levels, losses are in all likelihood largely a function of the metabolic demand on the inner ear (it gets 'tired out') and that above some spectrally dependent critical level, the loss mechanism changes to one of mechanical disruption … (the ear gets 'torn up'). Price goes on to argue that if the basilar membrane is allowed to oscillate past the zero (atmospheric pressure) point, then more damage will be sustained by the hair cells in the Organ of Corti in the inner ear. If impulses possess either completely positive or completely negative pressure waves, then the displacement of the ossicles in the middle ear cannot impart sufficient energy to create a "tearing" action to the inner ear structures.

To better understand this, I find it instructive to trace the sound disturbance from the environment to the inner ear. A rimshot or other percussion sound creates a certain well defined pressure wave. For illustration purposes let us assume that the wave is completely positive and never has any negative (less than atmospheric) pressure throughout the more intense region of its propagation. In this case, the eardrum is kept in a medial position transducing only limited pressure directly onto the middle ear ossicles. This pressure is then transferred to the structures of the inner ear. Because the eardrum is not allowed to move freely (i.e., there is no movement past atmospheric pressure to a negative pressure), relatively little sound gets through to the inner ear. This would be in contrast to another percussion impulse sound that does move through atmospheric pressure from positive to negative. At some point in its transduction, this oscillating pressure wave allows an optimal transduction (i.e., at atmospheric pressure) of the pressure wave to reach the inner ear.

In both cases the peak sound pressure level in the environment may be the same, but the actual equivalent sound level that reaches the cochlea may be dramatically different.

Despite a cap pistol (at 30 cm) and two small wooden blocks (impacting at 2 cm) having almost identical peak sound pressure levels (at 150-153 dB SPL), because of the shape of the pressure wave, the small wooden blocks would cause a 25-dB permanent hearing loss but the cap pistol would only result in a 10-dB permanent hearing loss.

While there are occasional uses of cap guns and wooden blocks in popular music, we have, as yet, little information on other percussion sounds that are frequently found in music. Hitting metal bars or cymbals, depending on the pressure wave that is formed, as well as the peak intensity, may be more or less damaging than expected depending on the nature and shape of the created pressure wave. This is an extremely important area for future research.

In the meantime my suggestion would be for everyone to play the clarinet.