



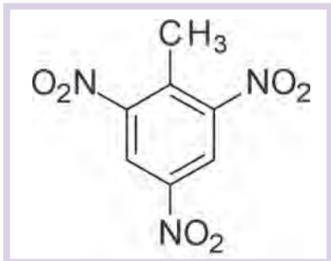
The Wattage of Warfare

By SPENCER SHORKEY

MILLERS FALLS – With the recent move by Vladimir Putin to invade Ukraine, we have been seeing many displays of powerful weapons used in this war. These bullets, bombs, and war machines contain a lot of energy. In this article I am going to discuss the embodied energy of various projectiles and explosives common in modern warfare.

The “watt” is a unit of power, and a watt-hour (Wh) is a unit of energy – power that is stored for later use. Other commonly used units of energy that can be interconverted with Wh, including kilocalorie (cal), joule (J), British thermal unit (BTU), and equivalent mass of tri-nitro-toluene (TNT).

The average human body on average uses, or “burns,” about 2,000 cal per day, equal to around 2,300 Wh, 8 million joules, 8,000 BTU, or 2 kilograms of TNT.

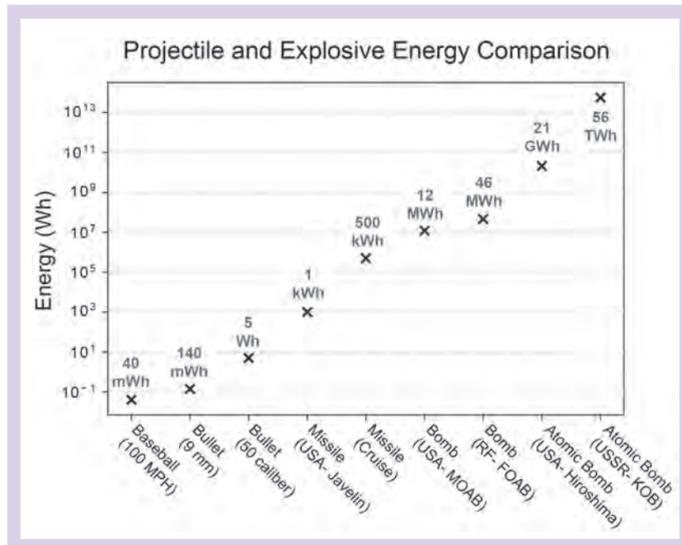


Each kilogram of trinitrotoluene (TNT) contains 2.7×10^{24} of these molecules, and about 4.6 million joules of energy.

Our bodies harness energy mostly by “cycling” adenosine triphosphate (ATP) and adenosine diphosphate (ADP) molecules in our cells. The theoretical return of the ATP-to-ADP cycle is 9 zJ (“zepto,” or 10^{-21} J) of energy per molecule.

The 30 trillion-odd cells in a body average out to 0.3 μ J (“micro,” or 10^{-6} J) of energy daily per cell, which means each cell is running at around 3 pW (“pico,” or 10^{-12} watts).

In terms of projectiles, such as baseballs or bullets from a gun, their embodied energy is simply calculated as kinetic energy, equal to the projectile’s mass, multiplied



A log-scaled energy comparison of various projectiles and explosives.

by its speed squared, and divided by two. (The equation for this is $KE = \frac{1}{2}mv^2$). A baseball traveling at 100 miles per hour comes in at 40 mWh, whereas a .50 caliber bullet traveling at 2,000 miles per hour, or nearly three times the speed of sound, comes in at up to 5 Wh – over a hundred times the kinetic energy.

North Atlantic Treaty Organization (NATO) countries have been supplying the Ukrainian army with a steady supply of missiles, which have been highly effective against Russian tanks and armored vehicles. The USA has sent Ukraine nearly 5,000 Javelin missiles, which each detonate around 1 kWh of explosive warhead upon impact.

A much larger explosive, such as a cruise missile, can pack around 500 kWh of energy. That explosion would pack the same energy as a two-ton vehicle traveling 1,500 miles, or over 10 million record-breaking fastballs hitting all at once. Putin, the *de facto* dictator of Russia, has reportedly sent well over 1,000 cruise missiles at Ukrainian civilian and military targets; however, Ukrainian missile defense systems have improved to the point that many of these are intercepted.

Among the largest non-atomic bombs in existence is the so-called

“Mother of All Bombs” (MOAB), made by the USA, with a blast yield of 11 tons of TNT or 11 MWh. Not to be outdone, Russia produced a “Father of All Bombs” (FOAB), which yields 44 tons of TNT explosive energy.

The USA has manufactured up to 15 MOABs since 2003, and has used only one, against ISIS-K in Afghanistan in 2017. Though the FOAB has not been used yet, it is likely the largest non-nuclear bomb in existence.

The first atomic bomb used in war was the “Little Boy,” dropped on Hiroshima, Japan in 1945, killing roughly 20,000 soldiers and 100,000 civilians. Its energy was the equivalent of 15,000 tons of TNT. In 1961 the USSR tested the “Tsar Bomba,” or “King of Bombs” (KOB), yielding upwards of 50 million tons of TNT and 56 TWh – equivalent in energy to a 6.5 to 7 magnitude earthquake, or roughly the amount of energy Massachusetts consumes annually.

Regarding the war in Ukraine, though in the past month Putin has repeatedly threatened nuclear action if NATO intervenes, Russian spokesman Dmitry Peskov clarified that Russia will only use nuclear weapons following a “threat for existence” against Russia itself.

MEDICINE

Seasonal Allergies? There are Options!

By CATHERINE DODDS, MD

TURNERS FALLS – April showers bring May flowers. They also bring stuffy noses and itchy eyes for many of us. With the return of spring comes the return of pollen from blooming flowers, grasses, and trees. Those who suffer from seasonal allergies become sensitized to certain allergy triggers early in life, often in childhood. Symptoms return whenever their particular triggers are in the environment.

Seasonal allergies are life-long, but symptoms can get better or worse over time, and often vary year to year. Identifying an individual’s allergy triggers can be complicated, but it’s also important because reducing or avoiding the trigger is the best way to relieve allergy symptoms. Many people are allergic to more than one thing. One individual person may have seasonal triggers, but also year-round symptoms due to mold, dust, or pet dander.

Testing for allergies may involve blood tests. These look at IgG antibodies, which show that the body’s immune system has been exposed to specific allergy triggers in the past. There are hundreds of different allergy triggers (allergens) that can be tested, so it’s helpful to limit blood tests to common allergens, or a specific trigger that is suspected by an individual’s history.

Allergy skin testing (called “patch testing”) can also be done, usually by an allergy specialist doctor. During an allergy skin test, a drop of the substance you might be allergic to is placed just under the skin by making a tiny prick in the skin surface. Then, we wait to see if the skin turns red and bumpy. The doctor can then interpret what allergy triggers you react to.

Some people choose not to be tested, instead accepting that they will have a few months of sneezing and eye watering each year, and managing those symptoms with over the counter treatments.

These include sinus rinses such as a NetiPot, steroid nose sprays including Flonase, antihistamine pills like Benadryl, Claritin, or Zyrtec, decongestants including Sudafed, and eye drops such as Zaditor. Each of these can have potential interactions or risks, so please discuss with your healthcare provider before starting any new treatment, even one that is available without a prescription.

If you consistently get symptoms around a certain time of year, it’s best to start allergy treatments two weeks before you anticipate your symptoms will start.

While medication is one way to manage allergies, other practical measures can help. Try to stay indoors as much as possible during your allergy season. Keep windows shut and use air conditioning when in the car rather than opening a window. Shower just before bed. Use a mask if working outside, particularly while raking or leaf-blowing. Avoid rubbing your eyes. Use a cool compress over the eyes or preservative-free artificial tears to help soothe and lubricate the eyes. Consider avoiding contact lenses and eye makeup during allergy season.

For those who have ongoing, severe symptoms, additional treatments are available, including prescription pills and injections, and immunotherapy (allergy shots). Allergy shots contain tiny amounts of individual allergens, so they do require testing first and are tailored to the individual. Allergy shots also mean a time commitment – the shots are given frequently (weekly to monthly) for several years, and are usually given and monitored in a medical office.

Many allergy sufferers find that allergy shots can reduce their symptoms for many years, even when no other treatments helped. If you dread the return of April showers and May flowers, speak with your healthcare provider about options to treat your allergies more effectively.

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