Toxicology of Vitamins*

Vitamin supplements can cause adverse reactions (ADRs) when prescribed properly. No therapeutic intervention, whether it is a medication or vitamin supplement, is without risk. Even my favourite vitamin (i.e., niacin) was implicated in causing five major effects (not deaths) in 2010[1] and seven major effects (not deaths) in 2009[2] from data collected by the American Association of Poison Control Centers. When an event is denoted as causing a "major effect," it means that: "The patient exhibited signs or symptoms as a result of the exposure that were life-threatening or resulted in significant residual disability or disfigurement (e.g., repeated seizures or status epilepticus, respiratory compromise requiring intubation, ventricular tachycardia with hypotension, cardiac or respiratory arrest, esophageal stricture, and disseminated intravascular coagulation)."[1]

Despite the reality that vitamin supplements can be implicated in serious ADRs, the overall advantages to taking vitamin supplements involve their low incidence of side effects, their extremely low risk of causing fatalities, their cost and affordability, their relative ease of use, and their therapeutic effectiveness. The most important point to emphasize is the extremely low risk of fatalities associated with vitamin supplements. The American Association of Poison Control Centers has been collecting data on the fatalities associated with numerous products (i.e., vitamin supplements, medications, household cleaning products, etc) for decades. There have only been 12 deaths linked to vitamins from 1983 to 2010.[3]

Medications, on the other hand, have a less than stellar safety record. In a meta-analysis of hospitalized patients, 106,000 patients had fatal ADRs, making medications between the fourth and sixth leading cause of death in the United States in 1994.[4] Another report estimates that deaths due to ADRs from medications to be about 100,000 annually in the United States.[5] If we estimate the annual death rate due to medications in the United States from 1983-2010, then some 2,700,000 deaths can be attributed to medications compared to only 12 from vitamins during the same time period.

Another method that we can use to compare the toxicities of medications to vitamin supplements is by calculating their respective therapeutic indexes (TIs). The TI represents an estimate of medication safety, for a very safe medication would be expected to have a very large toxic dose in comparison to a smaller effective dose. It is calculated by determining the ratio of the LD50 (i.e., the dose required to produce a lethal effect in 50% of the population) to the ED50 (i.e., the median effective dose at which 50% of the population exhibits a specified therapeutic effect).[6] Of course, the actual TIs of medications and vitamins are not calculated with exact precision, but are extrapolated from experimental studies, animal studies, drug trials, and accumulated clinical experience. It can be inferred that the TIs of medications are much narrower than that of vitamins as a result of being more toxic. In other words, the amount of medication that produces a lethal effect would be closer to the amount needed to produce a therapeutic effect.

To further illustrate this concept, let us compare the TI of diazepam to that of vitamin B_6 (pyridoxine). Both agents are used to treat similar neuropsychiatric disorders, such as anxiety and seizures. In an experimental study in mice, the TI of diazepam was calculated to be 350 (LD50/ED50 = 49 mg per kg/0.14 mg per kg).[7] I have calculated the TI of vitamin B_6 by using LD50 data from a material data sheet[8] and ED50 data from a published study.[9] Thus, the TI for vitamin B_6 in mice is 12,791 (LD50/ED50 = 5500 mg per kg/0.43 mg per kg); a result that is much greater than that of diazepam, suggesting that the risk of toxicity would be much less even when very large ("mega")

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doses are prescribed. The point here is not to disparage medications, as we are all fully aware of their essential therapeutic properties. My point, rather, is to simply state that vitamin supplements are much safer due to their apparently wider TIs and their tremendous safety record.

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