Botox versus Botulinum Toxin

Botox has become a household name much the way Xerox was back in the day. Botox, or more accurately "BOTOX® Cosmetic," is just a brand name, other brands sold in the United States include Xeomin® and Dysport®. These medications are forms of a naturally occurring protein, botulinum toxin A. (Brief aside, a toxin, by definition, is a poisonous substance produced by living organisms as opposed to synthetic chemicals or heavy metals which are toxic but not toxins.) Botulinum toxin A is one type of toxin produced by the bacteria *Clostridium botulinum*. The bacterial spores are common in soil and water but only make toxin under certain conditions, such as poorly processed canned food.

In biological research concerning toxins, initial research often focused on the amount of toxin required to kill half of the test subjects; known as the LD_{50} (median Lethal Dose). Botulinum toxin has one of the lowest LD_{50}s of any naturally occurring protein at 1.3 nanograms per kilogram (abbreviated ng/kg). 1.3 nanograms of toxin intravascularly, into a vein or artery, injected per kilogram body weight of victim required to kill half of the victims[1]. Cheery talk, I know, but hang with me I'll get to my point soon. A nanogram is one-billionth of a gram and just over 28 grams make one ounce. A kilogram is roughly equivalent to 2.2 pounds. For comparison, rattlesnake venom of the Western Diamond has an LD_{50} of 4,200,000 ng/kg. Lots of venom needed to kill someone (I still wouldn't want to be bit though). The Black Widow spider venom under the skin does better at 900,000 ng/kg and the puffer fish comes the closest with 8000 ng/kg when ingested. I'll pass on the Fugu sushi too, thanks. Based on these comparisons botulinum toxin sounds like pretty scary stuff but lets follow the math.

For a group of 75 kg (165 lbs.) subjects, the LD_{50} for botulinum toxin would be 97.5 ng if injected directly into a vein or artery. BOTOX® Cosmetic is dispensed most commonly in 100 unit vials which contain 0.73 ng of botulinum toxin A in the entire vial[2]. Therefore, it would take over 133, one hundred unit vials, or over 13,300 units of BOTOX® Cosmetic to kill half of the subjects, or 665 times a common dose of 20 units. For comparison purposes, the LD_{50} for acetaminophen is 334 mg per kg, orally, or only 38.5 times a common dose of 650 mg (a milligram is one-thousandth of a gram).

Despite the word toxin in the name, botulinum toxin, be it BOTOX® Cosmetic, Xeomin® or Dysport® when

used for cosmetic purposes is safe (and effective). Eating a bulging can of green beans, however, is still not a good idea.

Thanks for your attention,

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Next: Botox mechanism of action...

1. Arnon, Stephen S., *et al*; Working Group on Civilian Biodefense. (21 February 2001). "Botulinum Toxin as a Biological Weapon: Medical and Public Health Management" *Journal of the American Medical Association* **285** (8): 1059–1070. doi:10.1001/jama.285.8.1059. PMID 11209178.)

2. "Content of botulinum neurotoxin in Botox®/Vistabel®, Dysport®/Azzalure®, and Xeomin®/Bocouture®." Frevert J. *Drugs R D*. 2010;10(2):67-73.