The Math Behind Medicine: How Numbers Save Lives

“We've all asked the infamous question, “When will I ever use math in real life?” But for doctors, math isn’t just useful—it’s a matter of life and death. Every single day, doctors rely on mathematical calculations to ensure patients receive the right medication, in the right amount, at the right time.

Why Do Doctors Need Maths?

When prescribing medication, doctors not only have to rely on the drug’s effectiveness, but also must calculate the right dosage for each patient. You better hope and pray that your doctor aced his proportions test, because this is the key to ensure that the amount of medication given is neither too little, which renders it ineffective, nor too much, which could be fatal.

To maintain a balance of both safety and effectiveness, dosages are often determined based on a patient's weight (kg) or body surface area (BSA, m^2). This approach ensures that the drug is distributed in the body at an optimal concentration.

How Does It Work?

Many medications follow a formula:
Dosage = Dose per kg × Body Weight (kg)

For example, if a drug requires 5 mg per kg and the patient weighs 60 kg, the total dosage is: 5 × 60 = 300 mg

Some drugs, particularly chemotherapy medications, use Body Surface Area (BSA) for dosage calculations. The Mosteller formula estimates BSA:

If a drug's recommended dose is 50 mg/m^2 and the patient’s BSA is 1.7 m^2, the total dose is: 50 × 1.7 = 85 mg

RHEA HIREMATH

More Than Numbers: What Affects Dosages?

Ever wonder why hospitals make you fill in endless forms about your medical history before prescribing medication? Well, it is because it helps the doctor to determine the patient's metabolic rate and organ function, especially the liver and kidney. This is extremely essential to determine the exact dosage required.
Think of the liver as your body's chemical processor, it breaks down medications so they can be absorbed safely. Meanwhile, the kidneys act as a filtering system, flushing out excess drugs and toxins. If either of these organs is not functioning properly, medication can linger in the bloodstream, leading to toxicity and dangerous side effects.
But that's not all, age, genetics, other medications, and even lifestyle choices like diet and alcohol consumption can influence drug metabolism, reinstating the message that when it comes to medication, one size does not fit all.

Antibiotic Resistance: A Global Threat

One of the biggest global problems today with improper dosages, is antibiotic resistance. When antibiotics are underdosed, they fail to completely eliminate the bacteria, giving them a chance to mutate and become resistant. Over time, these resistant strains render common antibiotics useless, forcing doctors to use stronger, more toxic alternatives.

Diseases like tuberculosis and pneumonia already have multi-drug-resistant (MDR) strains, making treatment harder, costlier, and more dangerous. Precise dosage calculations—based on weight and infection severity—are crucial in preventing resistance and ensuring antibiotics remain effective.

The Future of Precision Medicine

Advancements in medical technology are making dosage calculations even more accurate, with AI-driven algorithms that can analyse a patient's genetic makeup to determine how they metabolize drugs, leading to more personalized treatments. Pharmacogenomics, using DNA to tailor drug prescriptions, is already being explored to optimise treatments for conditions like cancer, epilepsy, and cardiovascular diseases.
Beyond AI, smart drug delivery systems are being developed to release medication in controlled doses, reducing the chances of overdosing or underdosing. With these innovations, the future of medicine is shifting from a one-size-fits-all approach to personalised, precision-based treatments.

RHEA HIREMATH

CITATIONS

1Toney-Butler, Tammy J, and Lance Wilcox. “Dose Calculation (Desired over Have or Formula).” Nih.gov, StatPearls Publishing, 30 July 2019, www.ncbi.nlm.nih.gov/books/NBK493162/.

MOOC BLOG TEAM. “Math in Medicine: How Is Math Used in Healthcare?” Www.mooc.org, 30 Nov. 2021, www.mooc.org/blog/math-in-medicine-how-is-math-used-in-healthcare.

“The Medical Side of Math: How Is Math Used in the Medical Field?” American Career College, americancareercollege.edu/blog/the-medical-side-of-math-how-is-math-used-in-the-medical-field.

Johnson, Kevin B., et al. “Precision Medicine, AI, and the Future of Personalized Health Care.” Clinical and Translational Science, vol. 14, no. 1, 12 Oct. 2020, https://doi.org/10.1111/cts.12884.

Brody, Barbara. “Are Super-Personalized Solutions the Future of Healthcare?” Content Lab U.S., 14 Sept. 2023, www.jnj.com/innovation/are-super-personalized-solutions-the-future-of-healthcare.