Appendix 7.

Pharmacokinetic Model

The equations to be solved for the 1-compartment model given in Figure 1 are:

$$\frac{dN_1}{dt} = -k_1 * N_1 \quad \text{(S-1)}$$

$$\frac{dN_2}{dt} = k_1 * N_1 - k_2 * N_2 \quad \text{(S-2)}$$

And the general solution, which is the response to the intervention, is:

$$N_2(t) = A * (e^{-k_1 t} - e^{-k_2 t}) = N_2^f(t) \quad \text{(S-3)}$$

where $N_2^f(t)$ is the functional fit to the data, and $N_2^o(t_i)$ is the measured value at point t_i. The conventional error minimization reduces the error between $N_2^f(t_i)$ and $N_2^o(t_i)$ for all 15 data points for a given response, i.e., given micronutrient and dosage form. The general form for the solution for N_1 is:

$$N_1(t) = B * e^{-k_1 t} = N_1^f(t) \quad \text{(S-4)}$$

Since $N_1^f(0)$, which can be calculated from $N_2^f(t)$, represents the amount of the micronutrient initially in reservoir 1 that is transported into reservoir 2, it can provide an estimate of the fraction of the originally ingested micronutrient absorbed.

The complexity of the analysis increased following a progression from β-carotene < dl-α-tocopherol < ascorbic acid < copper < zinc. Several specialized approaches were required to provide convergence to the best fits for the different datasets, including some parsing of data where there was oversampling of the data (e.g. for dl-α-tocopherol), introduction of a lag time for absorption for the water-soluble nutrients where early negative data indicated no significant change in serum concentrations (ascorbic acid), combination of two absorption profiles where the GI absorption kinetics appears to be bimodal (zinc and perhaps copper), and in this case the need to convolute the simple two-compartment kinetics with a normal function required by the random bulk transport kinetics of the gut.