Urodynamics of Mitomycin

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Perhaps the theory below is useful information for people who are suffering from cancer of the bladder.

http://en.wikipedia.org/wiki/Mitomycin

For instillation into the bladder, an amount of 30 - 40 mg is used, as a standard chemotherapy. The chemical formula of Mitomycin is $C_{15}H_{18}N_4O_5$. Giving a molecular weight of $15 \times 12 + 18 \times 1 + 4 \times 14 + 5 \times 16 = 334$ Dalton.

http://en.wikipedia.org/wiki/Avogadro_constant

The number of molecules in 40 mg of the agent is:

$$M = 6.022 \times 10^{23} \times 40/(334 \times 10^3) = 0.72 \times 10^{20}$$

What's needed below is the logarithm of this number: $\ln(M) = 45.7$ and we could call it the therapy's constant. The therapy's constant is thus defined as the natural logarithm of the number of molecules of Mitomycin in 40 mg of the agent. Oh well, just remember its value: 45.7 .
It is known that the maximal volume B of the bladder is 500 - 800 ml. After urinating, the rest volume R of urine in the bladder should be less then 80 ml. However, for elderly persons, as is common with the therapy involved, more conservative values are likely to be assumed. Let us adopt for our calculations that $B = 200$ ml , $R = 100$ ml ; though more realistic values may be desirable.
Question: how many times N must people urinate in order to get rid of the toxic Mitomycin?
If the bladder is filled for the first time after instillation of the agent, its concentration becomes M/B. The number of molecules after urinating for the first time is: $M.R/B$. Filling for the second time and urinating for the second time: $M.(R/B)^2$. Filling for the N-th time and urinating for the N-th time: $M.(R/B)^N$. Approximately all of the Mitomycin molecules are outside the body if: $M.(R/B)^N < 1$. One thing is for sure: the first few times one goes to the bathroom are the most effective.
Note that, within this mathematical model, perfect mixing of the agent with the urine is assumed. This assumption becomes particularly *bad* as soon as only a few molecules are still left inside the body. But at that time our hypothesis has already fulfilled its purpose. So:

$$M.(R/B)^N < 1 \quad \Longrightarrow \quad \ln(M) - N.\ln(B/R) < 0 \quad \Longrightarrow \quad N > \ln(M)/\ln(B/R)$$

With the personal data assumed: $N > 45.7/\ln(2) = 65.96 = 66$.
As a rule of thumb, when urinating 10 times a day, then a safe contamination period to be assumed (: you don't want to intoxicate others, do you ?) is seven

days (which is what some hospitals say). But there is much uncertainity with this number.
There is another way to arrive at a result: let D be the amount of water a person is drinking. It's easy to see that: $D = N(B-R)$. Herewith it is assumed that the moisture balance is fulfilled and everything that goes **in** also goes **out** with the urine. But actually, it's not so simple as that. Most of the time, just drinking is not good enough and urinating must be stimulated somewhat, by using a diuretic. Quite fortunately, a simple, cheap, natural and effective diuretic is available in any supermarket. It's known as **beer**. Drinking two bottles of it is likely to be sufficient for your purpose.

`http://www.unibroue.com/beer101/sante.cfm`

Back to work. By substituting the above value of N into the formula for D we find:

$$D = \ln(M)/\ln(B/R).(B-R) = \ln(M)\frac{B-R}{\ln(B)-\ln(R)}$$

The upside down difference quotient for the logarithm is recognized. A well known and rather tight lower bound for this difference quotient is found as the area of the trapezium bound by the lines $x = R$, $x = B$, $y = 0$ and the tangent at $x = (B + R)/2$, the whole divided by $(B - R)$. It is equal to the derivative of the logarithm there: $1/(R/2 + B/2)$. Turning this upside down results in a simple, but useful, upper bound:

$$D = \ln(M)/\ln(B/R).(B-R) < \ln(M).(B+R)/2$$

The right side of this inequality can be interpreted as a mathematical model of continuous urinating, assuming that the volume of the bladder is always the *mean bladder volume*.
With personal data as above we find: $D < 150$ ml $\times$ 45.7 = 6.86 litres. So, As a rule of thumb, when drinking 1.5 litres of water a day, then a safe contamination period to be assumed would be: five days. This period can be shortened by simply drinking more; 2 litres a day, for example, already results in four days. Our hospital says that three days must be taken. The far more important rule is that I should drink *seven litres* of water in total, in order to get rid of the Mitomycin completely (still under the hypothesis that the personal values $R = 100$ ml and $B = 200$ ml are close to reality).
Let's summarize the main result once again in general for convenience, but expressed in common speech now. A rule of thumb for releasing **all** of the 40 mg of Mitomycin is to drink, or rather urinate, the following

$$\text{amount of water} = 45.7 \times \text{mean volume of your bladder}$$

This simple formula, in principle, enables a personal advice for any patient, in order to minimize the - inevitable - discomfort associated with the therapy.

Disclaimer

Anything free comes without referee, hence without guarantee.