Calculation Skills: Plasma Half-Life

The plasma half-life ($t_{1/2}$) of a drug refers to the time it takes for the plasma concentration of a drug to decrease to half of its initial value (Trounce, 2008). The concentration of a drug in the plasma falls as it is metabolised and excreted (Alder, Astles, Bentley et al, 2015). Knowing a drug's half-life is important in determining the dose of a drug needed to achieve and maintain a therapeutic effect and to avoid toxicity (Alder et al, 2015). The accumulated dose of the drug reduces with each dose.

Question A

Drug A has a half-life of 8 hours and a strength of 200mg.The first dose is taken at 06:00 hrs and 8 hourly thereafter.

(i) Insert the missing amounts from the table below, for the first two days of treatment with drug A.

Time	Dose	Dose still present	Accumulated Dose
06:00	200mg	0	0
14:00	200mg		300mg
22:00	200mg	150mg	
06:00	200mg		
14:00	200mg		
22:00	200mg		

(ii) How many doses will the patient have had for the accumulated dose to have be less than 1mg of the previous accumulated dose?

Question B

(i) Mr. Jones has taking drug B which has a half-life of 6 hours. He has plasma level of drug B of 120mg. If Mr. Jones takes no further doses of drug B, how long will it take for the plasma level to reduce to 1.875mg?

(ii) Mrs. Walters is commenced on drug C, taking 50mg per dose. Drug C has a half-life of 12 hours. After 36hrs, her current plasma level of drug C is 93.75mg. How many tablets has Mrs. Walters taken?

Question C

(i) The half-life of drug D is known to be between 15 and 50 hours. What is the mean half-life of drug D?
Tip: Mean is calculated by adding the known values and dividing this total by the number of known values.

(ii) The mean half-life of drug E is 4 hours, assuming only two values (whole numbers) were available to determine the mean, what are the possible values used to determine the mean of 4 hours?

Question D

(i) Miss Marsden is given a single dose of 400mg of drug F. After 24 hours, the plasma level of drug F is 6.25mg. What is drug F's half-life?

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References

Alder, J., Astles, A., Bentley, A. et al (2015) *The textbook of non-medical prescribing,* Chichester: Wiley

Greenstein, B. (2008) *Trounce's clinical pharmacology for nurses,* London: Churchill Livingstone

Calculation Answers

Question A

(i)

Time	Dose	Dose still present	Accumulated Dose
06:00	200mg	-	-
14:00	200mg	100mg	300mg
22:00	200mg	150mg	350mg
06:00	200mg	175mg	375mg
14:00	200mg	187.5mg	387.5mg
22:00	200mg	193.75mg	393.75mg

(ii) Three more doses will bring the accumulated dose to 399.2 which is 0.8mg (398.4 – 399.2) more than the previous accumulated dose. The patient will have had nine doses.

Question B

(i) 120mg to 60mg = 6hrs

60mg to 30mg = 6hrs

30mg to 15mg = 6hrs

15mg to 7.5mg = 6hrs

7.5mg to 3.75mg = 6hrs

3.75mg to 1.875mg = 6hrs

6 + 6 + 6 + 6+ 6 + 6 = 36hrs

(ii) 1st dose 50mg

2nd dose 50mg + 25mg remaining = 75mg

3rd dose 50mg + 37.5mg remaining = 87.5mg

4th dose 50mg + 43.75mg = 93.75mg

4 tablets have been taken.

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Question C

(i) The known values are: 15 and 50 hours, so 15 + 50 = 65
The number of known values is two (15 hours and 50 hours).
To calculate the mean:

$$\frac{15 + 50}{2} = \frac{65}{2} = 32.5$$

The mean half-life of drug D is 32.5 hours

(ii) The sum of the two values must be 8 (8 ÷ 2 = 4). The possible values could be:
1hr + 7hrs = 8hrs
2hrs + 6hrs = 8hrs
3 hrs + 5hrs = 8hrs

Question D

Miss Marsden is given a single dose of 400mg of drug E. After 24 hours, the plasma level of drug E is 6.25mg. What is drug E's half-life?

Drug F = 400mg

400 → 200 → 100 → 50 → 25 → 12.5 → 6.25

In reducing from 400mg to 6.25mg, there are 6 half-lives. 6 half-lives took 24hrs.
So 1 half-life = 24 ÷ 6 = 4hrs.