EDUCATION SESSION

A card and board game to reinforce learning of elementary clinical pharmacology

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Basic scientific pharmacology is taught at Nottingham Medical School as part of an integrated curriculum. Thus, as an example, medical students learn about local anaesthetics immediately after instruction on the nerve action potential and are taught this area of pharmacology by a pharmacologist sharing the lecture theatre with an anaesthetist. This progression from physiology and/or biochemistry to pharmacology and thence to elementary therapeutics is applied to all major classes of drugs and begins (with the above example) in the first term of the course.

This introduction of integrated scientific and clinical pharmacology early in the curriculum means that students need to absorb pharmacological mechanisms, drug names and key therapeutic principles without the opportunity for reinforcement offered in later years by clerking and ward rounds. Some form of simulation seemed appropriate to fill this reinforcement gap and, in obedience to the principle that learning ought to be fun as well as disciplined, a game was devised.

The game bears a superficial resemblence to 'Monopoly'[1]. Each of 3 to 5 players has a small number of counters and each counter represents a patient. The counters enter and are moved around the board on the throw of dice. At each throw the counter may land on a square which specifies a health problem (e.g. allergic asthma, post-partum bleeding). Each player also has eight cards dealt at the start of the game from a deck of 72. Each card bears the name and classification of a drug. Thus, to move away from a problem square, the player must display a card bearing an appropriate treatment. Treatment cards circulate on the 'pick up and discard' principle. Contraindications and other subtleties are built in via a second card deck with functions like 'Chance' in Monopoly. The objective of the player is to move all patients once round the board to the 'Discharge' square.

Students claim to enjoy the game. Unsupervised groups use it in their own time, the only request from staff being that they log their treatment of each problem and check these for validity with a member of staff. Their treatments are in general responsible and ethical. The game would appear to provide convivial and disciplined small group activity for absorption of drug names and therapeutic principles.

[1] 'Monopoly' is a registered trademark of Waddingtons & Co. Ltd.

Student-constructed hydraulic and mechanical models for learning fundamentals of pharmacokinetics

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Existing pharmacokinetic texts depend substantially on mathematical exposition which is unpalatable for many medical students. Models or simulations of drug distribution are a response to this problem. For example, Jansen (1977) has used dye distribution in glass vessels as a pharmacokinetic teaching aid. We have used student-constructed models to help learning in this field. A group of 7 third year medical students devoted approximately 10 h to the preparation of elementary explanations, for a non-mathematical audience, of pharmacokinetic principles founded on demonstrations with simple hydraulic and mechanical models.

The models constructed were:

(a) A model simulating regular oral dosing of a drug having a mono-exponential plasma elimination curve. This consisted of a large aspirator cyclically filled with water from a pipette-washer and drained from a bottom vent, the drug concentration being represented by fluid depth in the aspirator, and dose by fluid volume—so that volume of distribution was simulated by the vessel cross-sectional area.

(b) A model of two compartments having the features of the above model on a smaller scale and pro-

viding continuous monitoring of the fluid level ('drug concentration') in the plasma compartment. The record could be in either linear or logarithmic mode to demonstrate bi-exponential kinetics and the influence of various parameters including a simulation of displacement of a drug from plasma protein binding.

(c) A shaking table on which ball-bearings set in random motion were used to show:

(i) how binding (on magnets) would affect the free concentration and therefore the apparent volume of distribution of a substance.

(ii) the effect of barriers to diffusion on concentration, and the differences of distribution of two substances represented by two sizes of ball bearing.

These models, together with conventional demonstrations of diffusion and protein-binding of a dye and a simple computer simulation, are demonstrated in a videotape prepared by the student group. The students who prepared the models and the videotape experienced considerable benefit from the task. This tape is expected to be a helpful supplementary source for 1st year and 2nd year students studying elementary pharmacokinetics.

Reference

JANSEN, J.A. (1977). A simple simulator as an aid to teaching of pharmocokinetics. *Acta. Pharmac. Tox., Suppl.* 55.

A microprocessor-based simulator for teaching pharmacokinetics

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The simulation of the change of plasma drug concentration with time by dye-dilution (Jansen, 1977) or by electrical analogue (Danek, 1976) models has been found to be a useful teaching aid in the explanation of clinical pharmacokinetics, such as that described by Gray & Lasseter (1976), in that they do not seek to find the best solution to the data in compartmental and rate terms, but merely to illustrate the consequences of change in a few important parameters. Restriction to an elementary system with a limited number of parameters allows the student to appreciate some basic concepts in pharmacokinetics such as effects of change of dose size, dosing interval, apparent volume distribution and absorption and elimination rate constants.

An inexpensive and portable simulator based on the Intel 8080 microprocessor has been used for the teaching of pharmacokinetics to medical students. The simulator was constructed from a "Pocket teletype" keyboard (G.R. Electronics Ltd.), an Intel SDK 80 microprocessor kit, a digital/analogue converter (Signetics NE 5018) and a laboratory potentiometric recorder. A table of exponential values is stored in 256 bytes of a 1 k byte, read-only, (EPROM) memory. A single compartment model of the type:

$$Cp(t) = CPo\,(e^{-k_{el}t} - e^{-k_a t})$$

where

$Cp(t)$ = concentration of drug in plasma
Cpo = theoretical concentration at the moment of injection
K_{el} = Elimination rate constant
K_a = Absorption rate constant
t = time in hours

requires the computation of two exponential values which are taken by the program from values stored in the table. The machine produces an output corresponding to 8 min or real time at 1 s intervals or less, and continues until the values of the exponentials have both decreased to less than one unit. The output is displayed on a standard potentiometric recorder with a f.s.d. of 10 volts. The programme is able to run at speeds of between 60 and 6000 times real time, thus allowing a complete 24 h simulation to be displayed in less than one minute. The program is stored in the remainder of the 1 K EPROM.

Multiple dosing may be illustrated by pressing any key of the pocket teletype whilst displaying a run, a second dose is then added to the residual concentration and the output displayed accordingly.

The simulator is easy to use and has found ready acceptance by students for self instruction. Moreover, the nature of the model could be made more complex, by reprogramming the microprocessor to take account of more compartments, as future needs demand.

CGW acknowledges financial help from the Trust Fund of the University of Nottingham Medical School for the purchase of components.