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VIRTUAL EXPERIMENTAL PHARMACOLOGY AN ALTERNATIVE OR NOT? – A GLOBAL ASSESSMENT BY PHARMACOLOGY FACULTIES AND MBBS STUDENTS

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Abstract

Aim: To assess the preference and acceptance of the virtual and real animal experiment in experimental Pharmacology in undergraduate students. Materials and Methods: Study was conducted in practical hall in the department of pharmacology, Saveetha Medical College. Students who came for the practical class were exposed to both virtual and real animal experiments. 131 students were exposed to both virtual and experimental experiments. Four types of experiments has been exposed to the students. Virtual experiment exposed by Audio- visual aids. Real experiments were conducted by students themselves in groups of ten. Questionnaire was served to the students to find out their preference and acceptance. Questions were framed pertaining to 1. Knowledge 2. Recollection of subject 3. Research. The last question was about their acceptance. Faculties were also assessed on their preference. Results: The results were analysed to find out the knowledge gained, recollection of subject, and research orientation in both virtual and experimental pharmacology. Conclusion: Virtual experiments can be an alternative to animal experiments in experimental Pharmacology in undergraduate teaching.

Keywords: Virtual experiment, Animal experiment, Knowledge

Introduction

The undergraduate curricula for a wide range of biological, medical courses, in which physiology and pharmacology, traditionally include laboratory experiments that reflect the practical nature of these subjects. These often involve the use of animals or animal tissue, sometimes unnecessarily. The learning objectives of these classes can be summarised as 1. Teaching factual knowledge; 2. Demonstrating the dynamic processes of life; 3. demonstrating the integration of complex systems; 4. teaching methods of scientific research; 5. developing problem-solving capabilities in the experimental environment; 6. Stimulating independent working; 7. Training in technical and manual skills; and 8. developing attitudes toward animal experimentation[1]. Animals used in teaching should not be regarded as dispensable tools. If students are regularly confronted with animal use during their studies, they might not be able to develop a balanced attitude toward the use of animals in research.

Clearly, these objectives are important, and any alternative should fulfil these objectives at least as well as the traditional approach. The number of animals used for educational purposes, research and testing, is significant, because several hundred thousand animals are used across the world each year. In article 25 of the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes [2], the Council of Europe states that, "procedures carried out for the purpose of education, training or further training of professionals shall be restricted to those absolutely necessary for the purpose of the education or training concerned and shall be permitted only if their objective cannot be achieved by comparably effective audiovisual or any other suitable method." The use of animals in education has a major impact on the total use of animals in science, since animals are used to prepare students for research careers [1].

One of the most significant trends in modern research in recent years has been the recognition that the results of animal tests are rarely relevant to humans. Studies in esteemed publications such as the Journal of the American Medical Association and the British Medical Journal have repeatedly concluded that because of the fundamental biological differences

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among species, animal tests do not reliably predict outcomes in humans.

Most scientists and governments say they agree that animal testing should cause as little suffering as possible, and that alternatives to animal testing need to be developed. The "three Rs" [3,4] first described by Russell and Burch in 1959, are guiding principles for the use of animals in research in many countries

1. Replacement refers to the preferred use of non-animal methods over animal methods whenever it is possible to achieve the same scientific aim.

2. Reduction refers to methods that enable researchers to obtain comparable levels of information from fewer animals, or to obtain more information from the same number of animals.

3. Refinement refers to methods that alleviate or minimize potential pain, suffering or distress, and enhance animal welfare for the animals still used.

Two major alternatives to in vivo animal testing are in vitro cell culture techniques and in silico computer simulation. However, some claim they are not true alternatives since simulations use data from prior animal experiments and cultured cells often require animal derived products, such as serum. Others say that they cannot replace animals completely as they are unlikely to ever provide enough information about the complex interactions of living systems[5]. Other alternatives, involve the use of humans for skin irritancy tests and donated human blood for pyrogenicity studies. Another alternative is so-called micro dosing, in which the basic behaviour of drugs is assessed using human volunteers receiving doses well below those expected to produce whole-body effects [6]. "The Principles of Humane Experimental Technique" was published in London in 1959, and the book defined animal testing alternatives as "The Three R's: Refinement, Reduction, and Replacement." [4,7]

Depending on the learning objectives, animal-free models have several advantages over animal experiments. In cases where students are not well-prepared for work with animals, the emotions aroused by being confronted with a dead or live animal might distract from the actual learning experience. Non-animal models can be developed in such a way as to achieve the learning objectives more effectively. For example: 1. a specific animal experiment might only be offered once, whereas an alternative model can often be used over and over again without constraints on time and place of study; 2. alternative models can offer unambiguous and complete data, and so can avoid the negative learning experience of an unsuccessful experiment; 3. an alternative can have built-in self assessment to allow students to gauge whether staged learning objectives have been achieved; and 4. alternatives which make use of modern audio-visual techniques offer the possibility of demonstrating phenomena that are normally unobservable in the equivalent animal experiment, such as animations of organ and cell functions and fly-throughs of organ systems. So in many areas virtual experiments have been tried and is getting familiarised among the population. To minimise the suffering of animals and make the students aware about the virtual studies, this study was undertaken. Keeping all this in mind the study was planned and conducted in our department.

Objective

- To assess the preference and acceptance of the virtual and real animal experiment in experimental Pharmacology in undergraduate students.
- To assess the preference for virtual or animal experimentation in faculties

Method and Materials

Study was conducted in practical hall in the department of pharmacology, Saveetha Medical College. Students who came for the practical class were exposed to both virtual and real animal experiments. 131 students who attended the practical class were exposed to both virtual and experimental experiments. Four types of experiments have been exposed to the students. Virtual experiment exposed by Audio- visual aids. Real experiments were conducted by students themselves in groups of ten. Questionnaire was served to the students to find out their preference and acceptance. Questions were framed pertaining to

1. Knowledge 2. Recollection of subject 3. Research orientation.

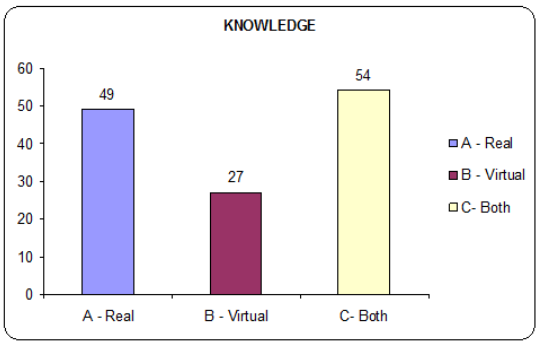
The last question was about their acceptance for the virtual experiments than real animal experiments. Faculties about 10 were also given with questionnaire and assessed for their preference.

Results

This is a simple observational study. The results were analysed to find out the knowledge gained, recollection of subject, and research orientation in both virtual and experimental pharmacology.

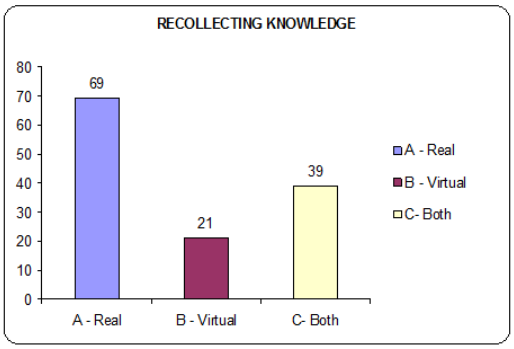
Regarding knowledge, student's response is shown in the fig 1

Figure 1



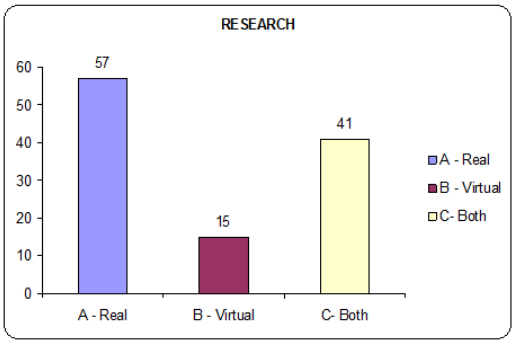
Students response to recollecting the subject is shown in fig 2

Figure 2



Results given by the students regarding research orientation and motivation is given in fig 3

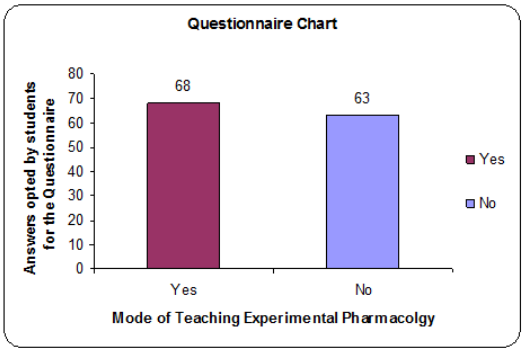
Figure 3



- This result is regarding the last question "Is virtual type of teaching experimental pharmacology an alternative to animal experiments"- yes/ no

The response is given in fig 4

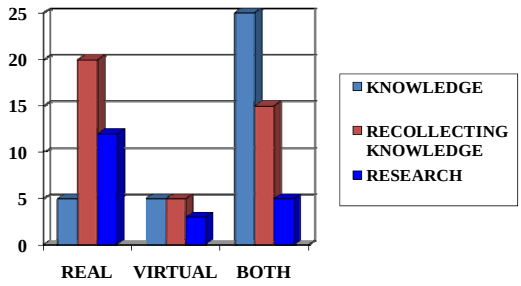
Figure 4



Faculties assessment

Faculties response towards both virtual and animal experiment is given in fig 5

Figure 5



Discussion

An area where animal use is particularly popular yet especially flawed in predicting effective drugs and identifying dangerous ones – yet still using this outdated, inaccurate method. Computers have revolutionised this area, as their ability to handle millions of interactions simultaneously enables them to model physical conditions. Scientists have been using computer modelling to simulate different experiments in minutes or hours compared to months or years performing experiments on animals. Drugs can now be designed on computers and introduced in virtual clinical trials or even tested on virtual organs. Scientists have been conducting research on the development of a full virtual model of a human that will be more reliable in predicting the effects of different chemicals on the human body[8]. This will be able to provide better results compared to the traditional animal models.

Computer packages predict drug effects – one specialises in those in babies and children, an area animal tests have shown their failure with dramatic results for the children involved [9] .The goal of developing an entire virtual human is being achieved already, with organs and their interactions being simulated accurately along with reactions to drugs[10]. Microdosing a technique where patients are given 1% of a test drug while their body is scanned using Accelerator Mass Spectrometry. This shows where the drug is and monitors it's activity and effects. Evaluation of microdosing has shown it to be accurate, even on drugs than have unusual, unexpected characteristics [11].

It's even been proven to work at lower test levels. Tests using one millionth (0.0001%) of therapeutic doses still enabled evaluation of drug concentrations in blood, saliva, urine, DNA and white blood cells. An expert explained "we can say with confidence that between 30 min and 45 minutes after dosing, 0.09% of the oral dose resided within the white blood cells in the blood. Such data could not have been obtained by any other method" [12].By comparison, animals are known to metabolise medicines along

different routes in the body[13]. The majority of dangerous reactions are missed in animal tests [14], and most dangerous reactions predicted at that stage never happen in humans[15].

Part of the problem with animal studies is that straight away there's a complex animal with millions of interactions that are too complex to unravel. Now it's obvious that we need to understand what's happening with individual cells, and even within individual cells. No animal liver is similar to a human liver, which is a major problem because this organ is central to the way a drug is handled in the body. But now human liver has been grown in the lab, and can be used to test drugs. A report said that the discovery "eliminates the need for animal experiments for drug testing "[16]. With this wealth of scientific methodology available, there clearly isn't a need for animal testing. Keeping all this things in my mind our department decided to get the opinion of virtual experiment among the students and the faculties to minimise the usage of animals in experimental Pharmacology.

Analyzing the above data, under knowledge – both(virtual and real experimental) acceptance is more compared to real and virtual. It shows students prefers both the live animal experiment and the virtual experiment. The data for recollection of subject revealed students has preference for real experiment , Since till then they have been exposed only to real animal experiments in their experimental Pharmacology . They will get adopted the virtual experiment soon if this method continues for a longer time. The data for orientation towards research shows students prefer either real experiment or both the methods not the virtual experiment alone which motivate them to do research. For the last question, whether they prefer virtual as alternate to animal experiment equal number of students have responded both to yes and no. it shows students prefer and accept the virtual experiment instead of animal experiment in experimental pharmacology .Faculties assessment also favor that knowledge about the experiment can be well understood by both virtual and real experiments. Virtual alone can be useful to attain knowledge about the subject, and recollecting the subject. But for research orientation they need real experiments. MBBS (Undergraduate) students are mainly concerned with gaining knowledge and to recollect the subject than research orientation. Further virtual teaching reduce the total investment, space, equipment, animals and faculty time. Although in some cases the development of an alternative model can be expensive, it can often be used repeatedly. Overall, the alternative model is cheaper than purchasing and caring for large groups of animals. The use of an alternative can also often save time for both the tutor and the students [17].

Conclusion

From this study our students and the faculties preferred and accepted virtual experiments. So virtual experiments can be an alternative to animal experiments in experimental pharmacology in undergraduate teaching.

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