Computer-aided veterinary learning at the University of Cambridge

M. A. Holmes, P. K. Nicholls

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An approach to computer-assisted learning in veterinary education at the University of Cambridge, involving the development of four types of learning module, is outlined. A tutorial on regional perineural anaesthesia in the horse, based on the familiar tape-slide format but with significant improvements, is described. A question and answer self-assessment package and a computer-based 'digital lecture' are also discussed, together with a case simulation involving the investigation of a polydipsic dog. All the tutorials were developed using standard software packages and image digitising processes. The philosophy behind the development of these computer-assisted learning packages is discussed.

IT is now 12 years since the United Kingdom Computer Board for Universities and Research Councils published the Nelson Report (Nelson 1983) which examined the role of computers in university teaching. It concluded that computer-based learning was underutilised in higher education. However, it seems that computers have yet to make a major impact in university teaching (Verbeek and Scarff 1993), although it appears inevitable that they will (Newble and Cannon 1989). Computers are considered to have great potential in medical and veterinary education, because visual recognition skills, the understanding of complex biological processes, experimental and case simulations can all be taught by computer-based learning systems (Longstaffe 1990). With expanding student numbers and no matching increase in staff and resources some medical and veterinary schools are turning to methods such as the demonstration of post mortem examinations by video (Ellis 1993, Goudie and others 1994) and the introduction of computer-assisted learning modules (Gouldesborough and others 1988, Longstaffe and others 1988, Underwood 1988, Robinson and others 1993) in order to cope with the increased teaching demands. Once they have been produced, some of the more traditional audiovisual aids, such as videotape, are difficult to alter in response to advances in knowledge or when changes in terminology occur (Goudie and others 1994), but most computer-based packages are easy to update and modify (Longstaffe 1993). The cost of computer hardware is no longer the formidable barrier that it once was. Other developments such as videodisc image archives are now available to act as sources of information for computer-based learning projects (Mercer and other 1988).

It was against this background that, during the academic year 1993-94, the Department of Clinical Veterinary Medicine at the University of Cambridge took its first tentative steps towards the adoption of computer-aided learning in the veterinary curriculum. Two factors led to the initiative at this time. The first factor was the recent advances in computer technology that have produced computers that can display photographic quality still images, and display video and play high quality sound for less than £1000. Until recently, any attempt to use computers with veterinary information resulted in a degradation of the original material. Another important technical development is the use of compact disc technology which can store vast amounts (up to 600 megabytes) of information on a single disc. These discs are very cheap to produce in large numbers (they are often given away with magazines) and even using 'write-once' discs cost only £13 each. The second factor was the adoption of a new curriculum which attempted to reduce the amount of didactic teaching; although this was considered to be a necessary development it placed a greater burden on self-learning and it was felt that steps should be taken to increase the facilities available for this.

A group interested in computer-aided learning was formed within the department and it was decided to develop a variety of packages as a first initiative to explore their potential and to provide examples for the other teaching staff in the school. A small number of computers capable of handling high quality images and sound were already available and it was decided to produce prototype packages before seeking funding for more computers to deliver the packages to students. Some additional funding for the development work was obtained from the Teaching and Learning Technology Programme via the Computer based Learning in Veterinary Education (CLIVE) consortium (Short 1994).

M. A. Holmes, MA, VetMB, PhD, MRCVS, **P. K. Nicholls,** BSc, BVSc, MRCVS, Department of Clinical Veterinary Medicine, University of Cambridge, Madingley Road, Cambridge CB3 0ES

Materials and methods

Four types of computer-aided learning package were developed during this first phase of the programme, a nerve blocking tutorial, MacQA, digital lectures and a case simulation.

Nerve blocking tutorial (Fig 1)

The first package produced in the department was a computerised version of a tape/slide package on regional perineural anaesthesia in the horse. In a conventional tape-slide presentation the student views a sequence of 35 mm slides which are accompanied by a commentary on audio tape. The computerised version has several advantages over this format. The user can start at the beginning of the tutorial and view all the slides in the original sequence, but they are also able to omit or review sections as they see fit. This makes it easier for the students to go at their own pace and either repeat difficult sections or skip previously covered topics should they so wish. The addition of a quiz enables the students to test their knowledge after having completed the presentation, thus reinforcing the learning experience.

The veterinary content, assembled by Dr J. Slater, includes photographs of fresh dissections of horse limbs to illustrate the anatomy of the sites of nerve blocks, together with photographs of the intact limbs with the injection sites clearly marked. These are combined with anatomical diagrams and other pictures which were transferred to a Photo-CD (Eastman Kodak) from which the images can be transferred to the computer. A script had been prepared for the commentary to accompany the slides and was narrated by the author and recorded on to video tape. The audio track from this video for each 'slide' was then recorded into the computer (digitised by using Macintosh built-in audio [Apple]) so that the computer could replay a narrated section when appropriate.

The slides or screen images were created by using proprietary presentation software normally used for the production of 35 mm slides (Powerpoint; Microsoft). The original photographs, stored on Photo-CD, were first loaded into an image manipulation program (Photoshop; Adobe) so that the original photographic images could be cropped and labelled. This type of program also has the advantage that it provides facilities for adjusting the brightness, contrast and colour balance of the images which can be used to improve the quality of under- or over-exposed images and to bring out the detail of areas of particular interest. These images were then combined with the text, diagrams and narrated commentary to illustrate the concept or information that the author was trying to convey. The final package has a total of 60 images including 11 multiple choice questions.

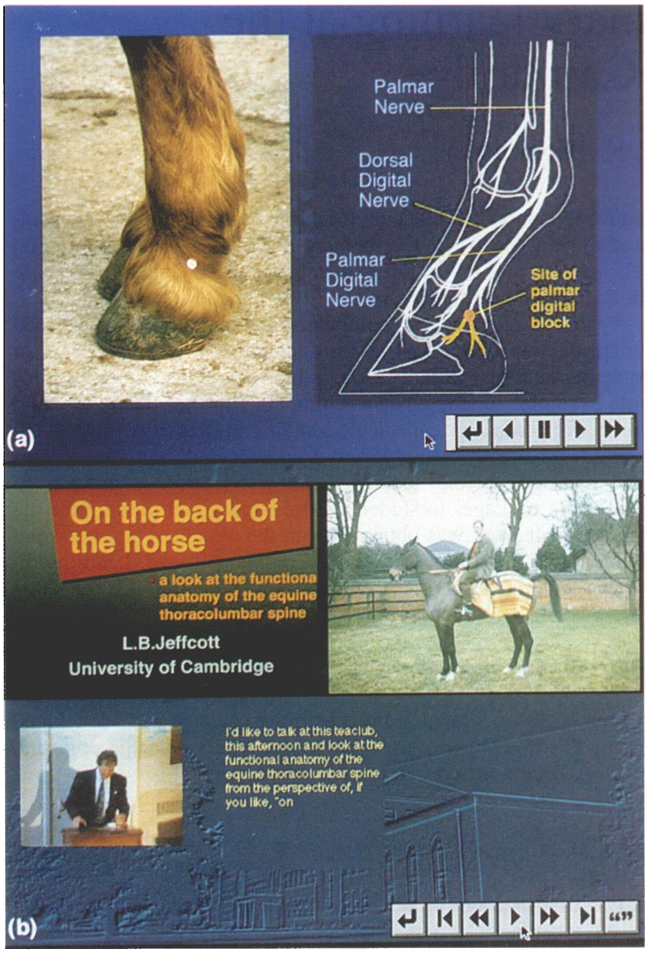

FIG 1: (a) Nerve blocking tutorial. This figure illustrates one of the screen images used during this computer-aided learning package. The photographic image of the horse's forelimbs was taken from a photo-CD and the anatomical illustration created by using Adobe Photoshop. (b) Digital lecture. This screen image was taken from a digital lecture prepared from a seminar given by Professor Leo Jeffcott on equine functional anatomy. This package simultaneously displays a video of the talk, high quality images of the slides used, and a searchable transcript of the text

One advantage of this type of computer-based educational package is that it is relatively simple to create. Existing resources in the form of tape-slide programs can easily be converted to the computer format by using the proprietary software described, and the material can be readily duplicated and updated or modified as necessary. The conversion of an existing, conventional tape-slide package to this format would take no extra time on the part of the author, and between five and 10 hours of audiovisual technician's time, depending on the number of images and length of narrative used. Since this prototype was produced, a package covering renal pathology has been created; the nerve block tutorial acted as a template for the renal pathology module, making further design and programming tasks unnecessary.

MacQA (Fig 2)

A simple question and answer program has been produced by G. McConnell at the Royal (Dick) School of Veterinary Studies in Edinburgh for use in its computer-based learning systems. This program displays a question on the screen together with an image such as a photograph, drawing or flowchart, to which the student then responds. Having thought about the problem, the students ask to see the answer which is displayed together with a suitably annotated photographic image or other illustration. They then mark their own answer right or wrong. The advantage of self-marking is twofold. First, it avoids the need to use the keyboard to type in a long answer, since all interactions are made by using a 'mouse' and an on-screen pointer. This makes the program easier for those students who are unfamiliar with computers or who have poor typing skills. Secondly, it avoids the frustration of having a correct response marked as wrong by the computer simply because the answer was unrecognised owing to a spelling mistake or a different word order from the computer's answer. Questions can be asked in a random order or a set sequence and the students can skip sections which they have covered in a previous session. When the students have completed the available questions the computer informs them of their success rate.

One of the most attractive features of the program is the simplicity with which the sets of questions can be assembled. All that is required is a word processor capable of producing text files. Each question consists of four lines of text; the first line contains the question, the second line the name of the picture to accompany it, the third line the answer, and the fourth line the name of the picture to accompany the answer. The pictures are mostly taken from digitised photographs or slides on Photo-CD, although some are diagrams that have been specially drawn for use with the computer. The shorter programs may take less than an hour to produce, but the larger programs may take several hours, depending on the number of questions and images used.

Digital lectures

One of the mainstays of university teaching is the lecture. With the advent of affordable video recording systems the video taping of lectures for remote or individual learning became a possibility.

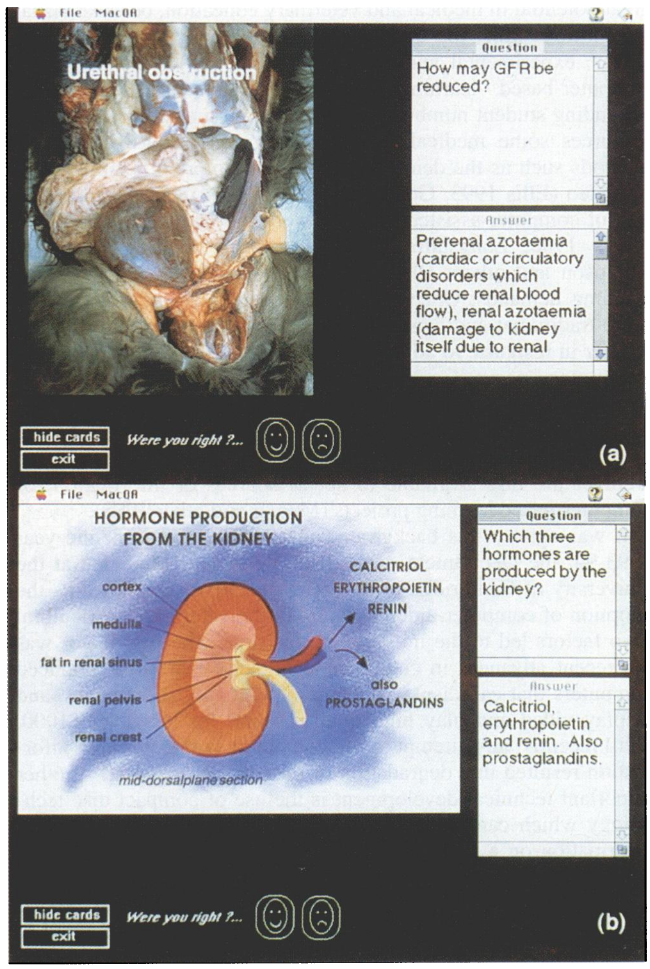

FIG 2: MacQA. This figure shows two screens from a renal pathology quiz. (a) This screen uses an image of gross post mortem pathology to illustrate the effects of urethral obstruction. The original image was on a 35 mm slide which was copied on to a Photo-CD. (b) This screen shows an illustration created on a computer by a professional illustrator for use in this quiz

Unfortunately, it rapidly became apparent that video technology had considerable limitations as a medium for recording lectures. The main problem is how to display slides together with the speaker with sufficient image quality that all the detail of the original photographic slide is retained; certain types of image, such as photomicrographs of histology, are severely degraded by reproduction on conventional video and the costs of off-line video editing are extremely high. However, with the pressures on the modern veterinary curriculum following the adoption of lecture-free final years and an ever increasing body of veterinary knowledge it would be of enormous value to be able to record lectures for later use.

By using computer technology the authors have produced a system which successfully recreates the original lecture and in some ways improves upon it. The lecture is presented to the viewer on a computer screen which is divided into three areas. In a small box in one part of the screen is a digital video of the lecturer giving the talk, in a second much larger box the slides are shown, and in a third box a transcript of the lecture is displayed. A sound recording of the lecture is played through the computer's speaker which is synchronised to the video image, slides and transcript. While viewing, the student may pause, advance or rewind the lecture. The inclusion of the transcript enables the text to be searched and the lecture played from that point. For example, if during a lecture on the use of a certain drug the student wants to find out if the lecturer talks about its use in cats it is possible to search for any occurrence of the word 'cat' in the transcript and to make the computer display the video, slide and transcript at that point in the lecture. The student can thus view only that part of the lecture which is of interest, or easily find a particular part. Additional transcripts can also be added containing simultaneous translations or commentaries. For the creation of this type of computer-aided package, no extra time is required because the lecturer can simply give their lecture as normal but with the addition of a microphone and video camera. Colour transparencies can be digitised in advance of the lecture or at a later date. The raw materials can be converted to the computerised format in a matter of hours by an audiovisual technician.

The CD-ROMS containing the digital lectures are 'hybrid' discs which can be used on either Apple Macintosh or IBM-compatible computers. The same disc contains two programs, one for each type of computer, and a number of shared data files which contain the video, slides and transcripts.

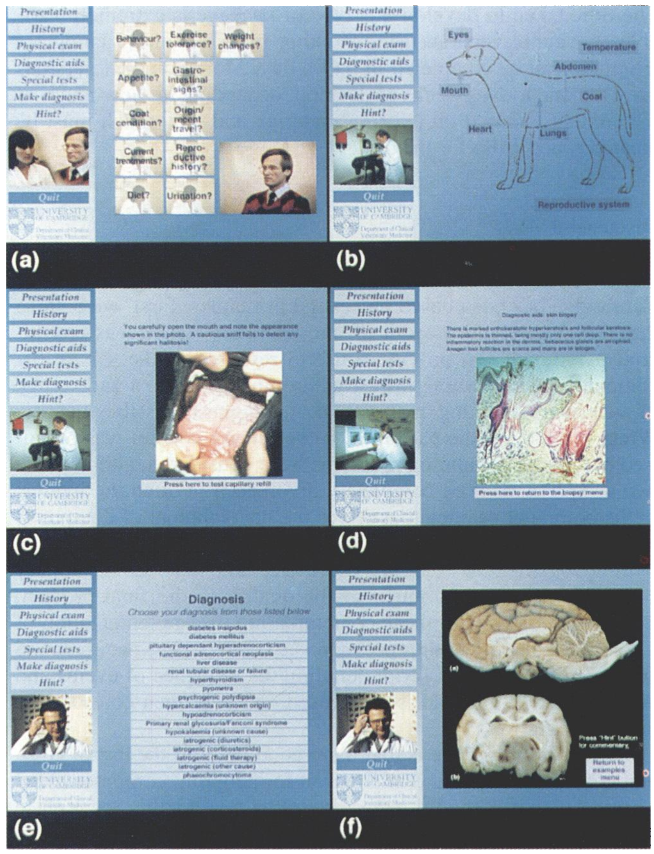

FIG 3: Case simulation. This figure includes a sequence of screen images taken from a case simulation program. (a) This screen appears when the user wants to take a history. The selection of a question from those listed on the screen results in the playing of a video of the question and answer in the bottom right of the screen. (b) A physical examination can be made by selecting the area of interest from a drawing of a dog, as shown in this screen. (c) Having selected an area of interest, such as the mouth (shown here), a combination of text, still images, video and audio are used to convey the results of the physical examination of the area. (d) The student may use various diagnostic aids such as radiography, ultrasonography, haematology, biochemistry or biopsy in order to gain more information. In this screen the results of a skin biopsy are shown. The tutor (hint) option is always available and in this instance would help with the interpretation of the histology. (e) After further special tests such as water deprivation or dexamethasone suppression tests the student chooses a diagnosis from the available polyuria/polydipsia differentials. It is possible to go back and do further tests at this point if the student realises that a certain possibility has not been ruled out. (f) If the correct diagnosis is made then there is an option to explore the pathological lesions associated with the disease, or to discuss its treatment. Again, the tutor (hint) option can provide help with the interpretation of the lesions

Case simulation (Fig 3)

The most elaborate computer-aided package developed at Cambridge has been a case simulation program which allows students to gather information from the history, physical examination, diagnostic aids and special tests before making a diagnosis. The students can decide which tests to use and may later use additional tests or review the history if they find they have made a wrong diagnosis. Students who attempt to use special tests or make a diagnosis without having first taken a history or made a physical examination are told that this is unreasonable and are asked to think again. Extensive help is available at each stage during the work-up by selecting a 'tutor' option from the on-screen menu. This provides access to more information or an explanation of a result or phenomenon that the student has encountered.

In this program a dog with polydipsia and polyuria is presented. The history is presented as a series of short video sequences showing the owner being interviewed by a vet. The student chooses from a list of pre-prepared questions and answers, and although the student is not given free range, there are a variety of possible questions, some more relevant than others. Some of the answers require a little interpretation, and the information available by pressing the 'tutor' option helps the student identify the salient information contained in the answer. The dog can be 'examined' by selecting the region to be examined from options displayed on a picture of a dog. Many of the options display a simple photograph, such as a close-up view of the eye, whereas others are more involved, such as the examination of the mouth. A request to examine the mouth prompts the display of a close-up view of the open mouth together with a short video of a capillary refill test being performed, which the student can then evaluate. When choosing to examine the heart the student can listen to the heart sounds and then work out the heart rate and check for murmurs. A wide variety of procedures is available during the work-up, including haematology, biochemistry, radiography, urinalysis, ultrasonography and electrocardiography. Special tests are available to distinguish the differential diagnoses of polyuria and polydipsia, including water deprivation and antidiuretic hormone response tests, portal angiography and dexamethasone suppression tests, among many others. Some of these tests are inappropriate but all the tests that are required to reach the correct diagnosis are included. Finally, when the student has a made a diagnosis a choice is made from a list of 20 or so possible differentials. If the wrong diagnosis has been made the student is told why it is an unlikely or unsuitable diagnosis and asked to review their findings. If the right diagnosis has been made the student is presented with a selection of images of the gross and microscopic pathology of the condition. The two other case simulations in the polyuria/polydipsia collection also include sections covering treatment.

The time taken to develop this type of package is extremely variable. A simple version, using existing materials and a computer template, can be completed in half a day. More complex versions can take one to two weeks to develop, depending on how much of the content is based on existing material, and how much must be created specifically for the project.

Discussion

The philosophy behind the computer-aided learning initiative at Cambridge has been based on several principles. First, we believe that the quality and breadth of the veterinary material is considered paramount. To provide a useful resource to the school the computer-aided learning infrastructure must provide a wide range of veterinary learning material of the highest possible quality. When assembling the packages the veterinary content was organised before the computing problems were considered; although the two aspects cannot be completely divorced it is often the interest in the computer science that drives the development of computer-aided learning, whereas the vast majority of the work lies in putting together the veterinary content, and it is the veterinary content which dictates much of the quality of the final product. The authors' advice to those contemplating the implementation of a computer-aided learning package is to collect the images, sound and video first, write a script detailing the sequence of events and how the source material is to be used and only then consider the programming.

The second principle is that there is no point in the use of computers for their own sake; the reason for adopting computer-aided learning is that it should either provide a new facility, or replace an existing facility with one that is more cost-effective or easier to use. In the case of the nerve block tutorial it was possible to take the tape-slide concept and extend its usefulness by adding a quiz at the end so that the students could test the knowledge they should have acquired. One of the biggest advantages from a maintenance point of view is the ease with which slides can be edited; changing the labelling or adding an extra slide is accomplished with little effort and no recourse to an outside agency. As a result it is relatively easy for other institutions to adapt the packages to their own curriculum. This is also the great advantage of the question and answer program, which is very simple to produce and which fulfils the need for an aid to revision at the end of courses or before examinations. Programs such as the case simulation are important in teaching students to integrate different courses and such a facility had not previously been available at Cambridge. Although it is possible to simulate a case on paper, or as a verbal session during a traditional tutorial, these methods lack the immediacy and visual appeal of the computerised version. By working on their own with the case simulation and other programs, students who lack the confidence to contribute during lectures or tutorials can become involved without fear of their weaknesses being exposed in front of their peers. It has also been found that some students enjoy using the case simulation together as a small group. These small group sessions provoke much discussion and sharing of collective knowledge in a constructive environment.

The third principle has been to attempt to make the involvement of contributors of veterinary content as simple as possible. If the expertise and knowledge of the brightest members of the profession are to be harnessed, they cannot be expected to produce computer-aided learning programs as an extra task in their already crowded schedules. This principle is best demonstrated by the digitised lecture. All the veterinary experts needed to teach Cambridge students are familiar with this method of communicating ideas. Although a digital lecture cannot provide the interaction that a live lecturer provides, a seminar given by a visiting scholars or distinguished lecturer can be made available to a much wider audience for a longer period. At present it is not expected that any of the core curriculum should be replaced with digital lectures but they can be used to increase the depth of cover in certain areas. Digitised versions of some lectures are now available as revision aids for students, or those who missed the original lectures owing to illness. The skills required from the veterinary authors of the other packages have been restricted to the basic use of a word processor. The computing and audiovisual expertise has been provided by a small interested group within the department, which consists of three people; one is an expert in computing, one is the departmental audiovisual technician, and the other is a member of staff with only basic computing skills. The initial work was carried out in unallocated spare time during lunch hours, and after hours and at weekends. Since January1995 some money has been allocated to the funding of a part-time author and coordinator of computer-aided learning programs. The role of the interested group is to enable staff to complete most of the production tasks rather than to produce complete packages in isolation. To this end much of the computing effort has been in the production of tools with which relatively unsophisticated computer users can produce the packages. A module for the question and answer section of a program might take only a matter of hours to produce if existing teaching material is appropriate, because the staff need only provide a word-processed document of questions and answers, with appropriate colour transparencies or diagrams. The more complex, larger packages such as the case simulation might take several weeks to produce because, although the outline script can be produced within a day or two, the other procedures such as the recording and editing of the video and audio sequences, and the photography and digitisation of colour transparencies, take much longer.

In the final analysis the success of the computer-aided learning initiative will be judged on its benefits to the staff and students within the department. The first packages were made available to students during the Lent and summer terms of 1994, and it has not been possible to assess their impact adequately. The packages are freely available to interested parties in both Apple Macintosh and PC formats, either from the department or via CLIVE and it is hoped that this attitude will help stimulate other schools to produce their own material and reciprocate. Strenuous efforts will be made to expand our home-produced materials ready for the next academic year and it is intended to include the assessment of the role of computer-aided learning in the curriculum as part of the regular examination of all teaching within the school. The body of veterinary knowledge is expanding at an ever increasing rate and the demands made on veterinary graduates increase year by year; the use of computer-aided learning in the veterinary curriculum and its potential in continuing education constitute a major opportunity for the veterinary profession.

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Haematological and biochemical values of 10 green iguanas (*Iguana iguana*)

S. J. Divers, G. Redmayne, E. K. Aves

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Ten clinically healthy green iguanas (*Iguana iguana*) imported from South America were examined, and haematological and biochemical measurements were made on samples of blood. This paper describes the methods of blood sampling, handling and laboratory analysis, and presents the results as a set of normal blood ranges for the green iguana.

REPTILES continue to gain in popularity as pets and zoological exhibits, and consequently the veterinary clinician is increasingly likely to be asked to examine them. The most important aspect of investigating reptile disease is an objective assessment of the animal's husbandry in captivity. This necessitates a detailed knowledge of the species, its natural habitat and diet, and its specific requirements for light, heat and humidity (Divers 1995). There have been substantial advances in the husbandry of captive reptiles over the last 10 years and it is now possible to provide species-specific environments within a vivarium by using the wide range of specialised equipment available. Unfortunately, despite these advances, and an increasing number of modern veterinary texts, there is still a relative paucity of species-specific clinical pathological information compared with the domesticated animals (Frye 1991, Beynon and others 1992). In clinical investigations, blood samples can be easily obtained and are often of great diagnostic value. However, clinical pathology is one area of herpetological medicine which is in need of further investigation because normal haematological and biochemical ranges for even the most popular species are largely lacking.

The 10 green iguanas (*Iguana iguana*) in this study were imported from South America and samples of faeces and blood were examined for parasites during January 1995 before their introduction into a zoological collection. The remaining blood was examined haematologically and biochemically in order to produce normal blood ranges for the group. This paper describes the collection, handling and clinical pathological assessment of the blood taken from them.

Materials and methods

The 10 iguanas (seven male and three female) were housed singly or in pairs within purpose-built enclosures and subjected to identical quarantine management before the blood samples were taken. They ranged in age from 1·3 to five years and were fed a totally vegetarian diet supplemented with Nutrobal (Vetark) and maintained on a 14-hour light, 10-hour dark photoperiod using broad spectrum lighting. Day time air temperatures ranged from 29 to 35°C and basking areas were maintained at 38°C. At night the temperature was allowed to fall to around 24°C. The iguanas were all eating, drinking and behaving normally. The only abnormality detected was a 2 cm subcutaneous abscess on the left shoulder of iguana 5. The iguanas were restrained without sedation, by holding the forelimbs laterally against the thorax and the hindlimbs laterally against the tailbase. A towel was then placed over the animal's head. The site for venepuncture was the ventral midline of the tail approximately one-third of the tail length from the cloaca. The 23 G 1 inch needle was inserted at an angle of 60 to 90° and advanced until the needle hit the vertebral body; it was withdrawn slightly while maintaining a slight negative pressure until blood entered the syringe. It is possible, for transfusion purposes, to collect up to 35 ml of blood from a 5 kg adult iguana by this method. However, 1·0 ml was sufficient for a complete haematological and biochemical assessment.

The blood from each iguana was immediately placed into a heparinised tube, and a fresh blood smear was made and air-dried to aid the haematological examination. In each case half the volume of the collected whole blood was centrifuged to yield heparinised plasma for the biochemical measurements. The heparinised plasma, whole blood and fresh blood smears were sent by courier to the laboratory and analysed on the same day.

Haematology

The following methods were used to produce a detailed haemogram for each iguana. The erythrocyte count (RBC) was determined on a Celltac 5108K. The haematocrit was determined by a manual microhaematocrit estimation. The haemoglobin concentration was determined by a cyanmethaemoglobin method on a Celltac 5108K. The mean cell volume (MCV), mean cell haemoglobin (MCH) and the mean cell haemoglobin concentration (MCHC) were calculated by conventional methods. The total leucocyte count (WBC) was determined in a 1:80 dilution of whole blood in 1 per cent ammonium oxalate solution in a Neubauer chamber. The differential counts were determined in a blood smear stained with May Grunwald/Giemsa by light microscopy; the absolute counts were determined as a percentage of the total leucocyte count.

Biochemistry

All the determinations were made on a Technicon RA1000 biochemistry analyser at 37°C, using standard commercial kits. The kits were supplied by Randox Laboratories with the exception of

S. J. Divers, BSc, MIBiol, CBiol, BVetMed, MRCVS, Elands Veterinary Clinic, Dunton Green, Sevenoaks, Kent TN13 2XA
G. Redmayne, MPhil, BSc, **E. K. Aves,** MIST, SRMLSO, Greendale Laboratories, Lansburg Estate, Knaphill, Woking, Surrey GU21 2EW