# Computerisation and digitalisation of real autopsy cases as the basis for independent learning in veterinary pathology

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**Abstract**
A brief description is given of the procedure by which the autopsy cases sent to a public veterinary pathology diagnostic service are used to programme:
1. A module of autopsy practical sessions carried out with real cases;
2. Teaching of self-directed learning by means of the production of clinical-pathological studies based on «real cases»;
3. Public exposition and discussion seminars of cases of self-directed learning presented by the students themselves;
4. Creation and maintenance of a collection-repository of digitised images of veterinary pathology that is unique in Catalonia;
5. A website of great educational interest in which a selection of the most important autopsy cases of those taking place every academic year is published;
6. ICTs and EHEA teaching procedures that actively encourage criticism and the systematic approach of explanatory hypotheses for the facts observed are actively used throughout the entire process, which is completely computerised and digitised. Taken as a whole, this is a very good introduction to professional practice.

**General area of interest of this innovation**
Generally in disciplines in the area of Health Sciences.

## 1. Objectives
1. Greater efficiency in autopsy practical sessions based on real cases. Use of a single autopsy case to:
    *a*) To schedule practical sessions based on real cases in the Autopsy Room in the Faculty of Veterinary Medicine.

*b*) To enable «virtual attendance» of additional autopsy cases — to which the students would otherwise not have access —by means of the presentation of seminars based on real cases (programmed teaching)

*c*) To provide free access to a selection of these autopsy cases by means of the Internet: the «virtual autopsy»

2. To eliminate «theory» seminars
3. To use cases of autopsies for programming self-directed learning based on real cases.
4. To develop self-directed learning skills for the production and explanation of complex reports, and for public presentation.
5. To create and maintain a large digitised archive of autopsy case images and clinical-pathological cases for an academic purpose and interest.

## 2. Description of the project

The methodological approach set out here makes sense in the context of the European Area of Higher Education as a teaching proposal that directly promotes:

1. self-directed learning as a teaching methodology,
2. teaching based on real cases,
3. continuous assessment,
4. the use of ICTs,
5. teamwork,
6. the intensive use of reasoning, argument and the presentation of hypotheses in order to solve problems. The proposal consists of using autopsy cases referred to the Public Veterinary Pathology Diagnostic Service of the Animal Health and Anatomy Department as cases of self-directed learning based on real cases that are prepared and solved in groups, and which are subsequently presented publicly in seminars on the subject. Finally, an illustrative selection of these is published on the Internet.

## 3. Methodology

This activity is compulsory. It is carried out in groups (2-3 students) and the basic process is as follows:

1. Students perform the autopsies during the scheduled practical Pathological Anatomy sessions («practical sessions based on clinical-pathological cases»),
2. Choice (supervised) of an autopsy case performed beforehand during the practical module (2 weeks),
3. Production — with the data obtained in the autopsy — of a complete clinical-pathological report in writing,
4. Public presentation of the case autopsied to other colleagues in specific sessions for the presentation of cases during seminars on the subject,

5.  Publication of a supervised selection of these cases on the Internet: «The virtual autopsy»,

The following are provided to carry out the task:

1.  The clinical history accompanying the request for an autopsy.
2.  A copy of the official autopsy report issued by the Veterinary Medicine Pathology Diagnosis Service for each case.
3.  The most important macroscopic and microscopic images necessary for presentation of the case autopsied in seminars are supplied to complete them.

The teaching staff of the subject is available for discussion of the progress of work or to solve possible problems or incidents that may arise while it is taking place throughout the process.

The clinical-pathological report must consist of the following compulsory sections:

### 3.1. Details of the animal autopsied
- species
- breed
- Age
- sex

### 3.2. Clinical history
This includes all the information relevant to the disease that caused the euthanasia or death of the animal. This includes

1.  the anamnesis of the case,
2.  the results of clinical examination of the patient or the inspection of a farm by health authorities
3.  the complementary analyses carried out (haemogram, serology, biochemical, microbiological, parasitology,…)
4.  the results of the image diagnosis techniques used. If the case for autopsy comes from the faculty's clinical veterinary hospital or farm, the students consult and study the records available in these centres.

### 3.3. Macroscopy
A concise but precise description of the lesions and anatomopathological macroscopic findings observed

### 3.4. Microscopy
Description of the microscopic lesions observed, and the complementary pathological techniques that may have been used.

Both the macroscopic images (which are produced during the autopsies) and the microscopic images are provided directly to the students by the teaching staff in charge of the subject. To that end, files (folders) are created for the autopsy cases which are

duly identified with the autopsy code. These are downloaded over the Internet in the temporary directory shared by all the computers in the faculty's computer room, where students can produce PowerPoint presentations for each case. The images used through-out the process come from the Pathological Anatomy Digital Pathology Archive of the UAB Faculty of Veterinary Medicine.

### 3.5. Diagnosis

Three types of diagnosis are encouraged, if possible:

1.  *Anatomopathological or lesional*, which requires a very precise and correct use of terminology
2.  *Etiological,* if any causal agent (viral, bacterial, parasitic, toxic, etc.) can be iden-tified.)
3.  when possible, *diagnosis of the disease* that caused the death (or euthanasia) of the animal.

*Students should be advised that all three types of diagnosis are not always possible, but this does not mean that there is no need to argue and speculate reasonably on the cause or causes of the disease that the animal autopsied was suffering from.*

### 3.6. Discussion

### 3.6.1. Pathogeny

The objective of this section is to integrate all the information available from the specific case analysed and to establish reasonable (and reasoned) cause-effect rela-tionships between the various anatomopathological lesions observed and between those lesions and the clinical signs (symptomology) manifesting during the animal's disease.

The pathogeny is subdivided in turn into three sections that facilitate general understanding of the case:
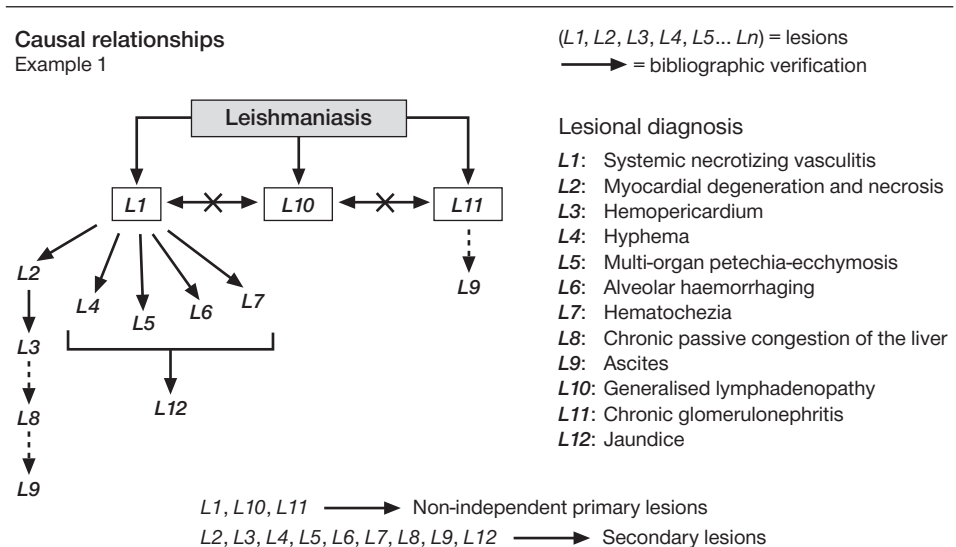
1.  Establishment of causal relationships between the lesions observe
    The objective of this exercise is:
    *a*) To ascertain whether there are causal relationships between the various lesions diagnosed.
    *b*) To ascertain whether these lesions, taken together, are physiopathologically linked to a single syndrome or a single disease or whether on the other hand there are lesions that are not apparently linked to each other which may have a different cause.
    *c*) to ascertain whether there are concurrent diseases. In other words, it is neces-sary to find out whether the various lesions observed are the consequence of the same primary cause or of various causes that could have been concomi-tant in the individual.
    *d*) to ascertain which lesions are primary (arising directly from the cause of the disease) and which are secondary (arising from primary lesions).

Some examples of pathogenic diagrams produced according to the causal relationships established and/or supposed in the range of lesions observed are shown below:

Figure 1. Pathogenic diagram for Leishmaniasis



**Causal relationships**
Example 1

(*L1, L2, L3, L4, L5... Ln*) = lesions
⟶ = bibliographic verification

Lesional diagnosis

*L1*:  Systemic necrotizing vasculitis
*L2*:  Myocardial degeneration and necrosis
*L3*:  Hemopericardium
*L4*:  Hyphema
*L5*:  Multi-organ petechia-ecchymosis
*L6*:  Alveolar haemorrhaging
*L7*:  Hematochezia
*L8*:  Chronic passive congestion of the liver
*L9*:  Ascites
*L10*:  Generalised lymphadenopathy
*L11*:  Chronic glomerulonephritis
*L12*:  Jaundice

L1, L10, L11 ⟶ Non-independent primary lesions
L2, L3, L4, L5, L6, L7, L8, L9, L12 ⟶ Secondary lesions

Assessment of the causal relationships between the various pathological lesions observed is based on simple hypothetical propositions that assess the possible cause-effect relationship between each one. These are simple propositions along the lines of: $L1 \rightarrow L2$, in which L1 would be the cause of *L2*. Obviously, the establishment of these causal relationships must always be argued in accordance with the basic existing bibliography (generic reference texts recommended by the various academic disciplines).

2.  Establishment of causal relationships between the lesions and clinical signs and symptomology observed.

    The objective of this exercise is:

    *a*)  to ascertain whether there are causal relationships between the various lesions diagnosed and the clinical signs and symptomology.

    *b*)  to ascertain whether the clinical signs observed are a manifestation of a single syndrome or the same disease or whether there are clinical signs and symptomology that are not apparently linked to each other and which may have different causes.

    *c*)  to ascertain whether there are concurrent diseases.

**Example 1:** (linked to «Example 1» – causal relationships)

Figure 2. Causal relationships
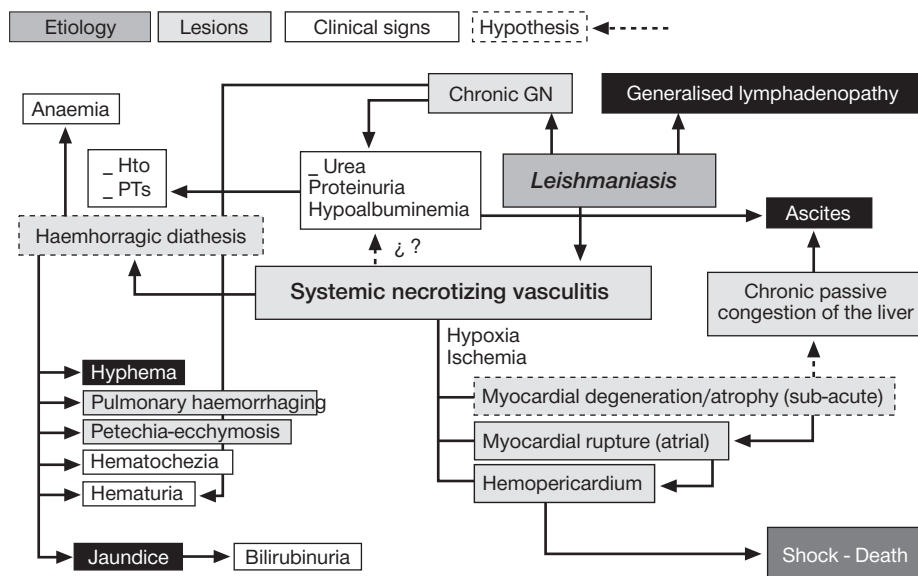


3. Ascertain the ultimate cause of death of the individual
   From both a point of view of professional ethics and the scientific point of view, in the final analysis, the ultimate objective is to try and explain the disease as thoroughly as possible or to ascertain the ultimate cause (or contributory causes) leading to the death of the animal; or where appropriate, produce reasoned and reasonable hypotheses (checked using the bibliography) in that regard.
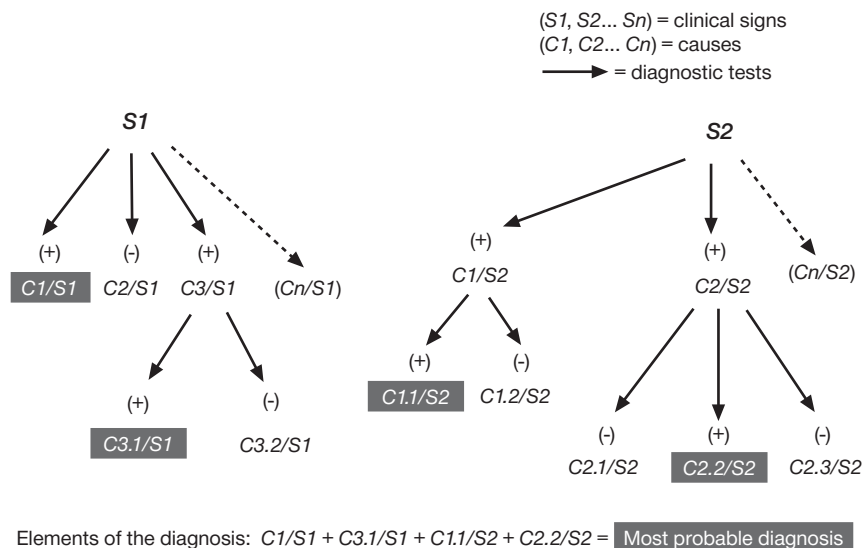
3.6.2. Differential diagnosis

In essence, this section involves a thorough «recreation» of the entire diagnostic process supervised by the professionals/teaching staff responsible for the clinical-pathological case studied: from the point at which the patient began to show clinical signs of disease —*ante-mortem*— until it was autopsied and the final report on the cause of death was produced —*post-mortem*.

This «recreation» takes place using a reasoned and systematic protocol which attempts to ascertain, from among all the possible causes of the clinical signs presented by the patient, only those that are really related to the disease that the animal suffered from. This process is called the ***diagnostic algorithm***. To that end, the protocol is helped by and uses the diagnostic techniques currently available in professional veteri-

nary practice to discern which cause or causes from among all those possible were in reality responsible for the pathological process analysed.

The diagnostic algorithm is as follows:

Figure 3. Diagnostic algorithm



Elements of the diagnosis:  *C1/S1 + C3.1/S1 + C1.1/S2 + C2.2/S2* =  Most probable diagnosis

### 3.6.3. Bibliography
http://minnie.uab.es/~veteri/necropsia/index.html

### 3.7. Presentation
The presentation of autopsy cases takes place in the classroom (seminars) as follows:
1.  4 seminars of 1.5 h
2.  3-4 cases / seminar
3.  2-4 students / group
4.  Procedure:
    *a*)  Free presentation (lasting around 15-20 mins).
    *b*)  Discussion between the group making the presentation and the other students and teaching staff.
    *c*)  Final comments by the teacher on the case and assessment of the strong points and weak points of the report presented and the presentation made.
·   Assessment: equivalent to 20% of the final grade. The format of presentation of work, the contents and presentation and classroom discussion is taken into consideration.

### 3.8. The virtual autopsy

A selection of the most relevant or representative cases among those considered during the practical autopsy module is permanently available on the Internet on the «Virtual Autopsy page»: http://minnie.uab.es/~veteri/necropsia/index.html

The objective is to build an archive that is sufficiently representative to be used as an invaluable complement to standard teaching.

Figure 4. Virtual necropsy
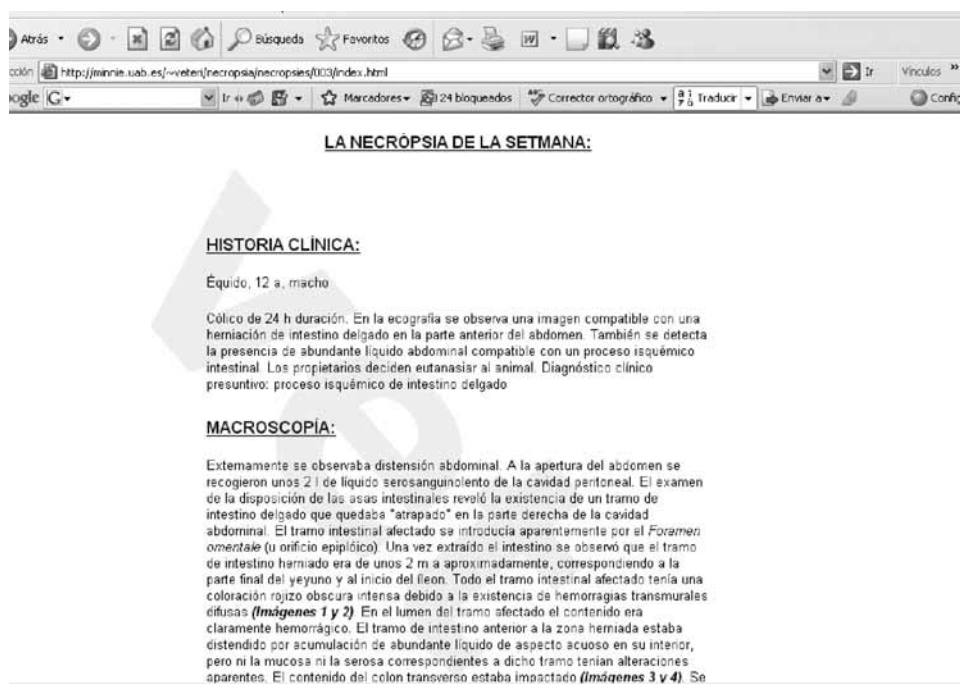


### 4. Results and discussion

The application of the initiatives described above enable the following results to be obtained

· An increase in the number of autopsies «attended» by students (12-15 additional autopsies /student): as well as the «real» autopsies attended by the students during the course's autopsy practical sessions (25 scheduled hours), all students have the opportunity to attend the presentation of 12-15 additional «virtual» autopsies, which have a high level of pathogeny development and discussion of these cases. In addition, the Internet Virtual Autopsy is a page that is always avail-

able, where the archive of autopsies of different species selected by the teaching staff of the discipline can be consulted.

· Use of the same autopsy for programming two different practical sessions: this means that some autopsies selected in the autopsy room because of their educational interest, as well as being discussed «in situ» in the autopsies room, are subsequently worked on by groups of students as set out above.

· Elimination of theoretical seminars: as the autopsy practical session is undoubtedly the most important and recommendable type of practical session in the subject from the educational point of view and one of the most important in the qualification, eliminating the seminars that were only for complying with the number of practical credits assigned and replacing them with practical sessions was a priority. In addition, given that the annual influx of autopsy cases and the number of students that take the subject each year (around 180) does not permit more than two weeks of autopsies/student to be programmed, the «virtual» autopsy was used as a type of practical session. Although it is of lower quality than the «real» autopsy, it nevertheless had other important characteristics that made it useful and interesting according to the teaching criteria set out by the EHEA.

· Reduction of presence learning: the effort that each students has to make to produce the autopsy report is estimated at 40 h.

· The main advantage and the most important educational benefit of this type of teaching is that it involves «integrated» learning of the clinical procedure and the entire diagnostic process of the disease. This in turn infers that the main characteristic of these practical sessions is their interdisciplinarity, as work with different subjects in medicine and veterinary health is required in order to produce the reports and their presentation in the classroom, and specifically those related to the professional sphere.

· Direct learning from the professionals responsible for the cases studied: as well as the tutorials for the subject itself, students can consult the clinical-pathological record of the case on an ongoing basis and discuss it with the professionals who were responsible in the case of the autopsy studied.

· Establishment of cause-effect relationships between the clinical profile and the lesional profile (pathogeny) of the *specific* case in the autopsy studied: this means that the student has to make an effort towards understanding the physiopathology and pathology of the case studied, the main advantage of which is that it refers to the specific animal autopsied and not to the disease which it may have suffered from in a generic sense. In other words, it is learning based on a «real» case, which has the very important advantage of being if not comparable, demonstrative and easy to assimilate to the real cases that students will have to solve during their professional life.

· Obligatory production of a justified and argued diagnostic algorithm: the crucial importance of the diagnostic protocol shown to the student in this type of prac-

tical session is that it is the same as the one used by medical and health veterinarians in their profession life. Teaching the student that not all cases can be solved (diagnosed) in a satisfactory or reliable manner is also considered of vital importance, as it is necessary to accept this due to its inevitability.

- Appropriate use of terminology and appropriate use of concepts: a great deal of emphasis is placed in the various sections of the report on the appropriate use of terminology, particularly as regards diagnoses.

- Encouragement of criticism and the consideration of explanatory hypotheses for the facts observed: as a whole, the general idea applied for the production of the report which is passed on as a key idea for future professional practice is that it is necessary to justify and argue all the terms of the clinical-pathological discussion of the possible problems that may arise during profession work. Furthermore, in terms of the final diagnosis of the disease that may have caused the death of the patient, the student is urged to learn how to distinguish between what is a certainty and what is a reasoned speculation that is considered probable. For this reason, in the event that it is impossible to give a reliable diagnosis (insufficient or contradictory information, lack of specific information, etc.) on the cause or causes of the animal's death, the student is made accustomed to consideration of explanatory hypotheses on what the most probable causes could be.

- Introduction to professional practice: in general, for all the reasons above, we feel that this type of practical session is a reasonable approximation to professional work.

## 5. Conclusions

1. This type of teaching is a very useful and relevant example of «learning based on real cases».

2. Conceptually and operationally, it is comparable to a «pre-professional» practice

3. It vastly increases the efficiency and use of autopsy cases, which is a type of activity that is lacking and quite onerous in terms of carrying it out: It maximises the use of real autopsy cases carried out by the Public Veterinary Pathology Diagnostic Service in the Faculty of Veterinary Medicine autopsy room.

4. It is a type of learning that promotes and encourages criticism and logical thought and systematic in a radical way.

5. The entire process enables a very important digital pathology archive to be maintained, which is unique in Catalonia.

6. There is a very significant level of acceptance and regard for the entire process by the students.

### References

Bosco, A. (2007). «EVAINU research: new virtual learning environments for educational innovation at university». *Journal of cases on information techonology*. 9 (2), 49-60.

### Interesting links
· Innovation website: http://quiro.uab.es

### Keywords
Self-directed learning based on real cases, interdisciplinarity criticism, digital pathology archive, teaching efficiency, EHEA, ICTs.

### Financing

### Supplementary materials on the CD-ROM
Demonstration of the VIRTUAL VET website: tour of the real necropsies for the the Special Pathological Anatomy course.

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### Presentation of the project leader
The author is a professor of Pathology (Pathological Anatomy) at the UAB Faculty of Veterinary Medicine. He is also head of the Veterinary Pathology Diagnosis Service which provides the cases for autopsy necessary for practical sessions in teaching. He works on the implementation of the ICTs and the EHEA in pathology teaching in Veterinary Medicine, and mainly on the use of the ICTs to achieve maximum accessibility for students to materials with a high educational value, as well as on types of self-directed learning and learning based on real cases as key strategies for the teaching of Veterinary Medicine in the future.

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