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THE INCIDENCE OF NEOPLASIA IN THE CANINE AND FELINE PATIENT
POPULATIONS OF PRIVATE VETERINARY PRACTICES IN SOUTHERN ONTARIO

A Thesis

Presented to

The Faculty of Graduate Studies

of

The University of Guelph

by

RICHARD J. REID-SMITH



In partial fulfilment of requirements

for the degree of

Doctor of Veterinary Science

March, 1999.





ABSTRACT

THE INCIDENCE OF NEOPLASIA IN THE CANINE AND FELINE PATIENT POPULATIONS OF PRIVATE VETERINARY PRACTICES IN SOUTHERN ONTARIO

Richard J. Reid-Smith
University of Guelph, 1999

Advisor:
Dr. B.N. Bonnett

This thesis is an investigation into the use of the computerized medical records of private veterinary practices for the collection of epidemiological information on canine and feline neoplasia. The patient populations of 5 veterinary practices in Ontario were characterized retrospectively over a 1 to 10 year period. The median age of both dogs and cats increased, the proportion of purebred dogs increased and the proportion of purebred cats decreased over the 10 year period. All neoplasms submitted for histopathological confirmation (HC) were identified retrospectively from histopathology records and compared with the corresponding patient populations in order to calculate the hospital prevalence of HC neoplasia over the 10 year period. All new neoplasms, both HC and non-HC, were identified prospectively over a 3 to 18 month period to determine the incidence of neoplasia for the 5 practices. The incidences of benign and malignant neoplasia in dogs were 3,965 and 852 neoplasms per 100,000 dog years respectively. The corresponding incidences in cats were 429 and 319 neoplasms per 100,000 cat years respectively. The most common malignancies of dogs and cats were mast cell tumour and squamous cell carcinoma respectively. Forty-nine percent of malignant neoplasms and 23% of benign neoplasms were HC in dogs. Differences in the proportions submitted for histopathology were evident between types of neoplasia. Intact dogs had a lower risk for benign neoplasia than neutered dogs. American Cocker Spaniels had an increased risk

for both benign and malignant neoplasia, as compared with mixed breed dogs. Golden Retrievers were also at increased risk for malignant neoplasia while Lhasa Apsos and Bichon Frises were at decreased risk for benign neoplasia. Using the computerized medical record systems of the participating practices proved to be a viable method for collecting data on patient populations and neoplasia occurrence. Future epidemiological studies of neoplasia in companion animals based on the patient populations of private veterinary practices will be facilitated by encouraging practitioners to more fully utilize their electronic medical record systems, by the development of a standardized nomenclature and coding scheme and by a better understanding of how to effectively conduct practice-based research.



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CHAPTER ONE

Introduction, Literature Review and Objectives

Epidemiological information regarding the occurrence of neoplasia in dogs and cats is available from a limited number of sources and is presented in a diversity of forms. This information is put to various uses by different segments of the veterinary health care community. The way the information is presented and how closely it reflects the true state of nature depends largely on the source of the original data. The Introduction will outline the need for companion animal cancer epidemiological information. The Literature Review will discuss the challenges in generating companion animal epidemiological information and the relative strengths and weaknesses of previous research in the field. The chapter will conclude with a statement of the objectives of this thesis.



INTRODUCTION: *The Need for Companion Animal Cancer Epidemiology*

Cancer has long been recognized in companion animals and cases of benign and malignant neoplasia are seen by general practitioners every day. It is generally believed that, because of improvements in health care and nutrition, companion animals are living longer, and are consequently both being exposed to carcinogens for a greater period of time and surviving to an age when cells, having undergone initiation, are more likely to reach the stages of tumour promotion and progression (Pierrepoint, 1985; London and Vail, 1996). Additionally, owner attitudes towards the care of companion animals are undergoing an evolution and an increasing proportion of owners are willing to seek veterinary care for their pets when they develop cancer. For these reasons, veterinarians are likely to be confronted with more cases of neoplasia, both malignant and benign, than in the past. Furthermore, improvements in cancer therapy have



expanded the options open to the general practitioner in the management of cancer patients and improved survival times for animals undergoing such therapy (Withrow, 1996).

Given the above, practitioners require sufficient epidemiological information to allow them to make diagnostic and therapeutic judgements. Information on the occurrence of specific types of neoplasia, age, breed and sex predispositions, optimum treatment modalities and the likely outcomes of those treatments is potentially useful but such information must be accessible and relevant to the patient at hand (Reeves and Reeves, 1995; Crow, 1996). In human medicine, data such as incidence, prevalence and survival rates are widely available, stratified according to characteristics such as tumour site and stage, sex, age, race, birth cohort and occupation (Reeves and Reeves, 1995). Some of this information is available in veterinary medicine but it is less complete and often derived from studies with comparatively inferior methodologic designs (Priester and Mantel, 1971), or from referral-based studies (Schneider, 1975). Ideally, for cancer epidemiological information to be relevant to the general populations of dogs and cats it should be derived from a representative population base (Schneider, 1983; Reeves and Reeves, 1995).



Practitioners use cancer epidemiological information when communicating with their clients, perhaps more so than with many other disease processes. As owners' awareness and understanding of cancer, cancer causing agents and cancer therapy in human medicine increases, they are becoming more demanding of information from their veterinary practitioner (Crow, 1996). The reasons for this include increased concern about the environment, media attention to cancer and carcinogens, and personal experience with cancer either directly or through a friend or relative. These factors combine to promote, in owners, preconceptions and misconceptions about cancer and cancer treatment. Additionally, cancer creates a state of anticipatory grief triggered by the pet's loss of bodily function and its physical deterioration over time (Hetts and Lagoni, 1990). In consequence, an owner's decision-making process

regarding case management may be more complex and more subject to emotional influences than with other diseases. This results in an accentuated need for accurate, detailed information to support owner decision-making. In helping their clients to understand the disease and make rational decisions, many practitioners rely on anecdotal information. This helps personalize the discussion, but the information is made more credible if there are some relevant data to reinforce the key points (Ciekot, 1995; Crow, 1996). Furthermore, owners may also want to know if they are personally at risk when their animal has cancer, either directly from their pet or from environmental risk factors.



As more is learned about the duration of immunity following vaccination and the deleterious consequences of overvaccination it is becoming increasingly likely that in the near future the accepted frequency of vaccination for dogs and cats will be lower than current practice (Smith, 1995). This will allow and, indeed, obligate veterinarians to devote more attention to other aspects of preventive health care. In human medicine a significant portion of preventive health care and screening for early detection of disease is devoted to cancer (Fink and Mettlin, 1995). Such efforts in companion animal oncology, with the exception of testing for feline leukemia virus, can currently be regarded as rudimentary at best. If veterinary medicine is to make advances in these areas, population-based cancer epidemiological information is critical for the determination of environmental and genetic risk factors, and for the development and evaluation of primary prevention recommendations, screening tests and early interventions (Dorn, 1976; Miller, 1985).

In addition to the needs of general practitioners, oncologists require epidemiological information in order to make accurate assessments of therapeutic interventions. Such assessments require long term studies with patient follow-up and, where ethically possible, controlled clinical trials. These types of studies are infrequent in veterinary medicine largely because of the relatively low number of cases available for long term observation or enrolment

into a clinical trial. Outcome information generally consists of one or more individual case histories with limited patient follow-up. This is changing as the limitations of uncontrolled trials and studies with short-term follow-up become more recognized, and as technological advances in information management facilitate the conduct of higher quality studies (Crow, 1996). **Pierrepoint (Pierrepoint, 1985)**, observed that one advantage of the relatively short lifespan of companion animals is that the results of long term follow-up studies become available to practitioners much sooner than would be the case for similar studies in human oncology. However, basic epidemiological information is needed to engender sound study design. In addition to providing information, epidemiological studies of cancer in companion animals, when registry-based, can also become a source of cases for clinical trials and case-control studies **(Schneider, 1975; Austin, 1983; Brenner, et al., 1995)**.

As well as veterinary applications, companion animal cancer epidemiological information has potential applicability in the practice of public health, principally in animal . . .

Table 3.3. Neoplasia incidence and Mantel-Haenszel relative risk (MH-RR)* for neoplasia, by gender and breed, for the combined canine patient population of 4 veterinary practices.

Risk Factor	Benign Neoplasia		Malignant Neoplasia	
	Incidence per 100,000 dogs years	MH-RR (95% CI)*	Incidence per 100,000 dogs years	MH-RR (95% CI)*
Gender†				
Male Intact	2,663	0.68 (0.51 - 0.90)‡	948	1.69 (0.95 - 2.99)
Male Neutered	5,143	1 (n/a)	761	1 (n/a)
Male	4,144	1.14 (0.95 - 1.37)	836	1.07 (0.72 - 1.58)
Female	3,808	1 (n/a)	876	1 (n/a)
Female Intact	2,241	0.71 (0.50 - 0.99)‡	685	1.14 (0.59 - 2.20)
Female Neutered	4,440	1 (n/a)	953	1 (n/a)
Breed§				
Mixed	4,259	1 (n/a)	978	1 (n/a)
Labrador Retriever	3,307	1.08 (0.82 - 1.41)	992	1.65 (0.98 - 2.79)
Golden Retriever	3,970	1.19 (0.84 - 1.69)	1,208	2.30 (1.43 - 3.70)‡
German Shepherd	4,116	1.07 (0.84 - 1.36)	433	0.50 (0.19 - 1.28)
Miniature Poodle	3,327	0.57 (0.31 - 1.06)	924	0.58 (0.28 - 1.19)
American Cocker Spaniel	7,371	1.42 (1.17 - 1.72)‡	1,843	1.81 (1.11 - 2.96)‡
Shetland Sheepdog	4,679	1.01 (0.87 - 1.18)	312	0.32 (0.10 - 1.03)
Shih Tzu	3,881	0.87 (0.57 - 1.22)	0	n/a
Lhasa Apso	2,410	0.51 (0.32 - 0.81)‡	689	0.63 (0.23 - 1.73)
Rottweiler	3,434	1.60 (0.77 - 3.30)	382	1.35 (0.42 - 4.31)
Bichon Frise	2,578	0.51 (0.33 - 0.79)‡	368	0.23 (0.05 - 1.06)

* MH-RRs are adjusted for age.

† One benign tumour was reported in a dog with unknown gender.

‡ Significant at $p < 0.05$

§ Breeds are listed according to the number of dog years in the PAR. Only breeds with ≥ 250 dog years are listed.

n/a: not applicable



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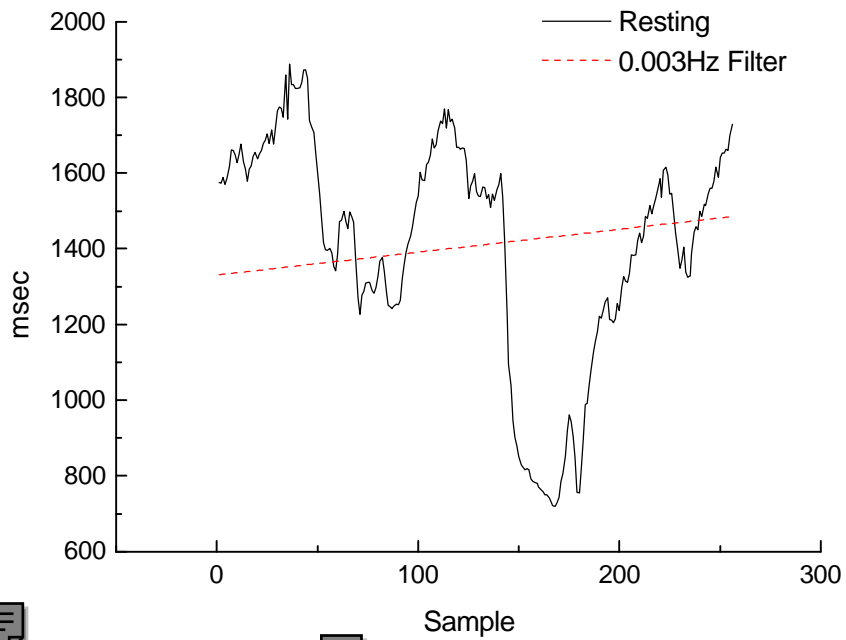


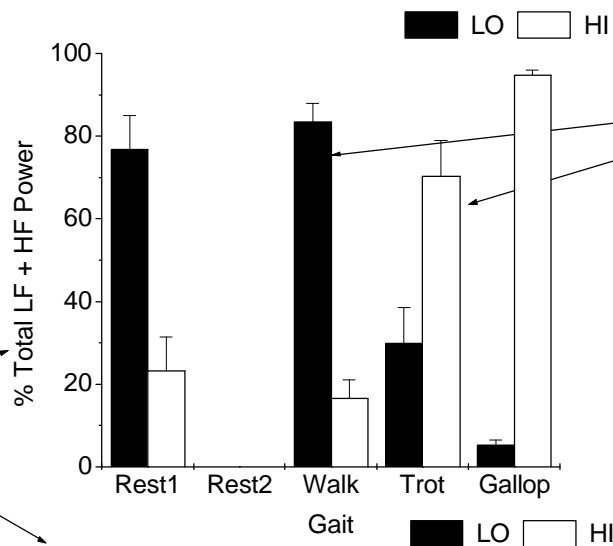
Figure 2.7.

Six minute R-R interval time series from a five-year-old Thoroughbred horse. The horse stood quietly in stocks in a soundproof room during radiotelemetric recording of heart rate, and was attended by one person, who did not handle or approach the animal during data collection. Fluctuations in heart rate are spontaneous and not the consequence of manipulation of the subject or of any detectable external stimulus. The output of a 0.003 bandpass filter applied to these data is overlaid, and reveals the trend in the time series.

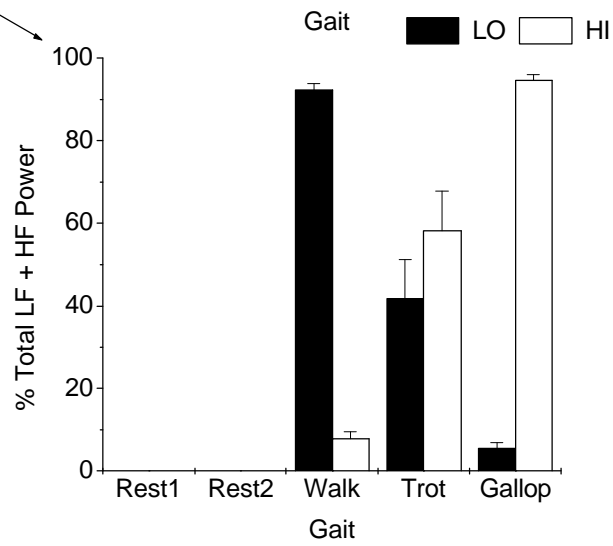


Figure 3. Distribution of normalized power for the three exercise protocols (P1, P2, P3). For each gait phase LO and HI power are shown as a percentage of total power (defined as LO + HI power). "Rest1" and "Rest2" designate resting phases on and off the treadmill, respectively. See Table 1 for details of exercise protocols.

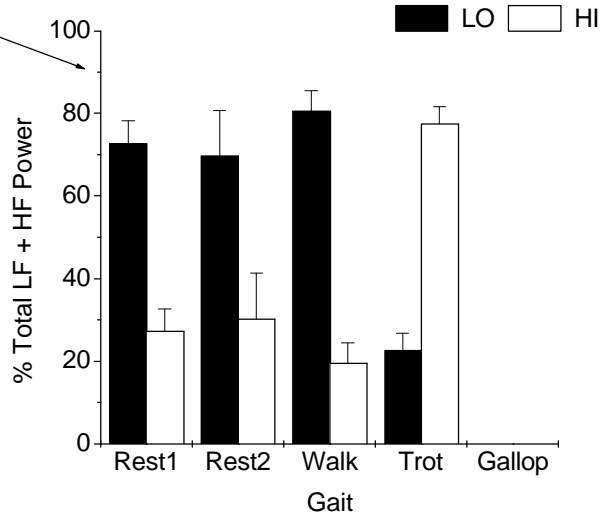
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Note 2; Date: 2/16/99 9:45:41 AM

COPIES:

These should both be original copies. One usually turns out to be a GOOD photocopy, but if you're using colour photographs or any other unusual output, then both copies need their own set of original colour prints/inserts.

Note 3; Date: 2/14/99 10:47:37 PM

DOUBLE-SPACING:

The body text of the thesis should be double-spaced throughout, but the Tables of Content, the References and Table/Figure legends should NOT. See the notes about these sections lower down.

Note 4; Date: 2/16/99 10:41:08 AM

SINGLE-SIDED:

Remember that you only type on ONE side of the pages - the back of each page must be blank. The only exception to this is the use of a left-side figure legend (see below).

Note 5; Date: 2/16/99 9:46:52 AM

MARGINS:

Watch these carefully - they are the most common cause of thesis re-formatting. In particular, make sure the TABLES and FIGURES do not go outside the margins, which should apply throughout the thesis, INCLUDING THE APPENDICES.

Note 6; Date: 2/16/99 9:53:35 AM

FONT & POINT SIZE:

Use a consistent font (typeface) throughout the thesis. Times New Roman (as in the example attached) or Dutch (or Helvetica, Arial, or an equivalent Swiss typeface) seem to work well. Avoid italic/script fonts and display fonts (e.g., Timpani). An 11 or 12 point font is best, and be consistent throughout the thesis. If you import graphics, make sure the font does not shrink too small if you do any re-sizing.

Note 7; Date: 2/16/99 9:54:30 AM

FIGURES:

See the detailed notes towards the end of this file.

Note 8; Date: 2/14/99 10:48:12 PM

CONSISTENT TYPEFACE:

Stick to something simple like Times New Roman or Arial. Use the same font throughout, BUT, you can use a different font in your figures - you sometimes have no alternative. BUT, use the same font throughout all your figures, and use the same font in Tables as you use in the body text.

Note 9; Date: 2/14/99 10:48:38 PM

POINT SIZE IN FIGURES:

If you import figures into your word processor from a spreadsheet you'll probably find yourself re-sizing them to fit the page - be careful that in doing so you don't make the point size in the legends and axes so small that they can't be read - see notes at the end on figures.

Page 2

Note 1; Date: 2/16/99 9:55:18 AM

FIGURE LEGENDS:

Figure legends should go directly BENEATH the figure, with a one or two line space (i.e., a single double space). If the figure is large and the legend needs to go on the facing page, put it in the middle of the page with the same orientation as the figure. In this case the figure goes on the right-hand page, the legend on the left. This means that the back side of the legend page is blank and un-numbered, the legend page is numbered, and that THE INCH AND A HALF MARGIN IS ON THE RIGHT SIDE OF THE PAGE.

Note 2; Date: 2/16/99 9:57:01 AM

REFERENCES:

See the notes on the sample reference page. Use the Procite output sheet marked "PopMed.pos" to obtain an acceptable bibliographic style. The style used in the example later in these notes is quite acceptable.

Note 3; Date: 2/16/99 9:57:36 AM

ABSTRACT:

Stay within the required word limits - you need to think about what you really need to say in the Abstract, because you don't have much space.

Note 4; Date: 2/16/99 9:57:46 AM

ABSTRACT:

They're very fussy about this spacing, so stick to it! (Note that they are referring to three lines spacing, NOT three carriage returns with the spacing set to double spacing, which would be six lines.)

Note 5; Date: 2/14/99 10:49:39 PM

CERTIFICATE OF APPROVAL:

Don't worry about this - it's generated by your examination committee at the end of your (successful) defence!

Note 6; Date: 2/16/99 9:59:11 AM

REQUIRED SEQUENCE:

This is the sequence for a traditional thesis. You may have decided with your advisor to write your thesis as a series of papers, each constituting a chapter. That's an O.K. way to go, but remember, you must still produce the sections (a-h) and (k), numbered as below, at either end of your series of paper chapters to build a complete thesis. (a) is generated with the chair of your examination committee after the defence. If you've built a series of papers, references can go at the end of each chapter, but you still need a bibliography after your literature review and after your general discussion, if you've used in-text citations there (see note below on body text).

Page 3

Note 1; Date: 2/16/99 10:00:45 AM

BODY TEXT:

This is a series of chapters that logically and progressively describe the work you have performed. The first chapter is the LITERATURE REVIEW, preceded by a brief INTRODUCTION. The last is a CONCLUSIONS chapter. If you build your thesis in the traditional manner, you have a single bibliography after the chapters and before the APPENDICES. If you write your body text as a series of one or more papers, then you still must include a Literature Review and a Conclusions chapter, but you can, if you wish, place references, as appropriate, after each chapter. It is still also possible to use a single bibliography with a thesis containing papers. USE THE SAME METHOD OF CITATION (author, date), THROUGHOUT, EXCEPT FOR MANUSCRIPT CHAPTERS -- USE THE STYLE USED BY THE JOURNAL TO WHICH YOU INTEND SUBMITTING THE PAPERS.

Note 2; Date: 2/14/99 2:24:55 PM

EXTRA COPIES:

You can have as many copies of your thesis bound as you wish. Grad Studies will only check the first two, and the cost of binding these is carried by the University, but you have to pay for additional copies at the rate, currently, of \$10.40 each.

Page 4

Note 1; Date: 2/16/99 10:02:27 AM

COLOUR PREFERENCE:

You can choose any colour you like, so long as it's Maroon, please (check the shelf in Helen's office). You can choose any color you like for the additional copies.

Page 5

Note 1; Date: 2/14/99 3:13:41 PM

TITLE PAGE:

Upper and lower case letters must be used as indicated in this example. Your name, the degree for which you are applying, and the appropriate dates are to be used. Spacing must conform to this sample page. ONLY TWO LINES ARE ALLOWED FOR THE TITLE.

Note 2; Date: 2/16/99 10:04:20 AM

STUDENT'S NAME:

Must be in capital letters, and should be the name that will go on the graduation certificate.

Note 3; Date: 2/14/99 3:10:51 PM

DEGREE:

Enter the appropriate degree (MSc, DVSc, PhD).

Page 6

Note 1; Date: 2/16/99 10:11:48 AM

ABSTRACT:

Spacing must be set exactly as shown at the beginning of the extract. Remember, 150 words for an MSc, 350 for a DVSc or PhD. The title, which is the same as the Title page, can go over more than two lines, though a title that goes beyond three is probably too long! Be careful to stick to the prescribed length - they will count the words and send you back if the abstract is too long.

Remember also that someone scanning theses (i.e., reading Dissertation Abstracts International) for work related to their own studies might have access only to the thesis title and abstract. If they don't get from these components the items of interest to them they might not follow up on your work. Make sure the title and abstract say what you feel to be most important/significant about your work.

Page 8

Note 1; Date: 2/14/99 3:34:54 PM

TABLE OF CONTENTS:

Page numbering (lower case Roman numerals) starts here, on a new page.

Use font size and bolding, plus careful spacing, to make the text as clear as possible. Identify Chapter headings with larger point size or bolding.

MAKE SURE ALL THE PAGE NUMBER REFERENCES ARE CORRECT BEFORE SUBMITTING YOUR THESIS.

Note 2; Date: 2/14/99 3:30:45 PM

TABLE OF CONTENTS - SPACING:

Double space between chapters and between sections within chapters, but within sections use single or nearly single spacing. In this example the sections in the LITERATURE REVIEW section are set at a line spacing of 1.2 for clarity.

Page 9

Note 1; Date: 2/14/99 3:33:35 PM

TABLE OF CONTENTS - PAGE BREAKS:

Sections within your Table of Contents rarely drop conveniently at the bottom of the page - be prepared to introduce a forced page break (usually Ctrl+Enter), to make the next section start at the top of the next page.

Page 10

Note 1; Date: 2/16/99 10:20:11 AM

CONCLUSIONS:

Some would say that this is the most important chapter of your thesis. What did you find, what conclusions did you draw, where would you suggest future researchers in this field should go next? What are the limitations of your study? You might even consider numbering your conclusions to give them clarity and emphasis. Your Conclusions chapter, and not the Abstract, should be the "crowning glory" of your manuscript. This is where you stand up to be counted as a nascent researcher!

Note 2; Date: 2/16/99 10:20:44 AM

APPENDICES:

Don't forget to include the Appendices in your Table of Contents.

Page 11

Note 1; Date: 2/16/99 10:23:17 AM

LIST OF TABLES & FIGURES:

Use indents so that the Table/Figure numbers stand out. Single space each legend, and force line ends so that the text never comes near to the page number, which should be right-justified. Leave a blank line between legends. If the legend is long, DON'T put it all in the list, just the (hopefully) descriptive first sentence. You MAY need more information, however, if the first sentence is the same for a series of Tables/Figures.

Page 12

Note 1; Date: 2/14/99 3:40:26 PM

LIST OF FIGURES:

Same comments as for List of Tables.

Page 13

Note 1; Date: 2/16/99 10:25:03 AM

CHAPTER TITLES:

The precise way you define a chapter heading is up to you and your advisor, but you ought to use some device (capitalisation, bolding, spacing, alignment, font size - NOT typeface), to define the start of a chapter. This helps readers (especially the examiners, and you want to please them) identify material when they are reviewing the manuscript.

Note 2; Date: 2/14/99 5:07:03 PM

SECTION HEADINGS:

Using clear changes in characters and layout to define subsections is also of help to your reader, and it helps you organise your material. You're likely to use these in your Table of Contents as a further guide to your readers.

Note 3; Date: 2/16/99 10:26:10 AM

IN-TEXT CITATIONS 1.:

Use (author, date) citation throughout your thesis. Use semi-colons between citations when citing multiple papers. Do NOT put authors' initials in your citations. Use a minimum of punctuation. Check spelling of names and dates very carefully,

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Note 1; Date: 2/16/99 10:27:07 AM

IN-TEXT CITATIONS 2.:

Make sure that you put punctuation (periods, commas), after the closing parenthesis, not before - in-text citations should be kept within the piece of text (sentence, phrase), where they are used.

Page 15

Note 1; Date: 2/16/99 10:27:25 AM

PARAGRAPH BREAKS:

Whether or not you put a blank line between paragraphs is up to you, but it isn't absolutely necessary, and when used, considerably lengthens your manuscript.

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Note 1; Date: 2/16/99 10:27:50 AM

DIRECT REFERENCE TO AN AUTHOR:

If you choose to refer directly to an author/group of authors, as in this example (of mine), include the in-text citation, including authors' name/s and the year directly after the name.

Note 2; Date: 2/16/99 10:28:30 AM

IN-TEXT CITATION 3.:

When citing multiple previous studies remember that the works must be cited in strict chronological, then alphabetic order, first work first.

Use "et al" when quoting a paper with more than two authors. It's up to you what punctuation you use, but keep it simple!

If you have two papers by the same author/s in the same year, use 'a', 'b', etc, to differentiate them.

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Note 1; Date: 2/14/99 5:27:03 PM

TABLE LEGENDS:

... should be descriptive and precise, yet as succinct as possible. Single space the text, and use an indent so that the table number is not obscured. Avoid excessive detail - supporting material can often be placed in a footnote beneath the table.

Note 2; Date: 2/16/99 10:29:19 AM

LINES IN TABLES:

Use an absolute minimum of lines. This one has three - but two is often enough, one beneath the table headings and one at the bottom of the table, to define the end of the material and to separate the table from any footnotes. Avoid vertical lines altogether, unless they are absolutely essential for reasons of clarity. Consider that far from helping, lines can actually make a table more difficult to read. You can often use character attributes to achieve the same effect as lines. This table makes very effective use of bold characters in the first column.

Note 3; Date: 2/14/99 5:43:49 PM

DECIMAL PLACES IN TABLES:

Carefully consider how many decimal places you are going to use in stating your results - it's rare that you need more than two.

Note 4; Date: 2/14/99 5:33:02 PM

FONT SIZE IN TABLES:

... should usually be the same as the body text, but sometimes you need to reduce the point size to make it all fit. This table is in 10-point, which is as small as you should go. If you can't fit it on the page with 10-pt, consider a different table layout or two tables. You don't want to give your readers a headache.

Centre the table on the page (using appropriate margins).

Note 5; Date: 2/14/99 5:40:53 PM

TABLES - SUPERSCRIPTS AND FOOTNOTES:

Use superscript characters (numbers, alphabetic characters or symbols), to guide the reader and explain your material. Be consistent. If you're using superscripts to identify statistical significance, for example, then always use characters for this purpose, and save symbols for a different purpose, such

as, for example, providing explanatory comments, as in this table.

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Note 1; Date: 2/14/99 5:52:30 PM

PROCITE AND IN-TEXT CITATION:

By the time you read this there should be an output style form about ready to go on the OVCNET that formats your references in a consistent manner. In the meantime, the style used here is very acceptable.

Note 2; Date: 2/16/99 10:33:10 AM

REFERENCES AND THE BIBLIOGRAPHY:

. . .author/s names first followed by the year, as in this example. Parentheses around the year are OK but not essential.

. . .reference list arranged in strict alphabetic order, then chronologically if there are multiple papers by the same authors.

. . .AFTER FINISHING YOUR WORK, MAKE SURE THAT EVERY CITATION IS ACCURATE, THAT EVERY IN-TEXT CITATION HAS A REFERENCE IN THE BIBLIOGRAPHY, AND THAT THERE ARE NO REFERENCES IN THE BIBLIOGRAPHY THAT ARE NOT CITED IN THE TEXT!

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Note 1; Date: 2/16/99 10:35:09 AM

Figures 4.:

Try to keep figure keys within the limits of the graph, or leave them in the legend. Don't let them take up space outside the graph axes.

Note 2; Date: 2/16/99 10:34:19 AM

Figures 1.:

Centre figures on the page, and wherever possible, have the legend on the same page directly beneath the figure. If there is a good reason to have more than one figure on the page, make sure you leave enough space for the legends without crowding the page. DON'T shrink the figures to fit to the extent that the font becomes so small it's not legible. Create your figures bearing in mind the final anticipated layout.

The most flexible and convenient format to use for figures is the Windows metafile (.wmf extension). These are vector-based files and, in general, resize well. They are also fully compatible with most word processors. They can be edited in the original package in which they were generated, but can also be touched-up in a package like Corel Draw or Adobe Illustrator. For minor changes this may be preferable to going back into the original package, especially for adding non-standard text to an image.

Note 3; Date: 2/14/99 10:26:14 PM

Figures 2.:

Make sure that the line weights you use will show up well. Use one point or 1.5 point lines for most purposes. The lines in this figure are 1.5. Heavier lines make the figure look clumsy and unclean, and don't photocopy well. Lighter lines are likely to disappear with photocopying. Red and dark blue photocopy quite well, but other colours do not show up.

Note 4; Date: 2/14/99 10:25:06 PM

Figures 3.:

The font in figures does not have to be the same as the body text, but the font in figures should be the same for all figures - don't swop around.

Note 5; Date: 2/16/99 10:36:03 AM

Figures 5.:

Don't use top X and right Y axes unless you need them to display two different data types on the same graph. Don't frame graphs and don't use grid lines unless your graph really needs them. Try to make the graphs as clean and uncluttered as possible.

Note 6; Date: 2/16/99 10:37:23 AM

Figures 6.:

Figure legends should be single-spaced and succinct, but explanatory, and should include keys to data types (e.g., symbols) if these are not included in the graph. Leave 2-3 lines blank between the figure and the legend.

If you generate your figures in a spreadsheet DO NOT let the package generate the legends for you - do them separately. You need the flexibility to be able to choose the body text font for the legend, to edit without changing the whole figure, and to move the legend in relation to the figure, so generate the legend independently in your word processor.

Number the legend accurately and leave space between the Figure title and the text so that it's clear.

Page 20

Note 1; Date: 2/16/99 10:39:05 AM

Figures 7.:

If your graph takes up the whole page, put the legend on the opposite page, centered, remembering to number the page at the bottom as for all other pages. This is the ONLY time you have anything on the left side of the thesis page. The thesis must be one-sided.

Page 21

Note 1; Date: 2/16/99 10:43:29 AM

Figure 8.:

Don't use grey shading on bar charts - it will not microfilm or photocopy well. Use solid fill or cross-hatching instead. If you produce a colour chart be prepared a) to provide a black and white (e.g., cross-hatched) version to go forward for microfilming, b) to make colour versions for every

additional copy that you decide to have bound.

Note 2; Date: 2/16/99 10:45:02 AM

FONTS & UNITS IN FIGURES:

Make sure you use font sizes that will tolerate shrinking of figures without the font getting too small when importing graphics. Use the same font throughout all your figures, though this need not be the same as the body text typeface.

You should make sure that any short forms or unit measurements used in the figures are the same as are used in the text. For example, if you use SI units in the text, do so in the figures and tables, too.

Note 3; Date: 2/16/99 10:45:28 AM

CONSISTENCY IN AXIS WEIGHTS:

Make sure that throughout your manuscript you use the same line weights for all axes and data lines. This means not only choosing the same line weight when you are generating your original figure, but also anticipating the effect on relative or absolute line weight of any increase/decrease in image size as you expand or shrink images. Best not to change the size of images, but to generate them in the first place at the size you anticipate for display.