2 **Rapid #: -2747692** **Ariel IP: 129.63.184.201**

Status	Rapid Code	Branch Name	Start Date
Pending	TFH	Tufts Hirsh Health Sciences	8/28/2009 7:53:20 AM

CALL #: **Shelved By Title**

LOCATION: **TFH :: Tufts Hirsh Health Sciences :: HHSL Journal Stacks**

TYPE: Article CC:CCL

JOURNAL TITLE: Archives of pathology & laboratory medicine.

USER JOURNAL TITLE: Arch Pathol Lab Med

TFH CATALOG TITLE: Archives of pathology & laboratory medicine.

ARTICLE TITLE: Statistical techniques reported in pathology journals during 1983-1985: implications for pathology educators

ARTICLE AUTHOR: Hokanson JA, Ladoulis CT, Quinn FB, Bienkowski AC

VOLUME: 111

ISSUE:

MONTH:

YEAR: 1987

PAGES: 202-207

ISSN:

OCLC #: 2300010

CROSS REFERENCE ID: 34387

VERIFIED:

LM 8/25/09 7PM

BORROWER: **ULN :: OLeary Library**

PATRON: **Ricard,Amanda**

PATRON ID: -

PATRON ADDRESS: -

PATRON PHONE: -

PATRON FAX: -

PATRON E-MAIL: -

PATRON DEPT: -

PATRON STATUS: -

PATRON NOTES:

And gladly would he learn and gladly teach.
CHAUCER, *Canterbury Tales*

Statistical Techniques Reported in Pathology Journals During 1983-1985

Implications for Pathology Educators

James A. Hokanson, PhD; Charles T. Ladoulis, MD; Francis B. Quinn, Jr, MD; Alexander C. Bienkowski, MSLS

• The increasingly scientific basis of medicine challenges pathology educators to incorporate quantitative skills into a very compressed curriculum. One strategy is to focus training on the statistical techniques pathologists will most commonly encounter in their literature. We identified the reporting of statistical techniques in nearly 5200 original articles published during 1983-1985 in 16 journals important to pathology. Our results suggest that a reader familiar with 12 fundamental statistical concepts can evaluate knowledgeably over 95% of the quantitative findings reported in these journals. With the exception of survival analysis and pharmacologic modeling, these techniques are typically encountered in many introductory statistical texts. In numerous articles, failure to identify the statistical methodology used made it impossible to identify the analytic procedures used and, hence, judge the scientific validity of results.

(*Arch Pathol Lab Med* 1987;111:202-207)

All pathologists face the challenge of keeping abreast of a body of biological knowledge that is expanding at an astonishing rate. It has been estimated that each hour over 1 million words are added to the biomedical literature. Current views on the causes, mechanisms, and treatment of disease are advancing too rapidly for physicians to have personal experience with each new finding. In general, this has led to a growing reliance on the published literature to learn about the new biomedical discoveries that influence diagnostic evaluations or therapeutic decisions.

A well-established premise is that the medical journal serves as an important channel in the dissemination of new knowledge.[1-12] Subsequently, effective evaluation of an article's scientific merit requires familiarity with the methodology described, especially when quantitative techniques, such as statistical procedures, are invoked to clarify research findings or summarize data.[3,6,7,13]

Academic pathologists must decide which quantitative methods to teach their trainees and how to incorporate teaching of these concepts into crowded training programs. Identification of the statistical techniques used in major pathology journals may provide one basis for these judgments.[14] Our goal was to describe the frequency with which various statistical concepts were reported in journals important to pathology. From these results, pathologists can identify the major statistical skills needed to critically evaluate their literature.

MATERIALS AND METHODS

We inventoried the statistical techniques reported in 5193 articles appearing in the 1983-1985 issues of 16 pathology-oriented journals. Our original goal was to review the 15 journals most commonly cited according to the "Journal Impact Factor" rating for Pathology in the 1984 *Science Citation Index Journal, Citation Reports*[15]. The *International Review of Experimental Pathology*, and the *Springer Seminars in Immunology and Immunopathology* are major journals according to this criteria, but their articles very rarely included quantitative methodology and, hence, these two journals were excluded. In the initial editorial review of this article, it was suggested that *Clinical Chemistry*, *Blood*, and *Transfusion* were three additional journals that should be analyzed with regard to the reporting of statistical methodology useful to pathologists. Because the 1985 journals were available at the time of this suggestion, we reviewed the 1984-1985 issues of these journals. Hence, in this report, a total of 16 journals are reviewed; 13 for their statistical content during 1983-1984 and three for their statistical content during 1984-1985. As indicated in the "Results" section, due to the similarity in the reporting of statistical techniques in consecutive years of a particular journal, there should not be major errors in inferences due to the noncongruent years reviewed for different pathology journals.

Special supplement issues were not considered to be regular journal issues and therefore were omitted. Editorials, letters, book reviews, meeting abstracts, and other short communications were also excluded from our report because they only rarely mentioned statistical concepts. The purpose was to inventory the reporting of statistical techniques in all articles that presented new findings or summarized previous studies (such as original research articles, case reports, symposia proceedings, and literature reviews).

The categories used to assess statistical content (Table 1) were modified from an article by Colditz and Emerson.[3] Each statistical procedure was scored only once per article regardless of the number of times reported. Techniques were also scored even if they were mentioned negatively. For example, if an author reported that Pearson correlation but not simple linear regression

Accepted for publication Aug 28, 1986.

From the Department of Preventive Medicine and Community Health (Dr Hokanson); the Cancer Center (Dr Hokanson); the Departments of Otolaryngology (Drs Hokanson and Quinn) and Pathology (Drs Ladoulis and Quinn); and the Moody Medical Library (Mr Bienkowski), University of Texas Medical Branch, Galveston.

Reprint requests to Cancer Center, Rt J-20, Rm G.104 Microbiology Bldg, University of Texas Medical Branch, Galveston, TX 77550 (Dr Hokanson).

was performed, then both the correlation and simple linear regression categories were scored for that article. Any technique cited less than five times in all journals surveyed was combined into the "other" category.

Since it was not the aim of this study to analyze the relative statistical sophistication of journals, only reported frequencies of statistical use were tabulated. Each occurrence of a category of statistical methodology (Table 1) was used in the calculation of the cumulative frequency distribution of statistical techniques reported for each journal between 1983 and 1985 (Table 2).[16]

We considered one category (no statistics or descriptive statistics only) in the Colditz and Emerson[3] article to be too broad and subdivided it. Our report differentiates between (1) articles that do not cite any statistical methods, or, at most, simple counts or percentages (typically case reports and morphological or ultrastructural reports); (2) reports of statistics describing a central tendency (usually a mean, median, or mode, either alone or as part of a more complex analysis) (category 1 in Table 1); and (3) reports of the concept of dispersion (SD, range, etc) (category 2). While the SEM is more an estimate of precision than of dispersion, it was so commonly interchanged for the SD, that, for our report, it was included in the dispersion category as were reports of dispersion without identification of the parameter used.[17]

In the article by Colditz and Emerson, the general topic of survival analysis was subdivided into three categories. Since it was only occasionally used in the pathology journals we reviewed, we combined their categories associated with survival analysis into a single category. Also, because of sparse usage, the adjustment and standardization categories from the article by Colditz and Emerson were considered to be an element of descriptive epidemiology and are included in our epidemiology statistics category.

If a "*P* value" was reported, we attempted to determine if it could be ascribed to an explicitly identified statistical technique. Articles that referred to the statistical significance of a hypothesis test but did not explicitly mention a particular technique or bibliographic reference (ie, a "*P* value not otherwise specified") were tabulated separately (category 9).

In our study, a statistician (J.A.H.) read and scored the statistical content of all articles reviewed. While our results depend on the qualifications and biases of this individual, we chose to ensure that all articles were scored according to identical criteria, and any biases should have been applied to all journals equally. Our technique of counting the reported techniques differed from a design research that evaluates the "quality" of the reported research; this can require a complex experimental design to reduce the effects of personal biases. The major error to be expected in our report would be an underreporting of statistical usage. While the listing of a technique may have been overlooked, it is very unlikely that techniques not actually published were systematically included in our Tables. Furthermore, the major implications for pathology education do not depend on a precise count of the use of a statistical technique (this will fluctuate with each issue of each journal) but, rather, on its general pervasiveness in the literature.

RESULTS

Table 2 shows the relative frequency with which each statistical method was used in the 16 pathology journals reviewed. An obvious finding is the frequent use of statistical methodology in every journal. With the exception of survival analysis and pharmacokinetic modeling, most topics appearing in the pathology journals reviewed were similar to those reported for the *Journal of the American Medical Association* and the *New England Journal of Medicine*,[3] but typically covered in many introductory statistics texts.

Table 1.—Category Label and Detailed Description of Contents Used to Assess Statistical Usage*

No.	Category†	Description
1	Descriptive statistics	Means, medians, and modes
2	Dispersion	SDs, SEMs, ranges, etc
3	*t* Test	One-sample, matched-pair, and two-sample *t* tests
4	Pearson correlation	Bivariate product-moment correlation
5	Simple linear regression	Least-squares regression with one predictor and one-response variable
6	Mathematical models	Mathematical models, Scatchard plots, Lineweaver-Burk plots, and pharmacokinetic models
7	Transformations	Use of data transformation (eg, logs)
8	χ^2	Contingency tables, Fisher's exact test, McNemar's test, and Yates' correction
9	*P* value not otherwise specified	Use of a statistical test of significance without explicit identification of methodology
10	Analysis of variance	Analysis of variance, analysis of covariance, and *F* tests
11	Nonparametric tests	Sign test, Wilcoxon signed-rank test, Mann-Whitney *U* test, etc
12	Epidemiologic statistics	Relative risk, odds ratio, log odds, measures of association, sensitivity, and specificity
13	Survival analysis	Actuarial life table, Kaplan-Meier or Berkson-Gage, Cox proportional hazard, logistic regression, Breslow's, Kruskal-Wallis, Lee-Desu, Gehan's, log ranks, or Cox's model for survival comparison
14	Multiple comparisons	Multiple inferences on same data sets (eg, Scheffe's contrasts, Duncan multiple-range procedures, and Newmann-Keuls procedure)
15	Multiple linear regression	Includes polynomial regression and stepwise regression
16	Nonparametric correlations	Spearman's ρ, Kendall's τ, test for trend
17	Power	Not well defined, includes use of the size of detectable (or useful) difference in determining sample size
18	Discriminant function analysis	Mahalonobi's distance, Rao, Wilks' statistics
19	κ Statistic	Coefficient of agreement
20	Bonferroni inequality	Correction of *P* values for multiple comparisons
21	Other	Anything not fitting above headings; includes cluster analysis, cost-benefit analysis, and factor analysis

*Modified from reference 3.

The two most commonly used statistical techniques in all 16 journals were the description of central tendencies and measures of dispersion. The *t* test was the next most frequently used statistical technique in the reviewed journals, followed by Pearson correlation, simple linear regression, and mathematical models.

There are clear demarcations in the patterns of statistical usage among the various pathology subspecialty journals. The *American Journal of Surgical Pathology* used life tables in 8% of its statistical methodology in 1983, while

Table 2.—Distribution of Statistical Techniques* in 1983-1985 Editions of 16 Major Patholog

	American Journal of Clinical Pathology		*American Journal of Pathology*		*American Journal of Surgical Pathology*		*Archives of Pathology and Laboratory Medicine*		*Blood*		*Clinical Chemistry*		*Clinical Immunology and Immunopathology*		*Histopathology*		*Human Pathology*	
	1983	1984	1983	1984	1983	1984	1983	1984	1984	1985	1984	1985	1983	1984	1983	1984	1983	1984
No. articles reviewed	288	269	168	210	83	94	137	198	403	457	394	368	173	174	77	83	146	179
No. with no statistics	170	124	56	88	56	64	92	124	111	136	41	40	15	2	46	53	83	106
No. statistical procedures used	315	351	318	350	40	53	106	148	830	903	1224	1176	479	499	51	55	118	130
Descriptive statistics	34.3	37.9	34.3	33.1	65.0	56.6	41.5	50.0	30.2	29.7	23.4	23.3	32.4	34.3	51.0	47.3	49.2	53.8
Dispersion	23.2	21.1	28.6	28.0	20.0	13.2	18.9	19.6	30.5	28.7	23.8	23.3	27.8	26.1	19.6	25.5	16.1	17.7
t Test	4.4	3.1	8.2	9.1	0	1.9	4.7	5.4	7.2	7.9	4.6	4.1	12.9	11.0	3.9	1.8	3.4	3.1
Pearson correlation	6.3	5.1	1.6	3.1	2.5	1.9	4.7	1.4	3.9	2.5	13.7	15.3	2.3	3.8	0	3.6	2.5	3.8
Simple linear regression	6.7	4.6	1.9	2.0	2.5	1.9	1.9	2.7	2.9	3.2	13.1	14.5	1.0	2.8	0	0	1.7	3.1
Mathematical models	4.1	5.1	5.7	6.0	0	1.9	4.7	2.7	5.8	5.6	7.4	5.3	4.2	1.4	0	1.8	5.1	0
Transformations	6.3	5.1	2.2	2.9	0	0	2.8	2.7	4.6	3.7	3.9	3.5	6.1	7.8	2.0	0	2.5	1.5
χ^2	2.2	4.3	3.1	2.0	2.5	9.4	7.5	5.4	2.7	2.5	0.9	0.9	2.9	2.2	5.9	5.5	2.5	2.3
P value not otherwise specified	3.2	1.1	5.0	3.7	0	1.9	2.8	5.4	3.0	3.3	1.2	1.1	2.5	3.0	2.0	7.3	3.4	5.4
Analysis of variance	1.9	1.7	3.8	5.1	0	3.8	0.9	0.7	1.4	1.8	2.4	2.3	1.3	2.4	3.9	0	1.7	2.3
Nonparametric tests	1.9	1.4	2.2	2.3	0	0	3.8	0.7	2.2	3.7	1.3	1.8	4.6	2.8	3.9	1.8	1.7	1.5
Epidemiologic statistics	2.5	6.0	0	0	0	1.9	0	0.7	0.6	0.3	2.0	2.2	0.2	0.4	2.0	0	1.7	0.8
Survival analysis	1.0	0.6	0.9	0.3	7.5	3.8	2.8	1.4	3.0	3.1	0.1	0	0.6	0.6	0	3.6	3.4	3.1
Multiple comparisons	0.3	0	0.6	1.7	0	0	0	0	0.5	0.8	0.3	0.2	0.4	0.2	2.0	0	0.8	0.8
Multiple linear regression	0.3	0	0.6	0	0	1.9	0	0.7	0.8	1.7	0.7	0.4	0	0	0	0	0	0
Nonparametric correlations	0.6	0.9	0.3	0	0	0	1.9	0.7	0.4	0.8	0.2	0.6	0.2	0.6	0	0	0	0
Power	0.3	0.3	0	0	0	0	0	0	0.1	0.1	0.2	0.3	0.2	0.2	0	0	0	0
Discriminant function analysis	0	0.9	0	0	0	0	0	0	0	0	0	0	0	0.2	2.0	0	1.7	0
κ Statistic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.0	1.8	0	0
Bonferroni inequality	0	0	0.3	0.6	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0.8
Other	0.3	0.9	0.6	0	0	0	0.9	0.5	0.2	0.6	0.8	0.9	0.2	0.2	0	0	2.4	0

*See Table 1 for expanded definitions.

†1983 and 1984 issues combined into one volume.

this technique was used less than 1% of the time in the *Journal of Clinical Pathology*, the *American Journal of Clinical Pathology, Clinical Immunology and Immunopathology, Clinical Chemistry, American Journal of Pathology*, and the *International Journal of Gynecology and Pathology*. Linear regression was commonly used in the *American Journal of Surgical Pathology*, the *American Journal of Clinical Pathology, Clinical Chemistry*, and the *Archives of Pathology and Laboratory Medicine*, but was only rarely used in the *Journal of Neuropathology and Experimental Neurology*.

Mathematical models of physiologic processes were commonly reported. This category was not scored for simple linear transformations, but rather, for complex mathematical relations between independent and dependent variables. Most of the models were represented by four techniques (Lineweaver-Burk plots, Scatchard analyses, reciprocal dose-response curves, or other pharmacokinetic models). Readers of *Laboratory Investigation, Journal of Neuropathology and Experimental Neurology, Virchows Archiv B*, and the *American Journal of Clinical Pathology* need familiarity with these techniques since they are very commonly reported in these journals.

We found that articles in *Human Pathology*, while only rarely reporting statistical methods, contained one of the greatest variety of different techniques; including cluster analysis, factor analysis, and inter-rater reliability. However, because of their overall relatively sparse usage in the pathology literature, these techniques are included as "other" in Tables 2 and 3.

Statistical methodology used in the pathology and general medical literature is similar, yet it is clear that readers of pathology journals must be familiar with survival analysis and mathematical models in addition to the techniques used in the more general literature. Unfortunately, if failure to identify the techniques used (*P* value not otherwise specified) had been considered a statistical "technique" it would have been among the nine most frequently scored.

For each journal, there was a great similarity in statistical techniques for the two years studied. For ease of interpretation, we combined the results for both years to show the ten most frequently used statistical procedures in order of decreasing frequency for each journal (Table 3).

This Table
ogy literat
article by (
reports of
compariso:
ly. Table 3
varies fron
statistical
tables, ep
regression
formation:
be familia
reported i
widely res

Publicat
laboratory
and teacl
expected t
tific criter
many qua:

985 Editions of 16 Major Pathology Journals Reported as a Percent of All Techniques Used

Histopathology 983	Histopathology 1984	Human Pathology 1983	Human Pathology 1984	International Journal of Gynecological Pathology† 1983 1984	Journal of Clinical Pathology 1983	Journal of Clinical Pathology 1984	Journal of Neuropathology and Experimental Neurology 1983	Journal of Neuropathology and Experimental Neurology 1984	Laboratory Investigation 1983	Laboratory Investigation 1984	Neuropathology and Applied Neurobiology 1983	Neuropathology and Applied Neurobiology 1984	Transfusion 1984	Transfusion 1985	Virchows Archiv B 1983	Virchows Archiv B 1984	All Journals 1983 1985
77	83	146	179	40	247	135	49	46	159	149	35	35	116	118	58	105	5193
46	53	83	106	25	107	62	27	30	46	29	14	19	37	50	26	49	1928
51	55	118	130	29	350	202	56	43	352	342	61	50	226	184	93	168	9302
·1.0	47.3	49.2	53.8	41.4	35.7	34.7	39.3	34.9	30.7	33.3	34.4	32.0	29.2	28.8	34.4	32.1	32.0
9.6	25.5	16.1	17.7	24.1	24.3	26.2	26.8	27.9	25.9	26.3	27.9	30.0	27.0	25.0	31.2	29.2	25.1
3.9	1.8	3.4	3.1	3.4	5.7	5.0	8.9	7.0	8.8	11.1	21.3	4.0	11.5	12.5	11.8	11.9	7.1
0	3.6	2.5	3.8	6.9	6.9	6.9	1.8	0	4.3	2.6	1.6	6.0	4.0	5.4	4.3	2.4	6.1
0	0	1.7	3.1	3.4	4.0	4.5	1.8	0	2.8	2.0	0	2.0	3.5	4.3	2.2	1.8	5.3
0	1.8	5.1	0	0	2.3	0.5	7.1	11.6	9.4	7.3	1.6	8.0	8.0	6.5	4.3	3.6	4.7
2.0	0	2.5	1.5	6.9	4.0	2.0	0	0	1.1	2.0	1.6	0	3.5	3.3	1.1	4.2	3.6
5.9	5.5	2.5	2.3	0	3.7	5.9	0	2.3	2.8	0.9	4.9	0	3.5	4.3	0	1.8	3.2
2.0	7.3	3.4	5.4	6.9	2.6	4.5	5.4	9.3	2.8	4.1	1.6	6.0	.4	.5	4.3	3.0	2.7
3.9	0	1.7	2.3	3.4	0.9	0.5	1.8	2.3	3.7	4.1	3.3	2.0	2.2	3.3	2.2	3.6	2.4
3.9	1.8	1.7	1.5	0	4.9	4.5	1.8	0	2.0	1.2	1.6	6.0	2.2	2.2	2.2	1.2	2.4
2.0	0	1.7	0.8	0	2.3	2.5	0	0	0.6	0.3	0	2.0	2.7	2.2	0	0.6	1.6
0	3.6	3.4	3.1	0	0.6	0.5	1.8	0	0.3	0.3	0	0	0	0.5	1.1	1.8	1.2
2.0	0	0.8	0.8	0	.0	0.5	1.8	4.7	2.8	2.9	0	2.0	0.9	1.1	1.1	1.2	0.7
0	0	0	0	0	0.3	0	0	0	0.6	0.6	0	0	0.4	0	0	0.6	0.6
0	0	0	0	0	0.6	1.5	0	0	0.6	0.3	0	0	0.9	0	0	0.6	0.5
0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0.6	0.2
2.0	0	1.7	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0.1
2.0	1.8	0	0	0	0.9	0	0	0	0	0	0	0	0	0	0	0	0.1
0	0	0	0.8	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0.1
0	0	2.4	0	3.4	0.6	0	1.8	0	0.3	0.7	0	0	0	0	0	0	0.4

vhile only ›ne of the ıg cluster ity. How- age in the :luded as

and gen- lear that with sur- ion to the Unfortu- . (P value ıtatistical .ine most

in statis- r ease of ı years to :edures in (Table 3).

This Table also permits a comparison between the pathology literature and more general medical journals.[3,18] The article by Colditz and Emerson did not distinguish between reports of central tendency vs dispersion. To facilitate comparison with our categories, these were ranked equally. Table 3 suggests that even though the frequency of use varies from journal to journal, a reader familiar with ten statistical procedures (descriptive statistics, contingency tables, epidemiologic statistics, *t* tests, simple linear regression, analysis of variance, survival analysis, transformations, dispersion, and pharmacologic modeling) will be familiar with over 90% of the quantitative techniques reported in the pathology journals surveyed as well as two widely respected more general medical journals.

COMMENT

Publication of the results of a clinical investigation or laboratory finding may rapidly affect both the practice and teaching of pathology. Because pathologists are expected to make decisions on the basis of rigorous scientific criteria, it is important that they be familiar with many quantitative skills, including statistical acumen. Our findings suggest that pathologists need statistical skills (survival analysis and pharmacokinetic modeling) beyond those of readers of more general medical journals.[2-4,8,18]

Complete understanding of the statistical validity of an article requires more than a superficial identification of the methodology reported. In addition to familiarity with particular tests, general issues in statistical inference need to be appreciated.[19] However, a frequency distribution of the commonly used techniques may be of assistance in structuring the statistical aspects of pathology training programs.

The primary purpose of our study was not to report statistical errors in the pathology literature; however, we noted some questionable practices. Measures of dispersion were often described ambiguously either with the SD and the SEM used interchangeably or with the identification of the dispersion parameter.[17] Studies using nonparametric tests of hypothesis often reported means and SDs without providing the rationale for mixing parametric and nonparametric analyses of the same data. Many studies rejecting a null hypothesis of no difference between experimental groups did not discuss the probability of being able to

Table 3.—Ten Most Commonly Mentioned Statistical Techniques in the 1983-1985 Editi[on of] 16 American Path

	American Journal of Clinical Pathology	American Journal of Pathology	American Journal of Surgical Pathology	Archives of Pathology and Laboratory Medicine	Blood	Clinical Chemistry	Clinical Immunology and Immunopathology	Histopathology	Human Pathology
Descriptive statistics	1	1	1	1	1	2	1	1	1
Dispersion	2	2	2	2	2	1	2	2	2
t Test	8	3	9	4	3	6	3	5	4
Pearson correlation	3	9	5	7	6	3	6	7	5
Simple linear regression	5	...	6	9	8	4	10	8	8
Mathematical models	6	4	...	6	4	4	7	...	9
Transformations	4	8	...	8	5	7	4	...	...
χ^2	9	7	3	3	...	...	9	3	7
P value not otherwise specified	10	6	...	5	7	...	8	4	3
Analysis of variance	...	5	7	...	...	8	...	...	10
Nonparametric tests	...	10	...	10	10	10	5	6	...
Epidemiologic statistics	7	...	8	...	...	9	...	...	...
Survival analysis	...	...	4	...	9	...	...	9	6
Multiple comparisons	...	...	...	...	...	...	...	...	...
Multiple linear regression	...	...	10	...	...	...	...	...	...
Nonparametric correlations	...	...	...	...	...	...	...	...	...
Power	...	...	...	...	...	...	...	...	...
Discriminant function analysis	...	...	...	...	...	...	...	...	...
κ Statistic	...	...	...	...	...	...	...	...	...
Bonferroni inequality	...	...	...	...	...	...	...	10	...
Other	...	...	...	...	...	...	...	...	...
	93.4%*	95.1%*	97.8%*	94.9%*	92.3%*	95.5%*	95.9%*	95.3%*	91.9%*

*For each journal the cumulative percent of statistical techniques represented by the ten most commonly mentioned procedures. For example, for *Human Pathology*, a reader understanding the ten techniques listed would be familiar with over 91.9% of the techniques mentioned in this journal.

detect a difference, if it existed (the concept of statistical power).[20] Some articles reported all differences were "not statistically significant," without any indication that statistical power had been considered.

We also noted the common omission of the identification of the methods used when a "*P* value" resulting from a statistical test of a hypothesis was reported (category 7 in Table 1). While more of a reporting oversight than a misuse of statistical methodology, this omission was one of the ten most common "categories" for the journals reviewed. We suggest that every test of statistical significance should be accompanied by an unambiguous identification of the techniques used to calculate this value. As part of their instructions for authors, we recommend more editorial boards require a standardized format for the reporting of results based on a statistical analysis.[21-26] For example, in their instructions for authors, *Transfusion* informs contributors in bold print to "state statistical methods." An alternative strategy requesting the name and credentials of individuals providing statistical support has been adopted by the *Journal of the American Medical Association* and *Archives of Pathology and Laboratory Medicine*. If statistical software is used for other than simple counts, the program and procedure used should be identified. We contend that authors should describe statistical analyses in sufficient detail such that readers could reproduce the calculations if the data were available.

Many articles did not report the use of statistical methods or used only descriptive statistics. We noticed numerous missed opportunities for reporting statistically meaningful inferences. There is more to modern pathology than hypothesis testing, and no biomedical scientist should ever forget how the reading about an unusual case finding can trigger the solution to a challenging problem. However, we encourage all authors to review their contributions to determine if their results would benefit from a statistical analysis.

This study was supported in part by grant CA-17701 from the National Cancer Institute, Bethesda, Md.

The authors thank Renee Sckittone, Dave Luttman, MS, and the staff of the University of Texas at Houston Education and Research Computer Center for their technical assistance.

1. Matthews D
tics. New York, S
2. Daubs J: A
Physiol Opt 1980
3. Emerson JI
England Journal
4. Hayden GF
future. Pediatric
5. Culliton BJ:
6. Colditz GA,
research: Some
1985;19:248-255.
7. Moore R, Si
read professiona
254.
8. Feinstein A
journals. Clin Pl
9. Emerson JI
general surgical
10. Wallenstei
in circulation res
11. Lavori PW
Parallel compari
12. Bailar JC
biomedical resea
University Depa
13. Glantz SA:

983-1985 Editions of 16 American Pathology Journals and From Two General Medical Journals [3,18]

...istopathology	Human Pathology	International Journal of Gynecological Pathology	Journal of Clinical Pathology	Journal of Neuropathology and Experimental Neurology	Laboratory Investigation	Neuropathology and Applied Neurobiology	Transfusion	Virchows Archiv B	Journal of the American Medical Association	New England Journal of Medicine*
1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	...
5	4	6	4	4	3	3	3	3	4	2
7	5	3	3	9	6	5	5	6	7	6
8	8	7	7	10	9	...	7	9	...	7
...	9	9	...	3	4	...	...	...	...	...
...	...	4	8	...	...	...	8	8	...	9
3	7	...	6	8	10	8	6	...	3	...
4	3	5	9	5	7	7	...	5	9	...
...	10	8	...	...	5	9	9	7	6	8
6	...	...	5	...	...	6	...	10	8	4
...	...	...	10	...	...	10	10	...	5	5
9	6	...	...	...	...	...	...	...	10	...
...	...	...	...	6	8	4	4	4	...	...
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	10
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...
10	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	3
95.3%*	91.9%*	100%*	94.9%*	97.0%*	94.4%*	97.3%*	95.4%*	94.6%*	90.6%*	87.4%*

...an Pathology, a

Laboratory
other than
l should be
ribe statis-
iders could
ilable.
statistical
We noticed
tatistically
pathology
itist should
ase finding
m. Howev-
ntributions
a statisti-

the National
nd the staff of
rch Computer

References

1. Matthews DE, Farewell V: *Using and Understanding Medical Statistics.* New York, S Karger AG, 1985.
2. Daubs J: A survey of biostatistics in clinical journals. *Am J Optom Physiol Opt* 1980;57:801-807.
3. Emerson JD, Colditz GA: Use of statistical analysis in the *New England Journal of Medicine. N Engl J Med* 1983;309:709-714.
4. Hayden GF: Biostatistical trends in pediatrics: Implications for the future. *Pediatrics* 1983;72:84-87.
5. Culliton BJ: Information as a 'cure' for cancer. *Science* 1984;227:732.
6. Colditz GA, Emerson JD: The statistical content of published medical research: Some implications for biomedical education. *Med Educ* 1985;19:248-255.
7. Moore R, Smith MC, Liao W, et al: Statistical background needed to read professional pharmacy journals. *Am J Pharmaceut Educ* 1978;42:251-254.
8. Feinstein AR: A survey of the statistical procedures in general medical journals. *Clin Pharmacol Ther* 1974;15:97-107.
9. Emerson JD, McPeek B, Mosteller F: Reporting clinical trials in general surgical journals. *Surgery* 1984;95:572-579.
10. Wallenstein S, Zucker CL, Fleiss JL: Some statistical methods useful in circulation research. *Circ Res* 1980;47:1-9.
11. Lavori PW, Louis TA, Bailar JC III, et al: Designs for experiments: Parallel comparisons of treatment. *N Engl J Med* 1983;309:1291-1299.
12. Bailar JC III, Louis TA, Lavori PW, et al: A classification for biomedical research reports, in *Research Report No. 215.* Boston, Harvard University Department of Biostatistics, 1983.
13. Glantz SA: Biostatistics: How to detect, correct, and prevent errors in the medical literature. *Circulation* 1980;61:1-7.
14. Colton T: An inventory of biostatistics teaching in American and Canadian medical schools. *J Med Educ* 1975;50:596-604.
15. Garfield E: Citation analysis: A tool in journal evaluation. *Science* 1972;178:471-479.
16. Nie NH, Bent DG, Steinbrenner K, et al: *Statistical Package for the Social Sciences.* New York, McGraw Hill International Book Co, 1975.
17. Bunce H, Hokanson JA, Weiss GB: Avoiding ambiguity when reporting variability in biomedical data. *Am J Med* 1980;69:8-9.
18. Hokanson JA, Stiernberg CM, McCracken MS, et al: The reporting of statistical techniques in otolaryngology journals. *Arch Otolaryngol Head Neck Surg* 1987;113:45-50.
19. Mainland D: Medical statistics: Thinking vs arithmetic. *J Chronic Dis* 1982;35:413-417.
20. Jones BJ, Brewer JK: An analysis of the power of statistical results reported in the *Research Quarterly. Res Q* 1972;43:23-30.
21. DerSimonian R, Charette LJ, McPeek B, et al: Reporting on methods in clinical trials. *N Engl J Med* 1982;306:1332-1337.
22. George SL: Statistics in medical journals: A survey of current policies and proposals for editors. *Med Pediatr Oncol* 1985;13:109-112.
23. O'Fallon JR, Dubey SD, Salsburg DS, et al: Should there be statistical guidelines for medical research papers? *Biometrics* 1978;34:687-695.
24. Weiss GB, Bunce H: Are we ready for statistical guidelines for medical research papers? *Biometrics* 1979;35:91.
25. Zelen M: Guidelines for publishing papers on cancer clinical trials: Responsibilities of editors and authors. *J Clin Oncol* 1983;1:164-169.
26. Simon R, Wittes RF: Methodologic guidelines for reports of clinical trials. *Cancer Treat Rep* 1985;69:1-3.