Arkansas Laboratory Medicine Surveillance Network
Survey 6: Assessment of Cultural Variation in Medical Laboratories
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George Avery, M.P.A.
Division of Health Services Research and Policy
School of Public Health
University of Minnesota
420 Deleware St SE, Box 729 Mayo
Minneapolis, MN 55455

Phone: 218-722-8982
e-mail: aver0042@tc.umn.edu

Jason Lee, Ph.D.
Stan Falk, Ph.D.

Division of Public Health Laboratories
Arkansas Department of Health
4815 West Markham Mail Stop 47
Little Rock, AR 72205
e-mail: jlee@healthyarkansas.com
sfalk@healthyarkansas.com

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Abstract

Context:

Organizational and institutional culture are important determinants of how a laboratory operates and performs. This culture constrains the decisions managers make, and affect how the laboratory reacts to a changing environment.

Objective:

This study attempts to develop and test a Discriminant technique for determining differences in the organizational environment of medical laboratories operating in different environments.

Setting:

Data was collected from 331 medical testing sites in the On-line Survey, Certification, and Reporting (OSCAR) database and participants in the Arkansas Laboratory Medicine Surveillance Network. Facilities were hospital, independent, physician office, and community health clinic laboratories.

Methodology

Participants returned a survey questionnaire with 52 questions related to aspects of the organizational culture of the laboratory. Significant discriminating items were selected using one-way ANOVA with the laboratory type as a dependent variable. These items were then analyzed with canonical discriminant analysis using one of two laboratory classification schemes as a dependent variable. Discriminant functions identified cultural differences between the laboratories.

Results

This technique successfully identified cultural differences between the laboratory types consistent with expectations. The model was significant at a conference level greater than 99.9%, and successfully identified 68.3% of cases.

Conclusions

This technique successfully identifies cultural differences between classes of laboratories, and may prove a useful tool for exploring how organizational culture influences laboratory performance and outcomes.

Introduction

The evolving healthcare environment has posed new demands, such as regionalization, consolidation, increased regulation, and financial constraints imposed through insurers on organizations involved in medical testing. Understanding the effects of this on the behavior of laboratories requires an understanding of the organizational and institutional factors that differentiate the practice of laboratory medicine in different environments. Much of the research performed to date on the management of clinical laboratories and medical testing has focused on technical issues such as order accuracy, turnaround times, contamination rates, workforce mix, etc.[1] What is often overlooked are underlying cultural, institutional, and environmental differences that determine the way laboratories operate and how they are managed.

Organizational and institutional culture are important factors in determining how an organization behaves. Organizational behavior is limited by constraints, both formal and informal, which create order in the environment and reduce uncertainty. [2] These rules limit the choices and behavior of the organization by constraining the range of acceptable solutions to problems. As such, it can be an important determinant of how an organization behaves, and how changes in the environment will cause the organization to change.

In the healthcare environment, formal measurements of organizational culture are relatively limited. Shortell and colleagues studied the impact of management on the quality of care in intensive care units.[3] Kralewski and colleagues, using stepwise discriminant analysis, developed a survey instrument which identified differences in organizational culture in different medical group practice settings.[4] Zinn utilized Delphi panels to develop measures of laboratory performance that included some factors of organizational culture.[5,6] Steindel and Granade have attempted to develop a classification scheme for laboratories based on the nature of tests

performed, but have found the heterogeneity of the laboratory community made their models useful for general classification, at best.[7] Despite the paucity of research, it is known that variation in the practice setting does have an impact the on the performance of the practice.[8] Hurst, in describing differences in quality between Physician Office Laboratories and other practice settings, suggested the need to better understand the contributing factors to poorer results in these facilities.[9] Measuring and understanding the cultural variation between these settings is an essential first step to understanding the performance variation.

Methodology

This study was designed to test the ability of a survey instrument to identify differences in the management culture between different types of medical laboratories. Such an instrument is potentially useful in assessing how the culture of a laboratory affects the outcome of policy decisions, the quality of testing performed in the laboratory, or the impact of management changes such as in the area of reimbursement. To assess the ability of the instrument to identify differences, this study used known differences in the operational environment to test the ability of the instrument to discriminate between the laboratory operational types based on differences in the organizational culture.

Surveys were sent to 2468 facilities holding a CLIA Certificate. These consisted of 269 facilities who have participated in the Arkansas Laboratory Medicine Surveillence Network and 2199 selected semi-randomly from the July, 2000 On-line Survey, Certification, and Reporting (OSCAR) database[10]. The sampling set was selected randomly from among physician office laboratories, independent/reference laboratories, community health clinics, and hospitals, supplemented with participants from the Arkansas network. This sampling was used to generate a database of responses from operating medical laboratories which was used to test the ability of the survey instrument to identify organizational differences between types of laboratories.

Surveys asked each facility a number of questions regarding the type and size of the laboratory, as well as 52 questions on the culture and environment of the laboratory (Table 2). The questions are based on those used by Kralewski et al[4] in their instrument for assessing the culture of medical group practices, modified to reflect the medical testing environment. These

items were pre-screened by staff members at the Arkansas Department of Health and the Division of Laboratory Services of the Centers for Disease Control and Prevention prior to use for relevance and completeness. These culture questions requested the respondent to answer on a five-point Likert scale, with 1=Strongly Disagree and 5=Strongly Agree. The survey instrument was not field-tested prior to use.

Responses were discarded from all laboratories except those classifying themselves as Physician Office Laboratories, Hospital Laboratories, Independent/Reference Laboratories, or Community Health Clinics. This culling occurred due to insufficient numbers to generate a statistically significant discriminant function. Facilities omitting responses were dropped rather than inserting an average value as Likert responses lack interval qualities, making averages suspect.[11] Responses were screened using one-way ANOVA with laboratory type as a sorting variable to determine the discriminating capability of the items. Items which were not scored significantly different ($P<0.05$) were dropped from consideration. The remaining items were then scored using Cronbach's alpha as a means to assess the internal reliability of the items. The standardized alpha score for the basic model was 0.83, exceeding the guideline of 0.70 in Nunnally.[12] The items used in the complexity model were less reliable, with an alpha score of 0.42. These remaining items were used in discriminate analysis, using the laboratory type as a discriminating variable.

Results

Responses were received from 331 facilities in 34 states and Puerto Rico (Table 1). The testing volume of the respondents is described in Figure 2. The high number of unspecified states for respondents arises from facilities which did not report the data and for which it proved

impossible to match the form to a specific laboratory. Twenty seven percent of responders were administrators, 37.6% laboratory testing staff, 5.5% physicians, 22.6% nurses, and 7.3% other staff or unspecified. Although the overall response rate is not high, it is not critical for determining whether the instrument can make the necessary discriminations.

The data was then used to generate a discriminant model, with laboratory type as a grouping variable. Cases missing a response to a selection item were dropped, leaving 183 valid cases – 43 community health clinics, 8 independent/reference laboratories, 57 hospitals, and 75 physician office laboratories. Laboratory type was reported by the facility on the questionnaire. Three discriminant functions were generated (Table 4). Function 1 serves to discriminate Physician Office Laboratories from Hospital Laboratories. Function 2 discriminates Community Health Clinics from the first two facility types, and Function 3 discriminates Independent/Reference Laboratories from the other facilities (Figure 1).

The model was found significant using the Chi-square function (P=0.000). Predictions of group identity using the discriminant functions were made for the 183 facilities used to generate the model. Fifty-eight cases were misidentified, for a success rate of 68.3%. Physician office and hospital laboratories were more likely to be classified as reference or community clinics than vice versa (Λ=0.216, P=0.002, predicted value dependent).

Cultural Differences Between Facility Types

The discriminant functions reveal a number of differences between the four types of laboratories

Function 1 indicates that, compared to hospital and independent laboratories, physician office laboratories are :

- more likely to evaluate profitability before adding test equipment, and to function as a profit maximizer (Questions 5, 22)
- more likely to share clinical information with the ordering physician, who is felt to be more likely to understand test limitations (Questions 6, 20, 41)
- less likely to use computers to manage test data (Question 12)
- less likely to compare practices to those in other laboratories (Question 13)
- less likely to have difficulty hiring qualified laboratory personnel (Question 14)
- more likely to encourage analysts to be open and forthcoming about testing and quality problems (Question 26)
- more likely to have a sense of belonging among testing personnel (Question 34)
- less likely to have access to scientific journals and literature (Question 45)

Function 2 indicates that community health clinics, in comparison to other types of testing environments, are:

- more likely to share clinical information with practitioners (Question 6) but less likely to have candid communication between bench personnel and practitioners (Question 20)
- more likely to manage test data with computers (Question 12)
- less likely to compare lab practices (Question 13)
- less likely to be profit maximizers (Question 22)

- less likely to have a sense of belonging among testing personnel (Question 34)
- more likely to be committed to measuring patient outcomes (Question 39)
- less likely to have up-to-date equipment in good repair (Question 49)
- less likely to receive training from manufacturer's instruction manuals or test kit directions (Question 40)

Function 3 indicates that reference laboratories, compared to other facilities, are:

- less likely to have difficulty hiring qualified laboratory personnel (Question 14) but more likely to be inadequately staffed for the testing they perform (Question 37)
- more likely to share clinical information with practitioners (Question 6) but less likely to have open communication between physician and bench personnel (Question 20)
- more likely to have a good relationship with the reference laboratories they use (Question 15)
- more likely to be a profit maximizer (Question 22)
- less likely to have open communication between physician and bench personnel (Question 20)
- more likely to have a sense of belonging among testing personnel (Question 34)
- less likely to rely on manufacturer's training materials but also less likely to have access to scientific literature (Questions 40, 45)
- more likely to believe that a medical technician/technologist certification is an indicator of technical ability (Question 46)
- more likely to judge the competence of analysts based on one-time problems or failures, rather than patterns of problems or failures (Question 50)

Cluster Analysis Model

Respondents were asked a series of questions designed to classify the laboratories by the complexity of testing performed. The model used is based on results of a cluster analysis performed by the Division of Laboratory Services at the Centers for Disease Control and Prevention.[7] First, they were asked if they performed any waived or provider-performed microscopy procedure (PPMP) tests. If the answer was yes, they were asked if they performed any tests *besides* waived or PPMP tests. If this was answered in the affirmative, they were asked if they cultured organisms. Facilities answering only the first question affirmatively were classified as "Type 1" facilities, those performing only the most basic testing. Those answering the first two questions affirmatively were classified as "Type 2" facilities, or those performing moderate and/or high complexity testing not involving the culture of organisms. Those answering all three affirmatively were classified as "Type 3" laboratories, or those performing moderate and/or high complexity testing involving the culture of microorganisms. Facilities answering other combinations of answers were dropped from the analysis.

Discriminant analysis was carried out as in the basic model. Fifteen questions were found to be significant discriminators, generating two discriminant functions (Table 5). The model was generated from 222 cases answering the classification questions as noted above. Of these, 78 were dropped due to incomplete responses to the questions on culture, leaving 144 valid cases for the model. Reclassification using the model correctly classified 70.1% of the cases. Type 1 cases totaled 26, with 56 Type 2 and 52 Type 3 cases. Function 1 discriminates differences between Type 2 laboratories and the other types, Function 2 between Types 1 and 3 laboratories.

Type 2 laboratories were found to be:

- more likely to share clinical information between practitioners and the laboratory, and feel that the physician understand the limits of the tests performed (Questions 6, 41)
- more likely to be weighted towards profit maximization (Question 22)
- more likely to face resource strains due to patient demand for test services (Question 35)
- more likely to not be performing tests that they feel they should due to the cost of the test (Question 42)
- more likely to feel that continuing education opportunities are inadequate (Question 43)
- less likely to have difficulty hiring qualified personnel (Question 14)
- less likely to rely on instrument and kit manufacturers for training

Type 1 laboratories are:

- more likely to share clinical information between analyst and practitioner, but less likely to have candid and open communications between the two. At the same time, practitioners are felt to be more likely to understand the limits of testing. (Questions 6, 20, 40)
- less likely to use computers (Question 12)
- less likely to compare lab practices (Question 14)
- less likely to be short-handed in the laboratory (Question 29)
- less likely to survey patients for satisfaction (Question 33)
- less likely to experience a resource drain due to patient requests for testing (Question 35)
- less likely to receive training from instrument/kit manufacturers (Question 40)
- less likely to see the need for more continuing education opportunities (Question 43)

Discussion

The cultural instrument used in this study reveals a number of differences relevant to the management and regulation of testing in various laboratory environments. Variations in training, ethics, motivation, staffing, and communications between testing personnel and practitioners can be identified and used to design programs appropriate to the environment in which testing occurs.

As an example, concern has been recently raised about regulatory compliance in laboratories holding a Certificate of Waiver under the Clinical Laboratory Improvement Act (CLIA) regulations. Recent studies have found that these facilities, corresponding to the Type 1 laboratories in the complexity model, are less likely to implement quality assessment measures than higher complexity laboratories for the same tests[13,14]. At the same time, discussions have been held to consider broadening the scope of testing classified at the “waived” level. These regulations require the laboratory to implement the assessment measures outlined in the manufacturer’s directions. Our model finds that these laboratories, however, are less likely than other types of facilities to utilize the manufacturers training or directions, which raises serious questions as to the ability of the regulating agency to obtain compliance with these instructions.

The models generated in this study reveal significant cultural differences between the various environments in which testing occurs, and can contribute to understanding differences in how these facilities operate. Independent laboratories, for example, tend to be profit maximizers. This offers an explanation for the apparent incongruity that they have less trouble hiring qualified personnel but are less likely to feel that they are adequately staffed. As a profit maximizer, the incentive structure for the manager encourages the use of the minimum amount

of labor necessary to produce the test result. Similarly, the study reveals that a more collegial environment in the physician office laboratory, where information is more likely to be shared, a sense of belonging exists among staff, and analysts are likely to be more forthcoming about problems.

The discrimant functions are consistent with an intuitive understanding of how the testing environment is reflected in organizational culture. The independent lab functions, according to this model, as a professionalized, routinized, profit-seeking organization. Credentials matter. Communications between the client physician and the laboratory are formal and do not involve bench-level personnel. The organization has the ability to hire skilled analysts, but operates in a manner in which the minimal number necessary are hired, which is consistent with the organization being a profit maximizer in that it minimizes labor costs. Community health clinics tend to be non-profit organizations. They are less likely to have an internal cohesion among personnel. Equipment is more likely to be aged and in good repair, an expected result of the non-profit natureof the organizational type, and a patient base that is more likely to be poor and uninsured. Physcian office laboratories have better communications between testing personnel and physicians, which is to be expected in that they operate in close proximity to the practitioner, and are an integral part of the practice. Internal relations are also closer between laboratory personnel, but involvement with the laboratory world outside the practice is weaker.

In a similar manner, the second discriminant analysis is consistent with what one would expect intuitively. Laboratories performing only the CLIA “waived” tests (Type 1) are less likely to be automated or be as concerned with training opportunities as those performing more demanding tests, as the model shows, This consistency serves to support the technique as a valid method of capturing real differences in organizational and managerial culture.

This study does not purport to make observations on universal differences between laboratory types. The sample is not completely randomized, contains a high concentration of laboratories in one state, and a relatively low response rate. Predictions are not perfect, in part because of variations within a laboratory type. A large local health department laboratory may have more in common with an independent reference laboratory than a rural county health clinic, and differences are expected between testing in a small, single practitioner physician office and the laboratory in a large group practice clinic. What it does do is demonstrate that the technique can elicit relationships between observed differences in operations and organizational factors that are related to those differences. This technique provides information related to non-technical and human factors that can have an impact on laboratory operation, information that is not well documented in the literature.

The success of this instrument in the cases presented indicate that using alternative measures related to quality as the dependent variable in the discriminant analysis may enable this technique to be used to probe the effects of organizational culture on laboratory performance. In order to implement changes in the way an organization operates, it is necessary to understand how the organization behaves and what motivates organizational decisions. These differences in the management culture of the laboratory can be measured by performing discriminant analysis as done in this study, using behavioral or attitudinal variations as the Discriminant variable, and the information obtained as a result from the Discriminant functions used to create policies that reflect these differences. Rather than rely on arbitrary taxonomic schemes as a surrogate for cultural variation , this technique potentially allows probing of managerial differences based on outcome, policy, or attitudinal differences between laboratories. As a result, a better understanding of how the organization affects the behavior of the laboratory is obtained.

Observations from outside the model

Responses to individual questions were examined and further observations made, as noted below.

Management processes in independent laboratories appear to be more hierarchal and less open to participation by analysts than in other laboratories. Question 24 shows a notably higher rate of response by the independent laboratories in disagreeing with the statement that consensus building describes their administrative processes. Similarly, Question 2 indicates higher levels of agreement with the description of the laboratory as hierarchal among the reference laboratory responders. These laboratories may also be slightly less encouraging of analysts to be forthcoming in dealing with analytical problems (Question 26), more likely to discipline those who produce poor quality data (Question 31), more likely to have well-defined procedures (Question 44), and more likely to have faith in credentials (Question 46). Single failures are more likely in the independent laboratory to result in disciplinary action than in other laboratories, indicating a possible disincentive to forthright handling of problems (Question 50). These facilities appear to differ from the other respondents in that they represent a far more formal and beauracratized practice of laboratory medicine.

Universal among laboratory classes is a desire for greater availability of continuing education opportunities. While laboratories appear to have some access to journals and professional literature, medical laboratories appear to be risk adverse in adopting new technologies. This may indicate a barrier that prevents innovations from making the transition from research to diagnostic laboratories.

All laboratory classes disagree with the statement that managed care helps make the laboratory more cost effective. Inherent in the conceptual model underlining managed care is the idea that cost controls will make practice more efficient. Practitioners appear to disagree with this proposition.

Table 1. Geographic distribution of sample

Type / State	Physician Office Laboratories	Hospital Laboratories	Independent/ Reference Laboratories	Community Health Clinics	Other Laboratories
Alaska	0	0	0	1	0
Alabama	3	1	0	1	0
Arkansas	58	32	3	18	8
Arizona	1	0	0	0	0
California	2	2	1	1	0
Colorado	1	0	0	1	2
Florida	2	0	0	1	0
Idaho	1	0	0	0	0
Illinois	3	0	0	1	0
Kansas	1	1	0	0	0
Kentucky	1	1	0	0	0
Louisiana	0	0	1	0	0
Massachusetts	1	0	1	0	1
Maryland	2	1	0	0	1
Michigan	0	3	0	0	0
Minnesota	2	2	0	0	0
Missouri	0	1	1	0	0
Mississippi	1	2	2	1	0
Montana	0	0	0	1	0
North Carolina	1	2	0	0	0
North Dakota	1	0	0	1	0
Nebraska	1	1	0	0	0
New Jersey	1	1	0	1	0
New York	2	1	1	0	0
Ohio	2	0	0	0	2
Oklahoma	0	1	0	0	0
Pennsylvania	2	4	0	0	0
Puerto Rico	0	1	0	0	0
South Carolina	1	0	0	0	0
Tennessee	0	1	0	0	0

Table 1. Geographic distribution of sample (cont)

Texas	1	1	0	4	1
Utah	1	0	1	0	0
Vermont	0	1	0	0	0
Washington	2	1	1	1	0
Wisconsin	0	0	0	1	0
Unspecified	32	24	3	47	10

Table 2. Annual Testing Volume of Study Participants

Type / Volume	Physician Office Labs	Hospital Labs	Independent / Reference Labs	Community Health Clinics	Other	Overall %
0-2000	40	13	2	49	21	37.9
2,001-10,000	34	6	5	22	1	29,6
10,001-25,000	14	3	1	2	0	6.1
25,001-50,000	6	1	0	0	0	2.1
50,001-100,000	5	8	0	0	0	3.9
100,001-500,000	3	14	1	0	0	5.5
500,000+	14	36	5	4	1	18.2
Unspecified	9	4	0	5	1	5.8

Table 3. Culture Questions

Please answer each of the following questions on a 5 point Likert Scale with 1=Strongly Disagree and 5= Strongly Agree

1. There is a close collegial relationship between analysts.
2. There is a well-defined hierarchy of authority.
3. We adopt new test technologies as soon as they are shown to be effective.
4. There is widespread agreement on most moral/ethical issues.
5. We will not add a piece of equipment if it won't make a profit.
6. There is a great deal of sharing of clinical information between the ordering practitioner and the laboratory.
7. Innovations by testing personnel are well publicized.
8. We have well defined data quality objectives.
9. Risk-taking in adopting innovative lab technology is encouraged.
10. We leave most strategic decisions up to our administrators or directors.
11. There is a great deal of organizational loyalty.
12. We rely heavily on computers to manage test data.
13. We know how our laboratory practices compare to those in other laboratories.
14. We have difficulty hiring qualified testing personnel.
15. We have a good relationship with the reference laboratory we use.
16. We rapidly change practices when studies indicate we can improve quality or reduce cost.
17. There is a great deal of internal consultation between testing personnel.
18. We have effective means of communicating the latest research results to our testing personnel.
19. We use electronic information systems to control our patient costs.
20. Candid and open communications exist between physicians and bench-level testing personnel.
21. Our organization readily pays for continuing education for testing personnel.
22. Business practices are heavily weighted towards profit maximization.
23. There is an open discussion of testing quality problems.
24. Our administrative process can best be described as consensus building.
25. Communications and information we obtain from professional societies are very useful in evaluating or improving our laboratory procedures.
26. Our analysts are encouraged to be honest and forthcoming in discussing problems with analytical results.
27. Our laboratory data is important in making a diagnosis
28. We communicate and exchange ideas regularly with personnel from other laboratories in our area.
29. We are occasionally shorthanded in the laboratory due to vacations, illnesses, etc.
30. We are highly committed to obtaining and using information which will improve the cost effectiveness of testing.
31. Testing personnel who produce low quality data face disciplinary action.
32. We periodically review laboratory data issues with all testing personnel.
33. We survey our patients to assess how well they think we do in serving them with our laboratory.
34. There is a strong sense of belonging among testing personnel.
35. Patient requests for additional testing have a significant effect on our resources.
36. The physicians we work with defer to the laboratory staff on the most appropriate test where options exist.
37. Our laboratory is adequately staffed to perform the tests we need.

Table 3. Culture Questions (cont)

38. Our organization recognizes exceptional performance by laboratory personnel with rewards over and above the standard compensation package.
39. There is a high level of commitment to measure the clinical outcomes of the patients for whom we perform tests.
40. Most of our training on test procedures comes from test kit/instrument manufacturers and their manuals or inserts.
41. The physicians we work with understand the limits of the tests we perform.
42. There are tests we should perform but do not due to costs.
43. We wish there were more opportunities for continuing education in our area.
44. We have well-defined written procedures for all tests we perform.
45. We have ready access to scientific journals and professional literature in our laboratory.
46. Certification as a medical technician/technologist is a useful indicator of technical ability.
47. Deviation from procedures is allowed for analysts with proven competency and judgment.
48. Managed care has helped our laboratory become more cost-effective.
49. Our equipment is up-to-date and in good repair.
50. Patterns of failure, rather than individual failures, are used to determine whether testing personnel are competent.
51. It takes time and experience to make a good laboratory analyst.
52. We readily adjust the way we work to make our laboratory operations more convenient for our patients.

Table 4. Discriminant Model for Laboratory Type

	1	2	3
5	-0.203	0.024*	0.132
6	-0.355*	-0.211	-0.201
12	0.416*	-0.372	-0.148
13	0.334	0.338*	-0.008
14	0.421*	0.080	0.579
15	-0.034	0.077	-0.373
20	-0.214	0.333*	0.348
22	-0.267	0.369*	-0.271
23	0.523	-0.057*	-0.199
25	0.085	-0.018*	0.092
26	-0.277	-0.014*	0.037
29	-0.005*	-0.003	-0.139
30	-0.091	0.022*	0.094
34	-0.219	0.201*	-0.220
37	-0.214	-0.041	0.435*
39	0.156*	-0.210	0.181
40	0.298	0.377	0.210
41	-0.453*	-0.122	0.028
45	0.247	0.070*	0.307
46	0.102	-0.017*	-0.464
49	0.015	0.498	-0.172
50	-0.141	-0.153	0.542*

(*) Strongest correlation between item and function

Function	Eigenvalue	% of Variance	Canonical Correlation
1	0.722	66.1	0.647
2	0.231	21.1	0.433
3	0.139	12.7	0.349

Table 5. Discriminant model based on complexity of testing

Function / Question	1	2
6	0.420	-0.144
12	-0.088	0.203
14	-0.353	0.290
20	0.185	0.425
22	0.479	-0.072
26	-0.039	0.087
29	-0.078	0.235
33	-0.094	0.327
35	0.465	0.230
39	0.089	-0.086
40	-0.351	0.256
41	0.403	-0.022
43	0.267	0.328

Function	Eigenvalue	% of variance	Canonical Correlation
1	0.463	66.4	0.576
2	0.250	33.6	0.448

Figure 1. Territorial of Functions 1 and Function 2 for Laboratory Type Model

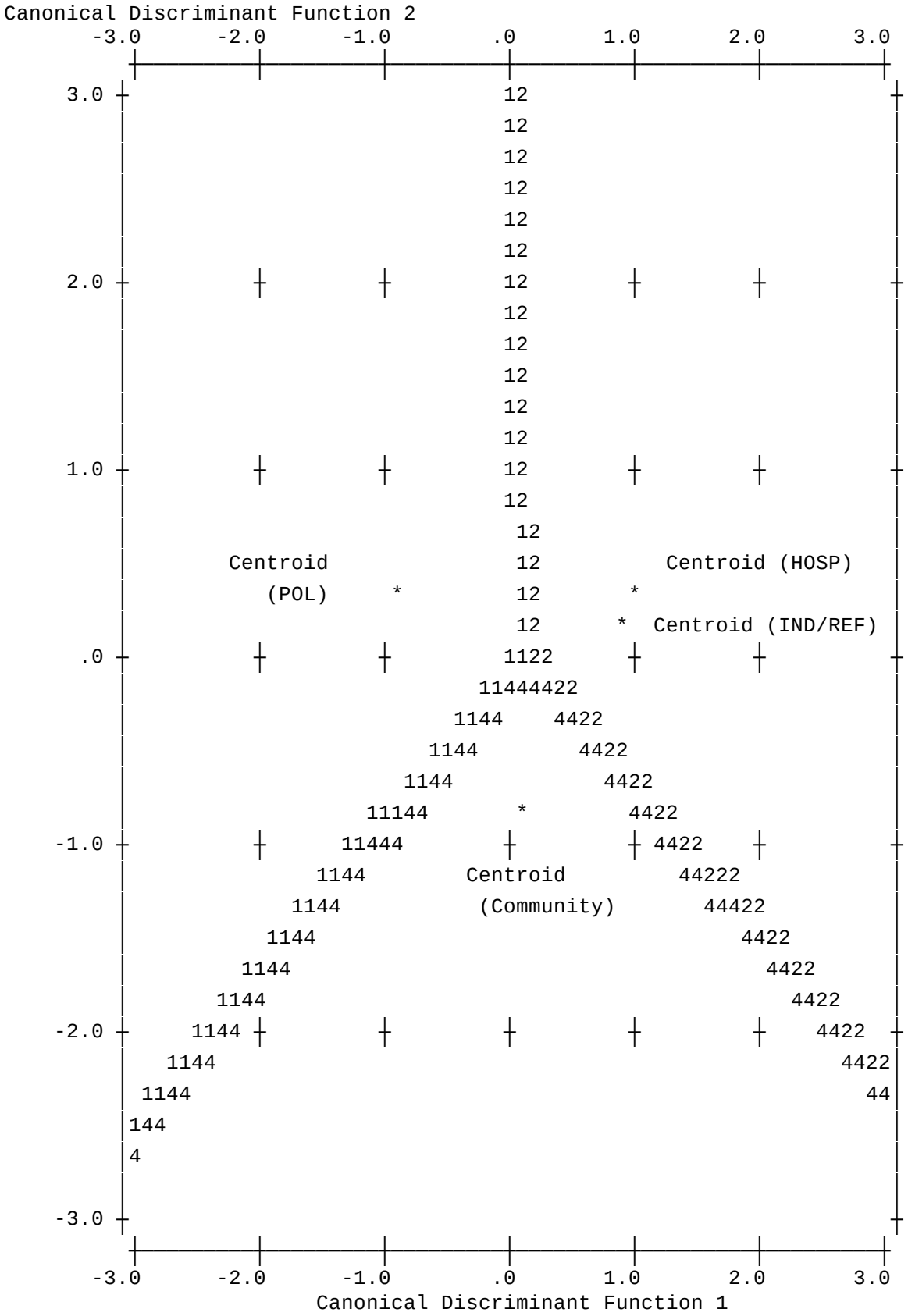
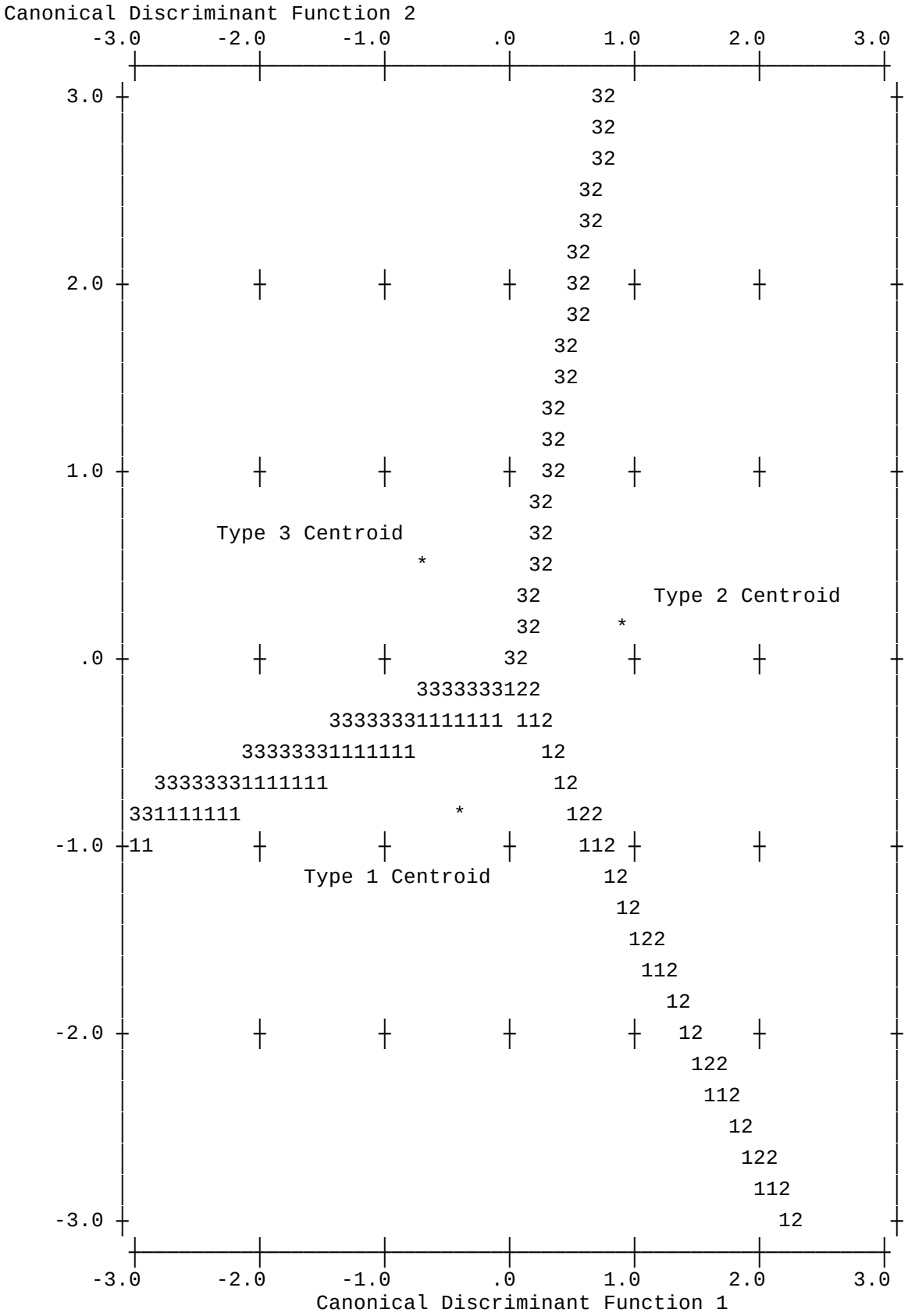


Figure 2. Territorial Map of Discriminant Functions for Complexity Model



References

[1] Heatherly SS. Benchmarking Laboratory Operations. ***Clin Lab Sci*** 2000, 13:187-189.

[2] North DC. Institutions. ***J Econ Persp*** 1991; 5:97-112

[3] Shortell SM, Zimmerman JE, Rosseau DM, et al. The performance of intensive care units: Does good management make a difference? ***Medical Care*** 1994; 32:508-

[4] Kralewski JE, Wingert TD, and Barbouche ME. Assessing the Culture of Medical Group Practices. ***Medical Care*** 1996; 34:377-388

[5] Zinn J. Use of the Delphi panel method to develop consensus on laboratory performance indicators. ***Clin Lab Mngt Rev*** 1998; 12:97-105

[6] Zinn J, Zalokowski A. The use of the Delphi panel for consensus development on indicators or laboratory performance. ***Clin Lab Mngt Rev*** 1999; 13:386-408

[7] Granade SE, Gonin R, PhD; Bethel J, Hancock JS, Steindel, SJ. "Results from the National Inventory ofClinical Laboratory Testing Services of an Analysis Grouping US Laboratories by Testing Performed". Abstract # 711. 2001 Am Assoc Clin Chem Annual Meeting, Chicago, IL (2001).

[8] Hlatky MA, Kerry LL, Botvinik EH, Brundage BH. Diagnostic test use in different practice settings: A controlled comparison. ***Arch Int Med*** 1983; 143: 1886-1889.

[9] Hurst J, Nickel K, Hilborne LH. Are physicians' office laboratory results of comparable quality to those produced in other laboratory settings? ***JAMA*** 1998; 279:468-471

[10] Available at http://www.phppo.cdc.gov/clia/labdemos.asp

[11] Roberson PK, Shema SJ, Mundfrom DJ, Holmes TM. Analysis of paired Likert data: How to evaluate change and preference questions. Fam Med 1995;27:671-675.

[12] Nunnally JC, **Psychometric Theory**. New York, New York:McGraw Hill, 1978.

[13] Avery GH, Falk S, Lee J. Quality Control Measures in Waived and PPMP Laboratories."Testimony before the Clinical Laboratory Improvement Advisory Committee (CLIAC), Atlanta, GA; February ,2001

[14] Labeau KM, Simon M, Steindel SJ. Quality control of test systems waived by the Clinical Laboratory Improvement Amendments of 1988**. Arch Pathol Lab Med**, 2000;124:1122-1127.