Clinical Laboratory Personnel Employment Patterns: Hiring Practices and Quality Issues

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Abstract: The state of Minnesota is in the forefront of managed care--approximately three-quarters of its residents are enrolled in this kind of provider system. The following report is concerned with a 25-year longitudinal study of employment patterns among laboratory personnel in the five-county Minneapolis-St.Paul area, which includes approximately 2.2 million persons, and almost 50% of the population of the state.

In 1970 there were over 10,000 hospital beds in 30 hospitals in the Twin Cities area. Also included among major employers of laboratorians were 2 blood banks and 4 clinic and reference laboratories. Altogether they employed approximately 1300 persons. In 1980 there were still 10,000 hospital beds, among 29 hospitals. Blood banks included 2 and clinics and reference labs included 6. During that decade, numbers of laboratory personnel almost doubled to 2500.

The impact of Prospective Payment and DRGs (1983) profoundly affected employing institutions and personnel in the 1980s. By 1990 hospital mergers and closures had reduced bed numbers to 7500, among 20 hospitals. There were 2 blood banks, and 9 clinics, reference labs, and HMOs, including 3 new reference laboratories. Total laboratory personnel employed were 2600.

By 1995 bed numbers were reduced to approximately 7000 among 18 hospitals. Again, there were 2 blood banks and 8 "other" employers. Total numbers of laboratory personnel employed were 2900.

We have seen a trend in hospital mergers and closures; since 1980, 10 major hospitals have closed or converted to a different kind of facility. There have been only two small suburban hospitals built in the last decade. Laboratory personnel almost doubled between 1970 and 1980. However, despite a decrease in hospitals, laboratory personnel numbers increased slowly, after 1980, largely due to new employing organizations, primarily independent commercial laboratories, as well as an increase in volume of testing.

Current (1995) employment trends include the following:

- baccalaureate-level medical technologists (clinical laboratory scientists) continue to be hired primarily in hospitals--regardless of size, where they make up 59% of all personnel. They comprise one-half of all laboratory employees.

- medical laboratory technicians are being hired mainly in HMOs and clinics. One of every five laboratorians is an MLT.

- cytotechnologists are being hired largely in medium-sized hospitals and independent laboratories, while histologic technicians/technologists are found mainly in medium-sized hospitals.

Personnel and issues of quality were addressed in the following retrospective study:

- A large HMO consisting of 1 central laboratory and 19 satellite laboratories was evaluated for error rates. In an eight-month study, all 20 laboratories had fewer than 1% laboratory errors among total tests. The central laboratory had the lowest error rate, averaging 0.05%. However, some satellite laboratories had somewhat larger error rates. Using common statistical analyses, there was no relationship between error rates and numbers of tests, workload, or kinds (levels) of personnel employed.

The connection between personnel and competency can be evaluated directly and indirectly. Direct methods include observation, establishing a relationship between proficiency test results and the personnel performing those tests, and establishing the relationship between laboratory error rates and kinds of personnel employed. One indirect method includes hiring practices, using the premise that employers hire those personnel whom they believe appropriate to their laboratory settings.

This paper describes both measurements--direct, in correlating laboratory errors and personnel in a major HMO consisting of 19 satellite laboratories and a central laboratory in the Twin Cities, and indirect, in a 25-year study of hiring practices in major laboratories in the Minneapolis-St. Paul area.

Hiring Patterns

Since 1970, and at 5-year intervals, we have surveyed employers of laboratory personnel in this five-county geographic area of 2.2 million residents. In this paper, laboratory settings and personnel numbers from January of 1970, 1980, 1990, and 1995 are compared (Figure 1).

Figure 1 shows the growth in numbers of laboratory personnel between 1970 and 1995. In 1970 there were 30 hospitals, 2 blood banks, and 4 clinic/HMO/reference laboratories in this area. Altogether they employed 1300 laboratory personnel. In one decade, numbers of personnel almost doubled, to 2500 in 1980; by 1990 there were 2600 laboratorians. In 1995 there were 18 hospitals, 2 blood banks, 3 reference labs and 5 clinics/HMOs, employing 2900 laboratorians. Between 1980 and 1995, 10 hospitals in the Twin Cities closed or were converted to another kind of facility, e.g., psychiatric or rehabilitation. Two small suburban hospitals were built in the 1980s. Despite the loss of traditional hospitals and their laboratories, numbers of laboratory employees increased--partly due to numbers of personnel in reference (independent) laboratories. Between 1990 and 1995, numbers of lab personnel increased almost three-fold in three independent laboratories.

Tables 1 - 3 provide a synopsis of these data. Table 1 shows a comparison between years 1990 and 1995 of the numbers and kinds of laboratory personnel by employing institutions. It can be seen that hospitals of all sizes continue to employ, primarily,

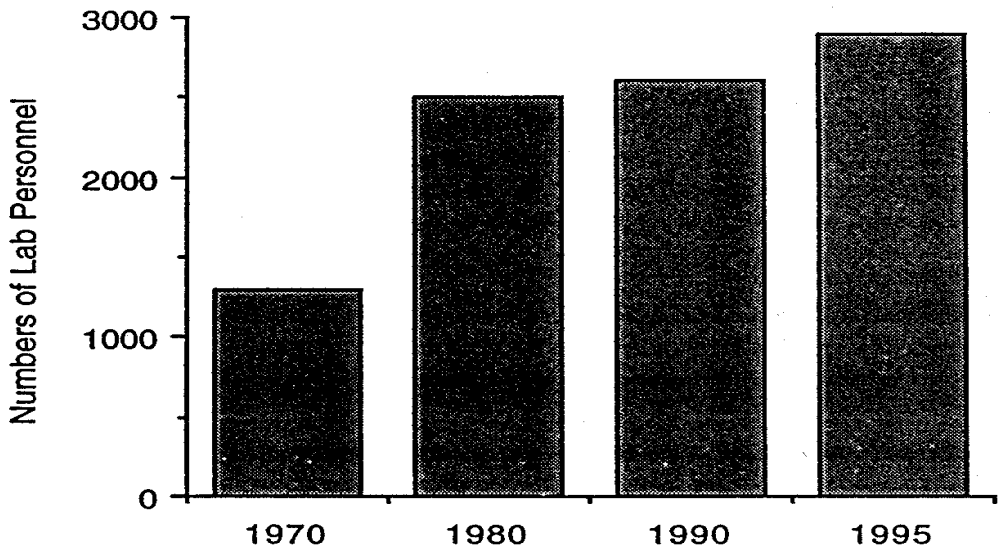

Figure 1. Total numbers of Twin Cities laboratory personnel from 1970 - 1995.

baccalaureate-level technologists, who comprised 59% of laboratorians employed in the 18 hospitals surveyed. In contrast medical laboratory technicians made up 65% of the laboratory personnel in clinics and HMOs, and 22% of total laboratorians employed in all institutions.

Most cytotechnologists (85 total) and histologic technicians (84) were employed in large and medium hospitals. Most phlebotomists and "others" were located in medium-sized hospitals and independent laboratories.

Table 2 shows categories and numbers of personnel by full-time or part-time status. Overall, full-time laboratorians outnumbered part-time personnel 3:1.

Table 3 provides information on hospital closures and openings since 1980. Here 10 hospitals closures, or conversions, released a total of 387 laboratorians (64% of whom were technologists) into the work force, while two new small hospitals brought 66 employees into the work force. The net loss (from closures over openings) was 321 laboratory personnel. Despite these closures, numbers of personnel increased to 2914 in 1995.

What might have caused this increase? One reason is increased volume of testing. As part of the survey, laboratory administrators were asked to report whether their laboratories had experienced increased or decreased test volume between 1990 and 1995. All 4 large hospitals, 6 of the 10 medium hospitals, and 3 of 4 small hospitals reported an increase in volume of testing during that period.

Both blood banks also showed increased testing; 4 of 5 clinics/HMOs had an increase; and 2 of 3 independents also showed an increase. (Three medium hospitals reported a decrease, I hospital had no change, and 3 institutions did not provide data.) Thus,

INSTITUTIONS SURVEYED

TWIN CITIES-MINNEAPOLIS-ST. PAUL
NUMBERS OF LABORATORY PERSONNEL

	CLS/MT		CLT/MT		Cyto and Histo Techs		Others, inc. Phlebotomy		Total	
	1990	1995	1990	1995	1990	1995	1990	1995	1990	1995
Large Hospitals (4) Abbott-NW, UMHC, VAMC, Riverside MMC*(*1990 only)	532	553	112	120	37	50	129	97	810	820
Medium Hospitals (10) North, United, Methodist, Hennepin, Ramsey, Fairview-So., St. Joseph's, Mercy, Unity, Midway	552	512	137	140	88	91	193	278	970	1021
Small Hospitals (4) St. Paul Children's, Mpls. Children's, St. John's NE, Fairview Ridges, Divine Redeemer* (*1990 only)	111	110	30	21	6	6	27	25	174	162
Total (18)	1195	1175	279	281	131	147	349	400	1954	2003
Blood Banks (2)	82	65	54	75	0	0	1	39	137	179
Independents (3)	82	148	15	34	10	22	17	155	124	359
HMOs/Clinics (5)	68	76	244	242	0	0	30	55	342	373
Grand Total 30 (1990) 28 (1995)	1427	1464	592	632	141	169	397	649	2557	2914

Table 1. Comparison of the numbers and types of laboratory personnel by employer, 1990 vs. 1995.

	Full-Time	%	Part-Time	%	Total	% of all Personnel
CLS/MT	1155	79%	309	21%	1464	50%
CLT/MLT	464	73%	168	27%	632	22%
Cytotechs	72	85%	13	15%	85	3%
Histotechs	69	82%	15	18%	84	3%
Other	265	69%	117	31%	382	13%
Phlebotomists	175	66%	92	34%	267	9%
Total	2200	75%	714	25%	2914	100%

Table 2. Category and Numbers of Personnel in 1995

summary data revealed, that at least 21 institutions (75%) had an increase in numbers of tests performed between 1990 and 1995. This probably accounted for the need for additional personnel.

Finally, in relating kinds of categories of personnel employed by different kinds of institutions, it seems logical that hospitals with acute care patients would need more CLS laboratorians trained at the baccalaureate level. On the other hand, HMOs and clinics, which see a clientele that is not as ill, could employ more two-year trained laboratory technicians, rather than four-year technologists.

Laboratory Error Rates and Personnel

A second study involved the retrospective analysis of laboratory error rates in 1 central laboratory and 19 satellite (clinic) laboratories of an HMO in the Twin Cities area. This HMO was established in 1956 and currently enrolls 241,440 members.

Errors were documented in 13 general categories (Figure 2). Figure 2 also includes examples of various errors, within 3 of the categories defined.

For each of the 20 laboratories, error rates for each of 8 consecutive months were determined and then averaged. They ranged from 0.05% (central laboratory) to 0.45% (Figure 3). Correlation analyses (e.g., Spearman and Pearson) were performed using 6 variables: error rate, education (ratio of MLTs to MTs) CAP workload, test volume, workload/test (W-T) and workload/CLS + CLT (W-M). Results are seen in Table 4. Multi-regression of error rates with other variables showed that no variable met the 0.1500 significance level for this model.

Although it might be tempting to conclude that error rates were not correlated with kinds of personnel employed (4-year CLS/MT or 2-year MLT personnel), one should not do so. Firstly, all error rates were low, less than 0.5%. Secondly, this laboratory system is well established and uniform in its function. For example, all satellite laboratories perform the same

Table 3

CHANGES IN MAJOR CLINICAL LABORATORIES IN THE TWIN CITIES: 1980 - 1995

Numbers of Hospital Lab Personnel Employed in 1980 Whose Institution has Closed or Converted to a Psychiatric, Rehabilitation or Long-Term Care Facility

Hospital	Year Closed/ Converted	Bed Size At Closing	Lab Personnel by Category at Closing				
			CLS/MT	CLT/MLT	Cyto/Histo	Others	Total
Riverview	1980	55	5	5	0	0	10
Golden Valley	1981	344	13	6	1	3	23
Eitel	1985	135	10	4	1	4	19
Lutheran Deaconess	1986	216	20	8	1	3	32
Samaritan	1987	78	21	7	2	5	35
Mounds Park	1987	205	26	3	0	0	29
Bethesda	1987	298	43	5	4	9	61
St. John's-St. Paul	1987	346	49	10	2	2	63
Metropolitan Med. Ctr.	1991	668	55	37	10	0	102
Divine Redeemer	1992	130	5	5	1	2	13
Total Loss of Beds/Personnel		-2475	-247	-90	-22	-28	-387

Numbers of Laboratory Personnel Employed in Hospitals That Opened After 1980

Year Institution Opened	Bed Size	MT/CLS 1995	MLT/CLT 1995	Cyto/Histo 1995	Others 1995	Total 1995
St. John's NE (1985)	169	24	4	2	12	42
Fairview-Ridges (1984)	150	19	4	0	1	24
	Beds	MT/CLS	MLT/CLT	Cyto/Histo	Others	Total
Net Loss (1995)	-2156	-204	-82	-20	-15	-321

Table 3. Changes in Major Clinical Laboratories in the Twin Cities: 1980-1995

Categories of Errors

1. Errors in data/result entry - RE errors
2. Errors in data/result entry - MEM errors
3. Errors in data/result entry - CEM errors
4. Errors in data/result entry - DRWP errors
5. Misuse of code/test
6. Specimen processed incorrectly by lab
7. Missed order on MSR, unable to perform test
8. Mislabeled or unlabeled specimen - lab
9. Test ordered but not performed
10. Non lab processing errors
11. QC errors
12. Testing errors (technical)
13. PHON1 not documented

Example 1: Specimen Processed Incorrectly by Lab

- Specimen not frozen
- Wrong tube drawn
- Wrong test ordered from reference lab
- Patient given incorrect container
- Wrong chart number entered into EKG machine
- Wrong culture plates set up
- Tube sent back to clinic by Central Lab
- Wrong amount of Trutol given for GTT

Example 2: Testing Errors (Technical)

- Reported morphology does not agree with CBC parameters
- Incorrect calculation on manual counts
- 200 cell diff not done with elevated monos, eos, or basos
- >50,000 WBC not sent to RI for Hemocue
- Procedure not followed for followup of abnormal values
- Prelim and final reports do not agree (Malarial smear, gram stain, HCON, etc.)
- Testing not completely documented

Example 3: QC Errors

- QC failure on any control. Appropriate troubleshooting procedures are not performed and documented before patient results are reported
- QC not appropriately documented (including date, test, results, tech, and computer input).
- Holdover out of range. No followup performed.

Figure 2. Categories and Examples of Errors Documented Within the Laboratory

procedures (Figure 4) using the same instruments. While MLTs were the predominant personnel in these satellite laboratories, each laboratory was headed by a baccalaureate-level technologist.

The central laboratory employed more technologists than technicians and performed the more complex testing for this HMO. It also had the greatest volume of testing.

Finally, all 20 laboratories performed well and below the QC established limit of an overall 1% or less error rate. Whether the different kinds of personnel performing the testing could be correlated to laboratory errors could not be established.

In summary, using employment patterns

Variables

Personnel

Clinic	Cummulative %Errors /8 months	#MLT (2yr)	#MT (4yr)	CAP Workload/units/month	Total Tests/month
1	0.45	3	0.4	10,400	1,060
2	0.44	11	1	35,840	3,700
3	0.42	4	0.6	13,040	1,300
4	0.40	3	0.6	11,425	1,270
5	0.39	7	1	35,050	3,510
6	0.38	9	0.5	25,280	2,660
7	0.35	3	0.4	6,870	660
8	0.32	5	0.5	13,240	1,480
9	0.30	6	0.85	27,400	2,770
10	0.22	3	0.4	11,200	1,250
11	0.19	7	0.7	26,670	3,100
12	0.17	8	0.7	31,200	3,290
13	0.16	3	0.3	6,910	680
14	0.16	5	0.7	18,000	1,780
15	0.15	6	1	39,800	4,150
16	0.13	3	0.5	10,600	940
17	0.13	8	1	34,050	4,260
18	0.10	3	0.3	8,170	860
19	0.10	12	1	60,250	6,970
20(Cent)	0.05	11	14	149,160	56,000

Figure 3. Comparison of errors rates of 20 laboratories over an 8 month period using 6 variables

Correlation analysis using Spearman without CENTRAL Lab
Correlation Analysis

	N	Mean	Std Dev	Median	Minimum	Maximum
Error	19	0.26105	0.12692	0.22000	0.10000	0.45000
Ratio	19	0.89075	0.02786	0.88235	0.83333	0.94737
Workload	19	22389	14423	18000	6870	60250
Tests	19	2405	1652	1780	660.00000	6970
W-T	19	9.55714	0.75296	9.59036	7.99296	11.27660
W-M	19	3301	910.82713	3158	2021	5686

Spearman Correlation Coefficients / Prob > IRI under Ho: Rho=0 / N = 19

	ERROR	RATIO	WORKLOAD	TESTS	W-T	W-M
ERROR	1.00000	-0.16960	-0.10716	-0.13175	0.19851	-0.24506
	0.0	0.4876	0.6624	0.5908	0.4153	0.3119
RATIO	-0.16960	1.00000	0.14870	0.18830	-0.38364	-0.22437
	0.4876	0.0	0.5435	0.4401	0.1049	0.3558
WORKLOAD	-0.10716	0.14870	1.00000	0.98596	-0.42105	0.75789
	0.6624	0.5435	0.0	0.0001	0.0726	0.0002
TESTS	-0.13175	0.18830	0.98596	1.00000	-0.50877	0.75789
	0.5908	0.4401	0.0001	0.0	0.0261	0.0002
W-T	0.19851	-0.38364	-0.42105	-0.50877	1.00000	-0.38070
	0.4153	0.1049	0.0726	0.0261	0.0	0.1078
W-M	-0.24506	-0.22437	0.75789	0.75789	-0.38070	1.00000
	0.3119	0.3558	0.0002	0.0002	0.1078	0.0

Correlation analysis using Spearman with CENTRAL Lab
Correlation Analysis

	N	Mean	Std Dev	Median	Minimum	Maximum
Error	20	0.25050	0.13225	0.20500	0.05000	0.45000
Ratio	20	0.86821	0.10437	0.88235	0.44000	0.94737
Workload	20	28728	31632	21640	6870	149160
Tests	20	5085	12092	2220	660.00000	56000
W-T	20	9.21246	1.70680	9.54706	2.66357	11.27660
W-M	20	3435	1068	3166	2021	5966

Spearman Correlation Coefficients / Prob > IRI under Ho: Rho=0 / N = 20

	ERROR	RATIO	WORKLOAD	TESTS	W-T	W-M
ERROR	1.00000	-0.00189	-0.23485	-0.25593	0.31314	-0.35303
	0.0	0.9937	0.3189	0.2761	0.1788	0.1268
RATIO	-0.00189	1.00000	-0.01583	0.01809	-0.18545	-0.33547
	0.9937	0.0	0.9472	0.9397	0.4338	0.1482
WORKLOAD	-0.23485	-0.01583	1.00000	0.98797	-0.50376	0.79248
	0.3189	0.9472	0.0	0.0001	0.0235	0.0001
TESTS	-0.25593	0.01809	0.98797	1.00000	-0.57895	0.79248
	0.2761	0.9397	0.0001	0.0	0.0075	0.0001
W-T	0.31314	-0.18545	-0.50376	-0.57895	1.00000	-0.46917
	0.1788	0.4338	0.0235	0.0075	0.0	0.0369
W-M	-0.35303	-0.33547	0.79248	0.79248	-0.46917	1.00000
	0.1268	0.1482	0.0001	0.0001	0.0369	0.0

Table 4. Results of Correlation Analyses (Spearman and Pearson) using 6 variables.

Laboratory Procedures

Bleeding Time
Blood Collection (Phlebotomy)
Body Fluids, Spinal Fluid, Synovial Fluid
CDC
Crystals - Synovial Fluid
Differntials, Morphology & Platelet Estimate, Wright Stain
Direct Gram Stain
ECG
Eosinophil Count
Glucose
Glucose Tolerance Test, 2 hour P.C.
Gram Stain Rapid Method
Hematocrit
Hemoccult
Icotest
Ketones - Serum
KOH
Malaria Smear
Mono Test
Nasal Smear
Parasite Identification Microscopic
Arthropods
Pinworms
Platelet Count - Manual/Platelet Estimate
Pregnancy Test - Urine or Serum
RBC Count - Manual
Reducing Substances
Reticulocyte Count
Sedimentation Rate (ESR)
Semen Analysis, Post Vasectomy, Post Coital
Stool for PMNs, Eosinophils, or Yeast
Strep Screen Group A
Urinalysis
Urine Crystals
WBC Count - Manual
Wet preps

Figure 4. List of Laboratory Procedures Performed in all Satellite Laboratories

to demonstrate personnel requirements for different kinds of laboratory settings, this study showed that more technologists were employed in hospitals, while more technicians were employed in HMOs and clinics. These patterns probably reflected severity of illness of patient clientele and kinds of testing needed, e.g., simple versus complex. Moreover, despite the closure of 10 hospitals in this geographic area, numbers of laboratory personnel increased slightly during the same period. In correlating laboratory error rates with five other variables, no definitive associations were established.

Thus, further studies need to be performed in order to link performance of laboratory testing with data concerning staff competency.