Relationships Among Patient Age, Diagnosis, Hospital Type, and Clinical Laboratory Utilization

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OBJECTIVE: The aging population will likely have a major impact on laboratory utilization. Utilization data will be necessary for laboratory managers to make informed decisions concerning staffing patterns and services offered.

DESIGN: In a retrospective non-descriptive study, the relationships among age groups, hospital type, diagnosis, and the numbers and types of laboratory tests performed were investigated.

SETTING: Half of the participants were from a private hospital, Touro Infirmary, and half were from a large public hospital, The Medical Center of Louisiana at New Orleans. Both facilities are located in New Orleans, Louisiana.

PATIENTS: Laboratory records from a random sample of 250 inpatients age 21 to 64, a sample from 250 inpatients age 65 to 84, and a sample from 250 inpatients age 85 and over with at least one of five admission or discharge diagnoses were analyzed.

INTERVENTIONS: Twenty-five records from each of the five diagnostic categories for each of the three age groups and two hospital types were analyzed, yielding a total sample of 750 records.

MAIN OUTCOME MEASURES: Laboratory tests for each inpatient stay were counted and categorized for analysis. The one-way ANOVA was used to test the degree of concordance between age groups and numbers of tests ordered and between age groups and types of tests ordered across hospital types.

RESULTS: Data analysis showed statistically significant differences in the total number of laboratory tests ordered for the three age groups regardless of facility (p 0.008). The age group with the highest number of total laboratory tests ordered was the group aged 65 to 84 (48.64 mean tests per patient). Across the total sample, more tests were ordered at the public facility than the private facility (51.75 and 32.42 mean tests per patient, respectively). Statistically significant differences in orders between the two facilities were noted in chemistry, hematology, and toxicology (p <0.001). When analyzing numbers of tests by age group and facility, no statistically significant differences were noted in any laboratory category. Analysis of disease and laboratory test categories, regardless of facility, showed statistically significant differences in numbers of tests ordered in microbiology, cytology, histology (p <0.001), and blood bank (p 0.001). When analyzing numbers of tests by disease category and facility, significant correlation was noted in toxicology (p 0.001).

CONCLUSION: This research allowed comparisons in laboratory utilization between a private and a public hospital among different age groups. Differences were noted in both volume and type of laboratory tests ordered on patients with specific diagnoses in the two facilities. Although comorbidity was not well controlled for, the study does suggest that clinical laboratories may undergo changes in utilization as our nation's population ages.

ABBREVIATION: ICD-9-CM = International Classification of Diseases, 9th revision, Clinical Modification.

INDEX TERMS: clinical laboratory; diagnosis; geriatrics; laboratory tests.

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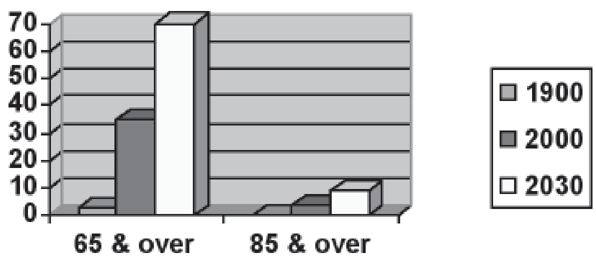
As a new century begins, the United States faces a fast-approaching situation that many other nations worldwide have been dealing with for some time—a graying population. Since the beginning of the last century, the number of persons under the age of 65 has increased three-fold, while the number of persons age 65 and over has increased eleven-fold.[1] In the last 35 years, the population of those 65 and older has increased by approximately 82%. With the majority of the baby boomer generation over 50 years of age, it is projected that by the year 2030, 21% of the U.S. population will be age 65 or older. Part of this group, those individuals age 85 and older, comprises the fastest growing segment of our population. It is expected that by 2030, these oldest individuals will be close to nine million in number (Figure 1).[2]

With the extension of life expectancy, the healthcare industry must strive to expand the quantity of life, as well as to maintain quality of life. Living longer theoretically exposes individuals to disabilities and chronic illnesses that burden our healthcare system. In both 1998 and 1999, the rate of hospital stays nationwide was more than three times higher for individuals age 65 and over as compared to those age 45 to 64, and over four times higher compared to those age15 to 44. For those age 85 and over, their rate of hospital stays is almost six times higher than those age 45 to 64, and almost eight times higher than those age 15 to 44. In addition to the number of hospital stays, the elderly population's average length of stay in the hospital is longer than any other segment of the population. These same statistics point to five conditions that most often affect the population age 65 and over, resulting in long lengths of stay in hospitals: heart disease, pneumonia, cerebrovascular disease, malignant neoplasms, and fractures.[3,4]

One reason given by physicians for ordering laboratory tests on patients is monitoring. Generally, the longer a patient stays in the hospital, the more the patient's health is monitored.[5] Another factor that appears to influence the number of tests ordered is the type of hospital, with more laboratory tests ordered in teaching hospitals than in private hospitals.[6] With an increase in the number of older Americans and an expected increase in the prevalence of chronic disease and hospital stays, laboratorians might question how these trends will impact the hospital-based clinical laboratory. Clinical laboratories provide the largest portion of quantitative data that is used in the treatment of patients; therefore, it is imperative that hospitals have access to the most complete and appropriate laboratory services in order to treat patients efficiently while thriving in the competitive healthcare marketplace. To thrive, however, laboratories must be prepared to focus their efforts and expand their services strategically. In an age when laboratories are rarely considered profit centers of hospitals, the laboratory workforce is decreasing nationwide.[7] While technology continues to expand the possibilities of laboratory services, administrators and laboratory managers need access to information that can impact the organization and operation of clinical laboratories.

Figure 1. Number of persons in US in millions



In recent years, only a few studies have focused on specific diseases and their volume and cost impacts on the clinical laboratory. No studies were found that specifically focused on the impact of a geriatric population on the laboratory, both in volume and in the types of tests utilized in providing care for this population. Previous research has shown laboratory costs associated with certain diseases and laboratory usage in teaching versus private facilities, but these studies did not investigate whether or not patient age played a role in the use of clinical laboratory tests. This information is vital to hospital administration planning efforts.

For the purposes of this study, teaching hospital shall be defined as a facility that is university-based, in which the majority of tests are ordered by interns or residents. Private hospital shall be defined as a community-based hospital, in which the majority of tests are ordered by attending physicians. Laboratory test shall be defined as an ordered procedure classifiable into one of the following categories: chemistry, hematology/coagulation, immunology, microbiology, histology, cytology, toxicology, and blood bank. Length of stay shall be defined as the number of days a patient remains in the hospital, from the date of admission to the date of discharge.

In this study, the researcher explored whether differences existed in numbers and types of laboratory tests ordered for younger and older segments of the population who have one or more of five conditions. The researcher also explored whether differences existed in laboratory tests for these populations in public versus private hospitals. The research was accomplished by comparing laboratory records from patients of different age groups from both a public and a private hospital located in the same urban geographic area. The following research questions were posed in this study: 1) Do differences exist in numbers of clinical laboratory tests ordered for an adult population under the age of 65, for an adult population age 65 to 84, and for an adult population age 85 and over with specific diagnoses for inpatient stays at public and private hospital facilities? 2) Do differences exist in the types of clinical laboratory tests ordered for these three populations across the two types of hospital facilities? 3) Do differences exist in comorbidity and lengths of stay for these three populations across the two types of hospital facilities? 4) Does a difference exist in total number of tests ordered between the two types of facilities? 5) Do differences exist in types of laboratory tests ordered between the two types of facilities?

MATERIALS AND METHODS

Research design

A retrospective, non-descriptive design (chart review) was used to examine the relationships among age groups, hospital types, diagnoses, and numbers and types of clinical laboratory tests ordered. Two facilities were used to obtain data, one a private, not-for-profit facility staffing over 300 beds (Facility 1), and the other a teaching hospital servicing two Schools of Medicine with two sites that staff approximately 850 total beds (Facility 2). For purposes of this study, the facility's two sites were considered one teaching hospital. The sample consisted of 750 inpatient laboratory reports equally divided between the two facilities. Laboratory records eligible for inclusion were those associated with individuals who were 21 years of age and over and were patients at either of the two facilities within a three year period from August, 1999 through July, 2002.

Objects of measurement

The objects of measurement for this study consisted of 750 laboratory reports from patient records. Individuals, both male and female, associated with these patient records, were treated as inpatients at one of the two facilities included in the study within the three year period. Each patient was 21 years of age or older upon admittance to the facility and had at least one admission or discharge ICD-9 diagnosis being studied. Based on a search of journal articles and national healthcare statistics, the researcher chose these diagnoses for this study due to prevalence among a population age 65 and over. These diagnosis categories include the following:

1. Heart disease—including acute myocardial infarction, coronary atherosclerosis, ischemic heart disease, cardiac dysrhythmias, and congestive heart failure (ICD-9-CM codes 391-392.0, 393-398, 402, 404, 410-416, and 420-429);
2. Pneumonia—including infectious (viral, bacteria, and fungal) and aspiration pneumonias (ICD-9-CM codes 480-486, 487.0, and 507);
3. Cerebrovascular disease—including stroke, Alzheimer's disease, and cerebral aneurysm (ICD-9-CM codes 430-438);
4. Malignant neoplasms—including all organ systems (ICD-9-CM codes 140-208 and 230-234); and
5. Fractures—including all body sites (ICD-9-CM codes 800-829).

These diagnoses are based on the International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM).[8] The diagnosis categories were made broad enough as to ensure an adequate sample size for the study.

Patients meeting the inclusion criteria were divided into three subgroups: those between the ages of 21 and 64 at the time of admission to the hospital (n = 250), those between the ages of 65 and 84 at the time of admission (n = 250), and those age 85 and over at the time of admission (n = 250). Within each of the three subgroups from each of the two facilities, approximately 25 patient records from each of the five diagnosis categories were randomly chosen for the study. This yielded a sample of 75 patient records per diagnosis (375 records per facility). Patients having more than one diagnosis from those included in this study were grouped according to the primary diagnosis coded for their stay. All secondary diagnoses, including those from the five groups in this study and all other diagnoses, were recorded by number as comorbid conditions.

Measurement

For each inpatient stay selected, the number and type of clinical laboratory tests, along with certain individual tests, were recorded. These individual tests were those that could have a high impact on a geriatric hospital population. Tests were grouped into one of the following categories:

1. Chemistry—including endocrinology and osmolarity. Individual tests and groups of tests recorded included basic metabolic panel, comprehensive metabolic panel, electrolytes, lipids, hepatic function panel, glucose, blood urea nitrogen, creatinine, calcium, creatinine kinase isoenzymes, troponin isoenzymes, thyroid stimulating hormone, hemoglobin A_1C, albumin, prealbumin, and serum iron.

2. Hematology/Coagulation—including urinalysis and hemoglobin electrophoresis. Individual tests included complete blood count with differential, urinalysis, activated partial thrombin time, prothrombin time, and fibrin split products.
3. Immunology—including complement components and protein electrophoresis. Individual tests included hepatitis B antigens and antibodies, hepatitis C antibody, human immunodeficiency virus, rheumatoid factor, serum protein electrophoresis, and antinuclear antibodies.
4. Microbiology—including parasitology, mycology, and virology. Individual tests included bacterial cultures for wounds, blood, urine, sputum/tracheal, and acid-fast bacilli; *Clostridium difficile* toxin; and general viral cultures.
5. Cytology—Individual tests included the papanicolaou stain.
6. Histology/Surgical Pathology—Individual tests included the hematoxylin and eosin stain and frozen sections.
7. Blood Bank—Individual tests included typing and crossmatching.
8. Toxicology—Individual tests included digoxin, vancomycin, and phenytoin.

Each category included any molecular testing which would have fallen into these areas. Point-of-care and respiratory testing (arterial blood gases) were not included in this study.

Procedures

Approval from the Institutional Review Board of the sponsoring institution, as well as approval from the Institutional Review Board of each hospital was obtained prior to data collection. The sample was chosen randomly from reports generated by the facilities' medical records systems. These reports were generated based on the afore-mentioned inclusion criteria of the sample and on the diagnoses of the patients and therefore included all possible patients who met the criteria.

Those participants' laboratory encounters were then accessed through the laboratories' information systems. Tests were recorded in appropriate categories according to patient age group, type of hospital, patient diagnosis, and type of test requested for each patient hospital stay. All results were recorded on a hand-written form and then transferred to a computer spreadsheet application.

Once data were collected for each patient stay, any information that could potentially identify the patient was removed and replaced with a number that was in no way associated with the patient's true identity. Strict patient confidentiality was adhered to. Obvious duplicate tests and canceled requests were not included in this study.

An independent clinical laboratory scientist from each facility performed an interrater reliability study by completing laboratory data collection forms on ten percent of the sample from each facility. These two individuals were trained by the researcher. Patient reports involved in this study were chosen at random, and reliability was calculated as a percentage (agreement divided by agreement plus disagreement).

Data analysis

Data were analyzed using both descriptive and inferential statistics. Descriptive statistics were used to describe the profiles of the subjects, such as gender, age, diagnosis, comorbid conditions, and length of hospital stay. The one-way ANOVA was used to test the degree of concordance between age groups and numbers of tests ordered and between age groups and types of tests ordered across hospital types. Data analysis was performed using SPSS software version 11.0.

RESULTS

A sample population of 375 patients from each hospital was randomly selected from all possible candidates who met the study qualifications. All laboratory data were collected and categorized by the researcher for each patient's total stay with the qualifying ICD-9 diagnosis.

Interrater reliability

Ten percent of the data from each facility was analyzed for interrater reliability. The interrater reliability was 98.2% at the private facility and 96.3% at the public facility.

Facility comparisons

Gender distribution varied little between the two facilities, with 62.1% female patients at the private facility (Facility 1) and 56.8% females at the public facility (Facility 2). Mean ages were slightly higher at Facility 1 among all three age groups, with the biggest difference noted in the 21 to 64 year olds (50.9 years at Facility 1 and 44.9 years at Facility 2). Length of stay differences between the two facilities were statistically significant with 13.31 days at Facility 1and 8.86 days at Facility 2 (p 0.003). Statistically significant differences in length of stay were also found among the five disease categories, irrespective of facility (p 0.033). There were no statistically significant differences in lengths of stay among the three age groups, irrespective of facility (p 0.435). Differences in comorbidity between the two facility types were not statistically significant (p 0.093) (Table 1).

Test categories

The mean number of total laboratory tests per patient was 42.09 for both facilities combined. By individual facility, patients at Facility 1 had 32.42 tests ordered for their stay, and those at Facility 2 had an average of 51.75 tests ordered for their stay. Among the eight laboratory categories, larger numbers of tests were ordered at Facility 2 than Facility 1 with the exceptions of microbiology and histology. Significant differences were seen in chemistry (p <0.001), hematology (p <0.001), and toxicology (p <0.001) (Table 2). Among the individual tests in the chemistry category, more comprehensive metabolic profiles were ordered at Facility 1 than Facility 2 (mean of 1.54 at Facility 1 and 0.80 at Facility 2) while basic metabolic profiles were utilized more often at Facility 2 than Facility 1 (6.67 and 4.44, respectively). In addition, cardiac en-

Table 1. Facility comparisons

	Facility 1 (private)	Facility 2 (public)
Male (%)	37.9	43.2
Female (%)	62.1	56.8
Mean age years (21-64)	50.90	44.85
Mean age years. (65-84)	75.25	74.13
Mean age years (85 and over)	89.55	89.26
Mean total length of stay (days)	13.31	8.86
Age 21-64	12.14	8.53
Age 65-84	13.00	9.05
Age 85 and over	14.78	9.00
Heart Disease	12.77	7.77
Pneumonia	11.73	7.69
Cerebrovascular disease	14.28	8.73
Neoplasms	15.81	12.21
Fractures	11.93	7.88
Mean additional ICD-9 codes	7.08	6.66

Table 2. Mean tests by laboratory category

	Facility 1	Facility 2	p
Chemistry	12.89	26.82	<0.001*
Hematology	10.05	13.95	<0.001*
Immunology	0.96	1.09	0.561
Microbiology	4.13	3.10	0.012
Cytology	0.13	0.32	0.020
Histology	1.31	1.19	0.651
Blood Bank	1.75	2.30	0.064
Toxicology	1.19	2.98	<0.001*

* Statistical significance at alpha = 0.006

Table 3. Age group and mean laboratory test analysis

	Facility 1	Facility 2	P*
Chemistry (total)	12.89	26.82	0.174
Age 21-64	13.62	23.39	
Age 65-84	14.39	32.41	
Age 85 and over	10.66	24.67	
Hematology (total)	10.05	13.95	0.614
Age 21-64	11.10	13.83	
Age 65-84	11.26	16.55	
Age 85 and over	7.78	11.48	
Immunology (total)	0.96	1.09	0.778
Age 21-64	1.06	1.37	
Age 65-84	1.15	1.30	
Age 85 and over	0.66	0.59	
Microbiology (total)	4.13	3.10	0.960
Age 21-64	4.32	3.38	
Age 65-84	4.46	3.26	
Age 85 and over	3.62	2.66	
Cytology (total)	0.13	0.32	0.367
Age 21-64	0.15	0.47	
Age 65-84	0.13	0.33	
Age 85 and over	0.12	0.16	
Histology (total)	1.31	1.19	0.772
Age 21-64	1.46	1.60	
Age 65-84	1.38	1.01	
Age 85 and over	1.08	0.95	
Blood Bank (total)	1.75	2.30	0.744
Age 21-64	1.92	2.48	
Age 65-84	2.03	2.86	
Age 85 and over	1.31	1.58	
Toxicology (total)	1.19	2.98	0.072
Age 21-64	1.02	3.31	
Age 65-84	1.26	3.52	
Age 85 and over	1.28	2.10	

Computed using alpha = 0.006
* facility/age group

zymes were ordered more than three times more often at Facility 2 than Facility 1. Among the individual tests in the hematology category, mean numbers of tests ordered were higher at Facility 2 for all tests with the exception of fibrin split products, which were equal at 0.04 tests.

Age

Among the three age groups, differences were noted in the numbers of tests ordered. The mean numbers of tests were higher for the 65 to 84 year age group in many categories with the exceptions of cytology and histology, with statistically significant differences found in hematology (*p* 0.004). When analyzing numbers of tests by age group and facility, no significant differences were noted (Table 3).

Disease categories

Among the five disease categories, the laboratory was utilized in various ways. Tests for patients with heart disease were most often associated with chemistry (22.24 tests per patient), while microbiology and immunology tests were often associated with patients with pneumonia (5.94 and 1.49 tests per patient, respectively). A majority of toxicology orders were seen in patients with cerebrovascular disease (2.89 tests per patient), and neoplasm was most often associated with chemistry and hematology (22.09 and 14.23 tests per patient, respectively). Cytology and histology tests were most often ordered on patients with neoplasms (0.61 and 4.17 tests per patient, respectively), and the blood bank was most often utilized in cases involving fractures (2.84 tests per patient).

Analyzing disease and test categories, statistically significant differences in ordered tests were noted in microbiology, cytology, histology (*p* <0.001), and

Table 4. Disease category and mean laboratory test analysis

	Facility 1	Facility 2	*P**
Chemistry (total)	12.89	26.82	0.928
Heart disease	15.81	28.67	
Pneumonia	12.84	26.29	
Cerebrovascular disease	14.59	26.89	
Neoplasms	13.52	30.65	
Fractures	7.71	21.61	
Hematology (total)	10.05	13.95	0.796
Heart disease	9.80	12.67	
Pneumonia	8.91	12.89	
Cerebrovascular disease	9.49	14.88	
Neoplasms	13.29	15.17	
Fractures	8.73	14.16	
Immunology (total)	0.96	1.09	0.027
Heart disease	1.36	0.84	
Pneumonia	1.93	1.05	
Cerebrovascular disease	0.48	1.33	
Neoplasms	0.73	1.69	
Fractures	0.28	0.51	
Microbiology (total)	4.13	3.10	0.919
Heart disease	3.53	2.57	
Pneumonia	6.79	5.09	
Cerebrovascular disease	3.72	2.87	
Neoplasms	4.31	3.15	
Fractures	2.32	1.83	
Cytology (total)	0.13	0.32	0.554
Heart disease	0.16	0.35	
Pneumonia	0.11	0.29	
Cerebrovascular disease	0.01	0.08	
Neoplasms	0.39	0.83	
Fractures	0.00	0.05	
Histology (total)	1.31	1.19	0.716
Heart disease	0.60	0.19	
Pneumonia	0.41	0.20	
Cerebrovascular disease	0.71	0.56	
Neoplasms	3.85	4.48	
Fractures	0.97	0.51	
Blood Bank (total)	1.75	2.30	0.907
Heart disease	1.23	1.80	
Pneumonia	0.84	1.64	
Cerebrovascular disease	1.79	1.80	
Neoplasms	2.33	3.19	
Fractures	2.59	3.09	
Toxicology (total)	1.19	2.98	0.001*
Heart disease	1.23	2.41	
Pneumonia	2.11	2.39	
Cerebrovascular disease	0.96	4.83	
Neoplasms	0.88	1.87	
Fractures	0.77	3.40	

Statistical significance at alpha = 0.006
* facility/disease category

blood bank (p 0.001). When analyzing tests by disease category and facility, statistically significant differences in ordered tests were noted in toxicology (p 0.001) (Table 4).

DISCUSSION

The aim of this study was to determine the effects of hospital type and age on laboratory utilization in patients with specific diagnoses. Even though only two facilities were used in the study, the researcher was able to make comparisons between a private hospital of moderate size and a larger, public teaching hospital.

The significant difference in lengths of stay between the private hospital and the public hospital was surprising. Previous research has shown no significant difference in lengths of stay between private and public facilities, but in this study, the average length of stay was 13.31 days at the private facility and 8.86 days at the public facility, with the average length of stay for the entire sample being 11.08 days.[6] It was expected that the figure would be higher than the national average of 5.2 days due to the disease categories that were chosen for examination. The 13.31 day average stay at Facility 1, however, was unexpectedly high. One possible explanation could be comorbidity, which was not well controlled for in this study. Like past research, the lengths of stay were slightly longer at both facilities for patients age 65 to 84. The average stay for this group was 11.02 days, which is also higher than the national average of 6.5 days for this age group. In addition, this study also found that patients diagnosed with neoplasms had slightly longer lengths of stay at both facilities than the other four disease categories.

No significant difference was found in the numbers of additional diagnoses for each patient between the two facilities. One of the weaknesses of this study was an inability to control for comorbidity . The study does include the number of additional ICD-9 diagnoses for each patient (in addition to the qualifying diagnosis), but the types and severity of these additional diagnoses were not included. Perhaps future research can include this information, as comorbidity has been shown to affect length of stay, and thus, utilization of hospital resources, including the laboratory.

Previous research showed that the laboratory was utilized more frequently in public hospitals, and that was also the finding in this study.[6] The average patient at the private facility (Facility 1) had 32.42 laboratory tests ordered for his/her stay, as opposed to 51.75 tests at the public (Facility 2). This study also found that the total number of laboratory tests ordered on patients age 65 to 84 was significantly higher than the other two age groups, regardless of facility type. Surprisingly, this study showed that the lowest number of tests ordered was for patients age 85 and over. Their average of 35.36 tests was lower than the 42.25 tests for the patients age 21 to 64. One possible explanation for this finding could be less aggressive actions taken by physicians in managing patient care for those age 85 and over. No significant differences were found in total tests ordered among different disease categories, although as in past studies, the highest numbers of tests were ordered at both facilities on patients with neoplasms.

As expected, chemistry and hematology were the most often utilized departments in the laboratory, with 19.86 and 12.00 tests per patient, respectively. Of the eight main test categories, chemistry, hematology, and toxicology showed a significant difference in the number of tests ordered across the two facilities. In the cases of chemistry and hematology, these findings can probably be explained by the sheer volume of tests ordered in these two categories. In the case of toxicology, the difference may be explained by the disparity in orderable in-house tests available at the facilities. Facility 1 offered only a qualitative overdose procedure, which could be sent out for confirmation of those analytes found to be positive. At Facility 2, individual procedures were offered for the drugs of abuse, along with confirmations for those analytes. Toxicology was the only department in which this disparity in orderable tests was found in this research.

When age was studied in relation to the types of tests being ordered regardless of facility type, the researcher found that the largest number of tests by department were ordered on patients age 65 to 84 in six of the eight categories: chemistry, hematology, immunology, microbiology, blood bank, and toxicology. Of the six, only hematology showed a significant difference in the number of tests ordered among the three age groups. The difference in chemistry, although not significant, was substantial. In the other four areas, the volume of tests ordered was simply not large enough from which to draw any conclusions. When age groups were analyzed in conjunction with facility, no statistically significant differences were found in the numbers of tests ordered by category. The high utilization of the clinical laboratory by those patients age 65 to 84 cannot be explained with one answer. Nationwide, this age group has longer lengths of stay, higher incidence of chronic disease, and larger numbers of comorbid conditions, all of which probably play a part in higher laboratory utilization. In both cytology and histology, the largest numbers of tests were ordered on those patients age 21 to 64. In this study, these

two departments were almost exclusively linked to neoplasms. Perhaps more aggressive measures were taken to treat the younger age group with malignancies, and thus cytology and histology were more widely utilized in this group.
When analyzing types of tests ordered on patients with specific diagnoses, significant differences were found in several areas of the laboratory, including cytology, histology, and blood bank. As expected, cytology and histology were most often associated with malignant neoplasms. In the blood bank, the largest numbers of tests were ordered on those patients diagnosed with fractures. The researcher can speculate that this finding is tied to surgical procedures that are often necessary to correct fractures. When facility is factored into the analysis of tests ordered on patients with specific diagnoses, significance was found only in the area of toxicology; however, again, one should not draw many conclusions from this finding because of the disparity in available tests at the two facilities.

The most disappointing results of this research are associated with the individual tests that were categorized for each of the eight main areas of the laboratory. Very few values stand out when reviewing the utilization of these individual tests in the two facilities. The comprehensive metabolic profile was ordered almost twice as much at Facility 1, despite the fact that twice as many chemistry tests were ordered at Facility 2. In addition, cardiac enzymes were ordered more than twice as often at Facility 2 than Facility 1. The researcher expected to find a higher number of these tests at Facility 1 where the length of stay was longer for patients with heart disease, but perhaps the finding can be explained by Facility 2's status as a teaching hospital. If future research is conducted in the area of laboratory utilization, it should perhaps include a much smaller number of individual tests in each category, if any, for analysis.

CONCLUSION

Differences were found in both volume and type of laboratory tests ordered on patients with specific diagnoses in two types of inpatient facilities. After extensive literature review, the researcher believes that this was the first study that specifically looked at the impact of age on the entire hospital laboratory and its main departments. These results do seem significant enough to warrant interest in the utilization of clinical laboratory resources in the coming years. Perhaps a future study could include point-of-care testing and could better control for comorbidity. Additionally, research in this area should include studying rural versus urban community hospitals and a study of the number and type of clinical laboratory scientists who will be necessary to efficiently operate our nation's hospital laboratories.

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