Utilization of Laboratory Investigations in Primary Health Care Centers in Al-Khobar, Saudi Arabia

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Objective: The objective of this study was to determine the pattern of utilization of laboratory investigations in the Al-Khobar area of Saudi Arabia.

Material and Methods: A two-stage sampling design was used to select a Family Health Records checklist. At the first stage, 5 Primary Health Care Centers were selected out of 9 using a random sampling method. A Family Health Records checklist was selected using a systematic sampling design from each selected Primary Health Care Center at the first stage.

Results: The results showed that laboratory investigations were used for 49% of the sample population tested. Of these, 84% recorded a maximum of 3 laboratory investigations.

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tests. In over half of the cases, the tests were inappropriately utilized, 37.8% were underutilized and 13.2% were over-utilized. There was no significant difference in the pattern of utilization between males and females and between Saudi and non-Saudi patients. However, laboratory services were utilized more for patients above the age of 40 years, where an average of 2.1 tests per patient was recorded.

**Conclusion:** There was a significant difference between primary health care centers regarding pattern of laboratory utilization. Respiratory disease accounted for the majority of the health problems, followed by diabetes mellitus and hypertension. Microbiology was the most heavily used investigation followed by biochemistry and hematology. Urinalysis was the most frequently requested test followed by blood glucose and complete blood count (CBC). This study highlighted the problems in the utilization of laboratory investigations and led to a number of solutions and recommendations.

**Key Words:** Laboratory utilization, sampling, primary health care, diagnosis.

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**INTRODUCTION**

The clinical laboratory has become an essential component in meeting high-priority consumer need and a vital patient resource, occupying an increasingly important part of mainstream medicine. Knowledge of a utilization pattern of laboratory investigations can provide health planners with basic information that can help in resource allocation. For a long time, obtaining the history of a patient and physical examination have been the most important elements of patients assessment. However, in recent years, the care of patients has become increasingly dependent on the results of laboratory investigations as well, and it follows that clinical laboratories have become a major component in the delivery of health care. Laboratory investigations have always been and will continue to be an integral part of clinical practice in Primary Health Care Centers.

The advancement of medical technology has made laboratory tests easily obtainable and virtually indispensable to physicians in diagnoses from the most common to the rarest disease. There would be less concern regarding the over-utilization of diagnostic tests if the use of more tests led to an improvement in health, but there is evidence to suggest that part of the increase in test ordering is unnecessary. Moreover, the gain from these laboratory investigations is minimal. Several studies have found that test results were often ignored by physicians, implying that the tests were not needed to begin with.

In the USA, between 1975 and 1978 the total number of clinical laboratory investigations performed increased at an annual rate of 8%, even though the per capita visits to physicians decreased from 5% to 4.8%. Between 1972 and 1978, out-of-hospital laboratory tests (excluding x-rays and radiation therapy) increased from 850 tests per 1000 visits to 1510 tests per 1000 visits.

The aim of this research was to study the utilization of laboratory investigations in primary health care centers in the Al-Khobar area by studying the Family Health Record checklist of patients.
MATERIAL AND METHODS

This cross-sectional study was conducted in the Al-Khobar area. All the 9 primary health care centers were taken as population under study. Before selection of a sample, Al-Khobar Government Hospital (one of the PHC Centers) was included in the sample as a special case as it was a primary health care center well-equipped with both personnel and facilities. Moreover, it had a sophisticated laboratory set-up that acted as a referral laboratory for other centers.

A two-stage sampling design was used. At the first stage, 4 primary health care centers were selected by means of a simple random sampling design and at the second stage, Family Health Records of the patients were selected using a systematic sampling design within each selected first stage primary health care center. In all, 5 primary health care centers were selected.

A pilot study was conducted in Dammam. For this purpose, two primary health care centers were selected at random, by means of a simple random sampling design. It was found that there was 47% improper laboratory utilization. Accordingly, the sample size was calculated as 659 from the total records of 179,272. The sample was distributed proportionately among all selected primary health care centers: South Khobar, Al-Doha, Albaorlia, South West Thougba and Al-Khobar Government Hospital’s Primary Health Care Centers.

Each Family Health record was studied according to the patient’s complaint, and the diagnosis at the particular visit subjected to the check list. This was used to collect information retrospectively about patient’s age, gender, nationality, diagnosis and the laboratory investigations which had been requested.

A standard list of the most common health problems encountered in primary health care centers and the laboratory investigations that should be done for each disease was compiled to determine whether the diagnosis was legitimate. These laboratory investigations were established by using references, such as the quality assurance guidance in primary health care published by the Ministry of Health as well as Laboratory Medicine, Primary Care and Family Medicine textbooks and WHO guidance for basic laboratory medicine.

Moreover, for validity, the standard list was verified and re-evaluated by 5 faculty members at the level of consultants in the Department of Family and Community Medicine, College of Medicine, King Faisal University (KFU) to enumerate the laboratory tests required for a proper diagnosis of a health problem. The investigations were considered inappropriate when (i) more or fewer tests than those listed for a particular disease in the standard list were requested or (ii) if non-relevant tests were requested for a case. They were considered appropriate (a) when for chronic diseases such as diabetes mellitus or hypertension, all follow-up visits during the year showed that laboratory tests, which needed to be performed at intervals, were ordered according to the standard list (b) if the test was carried out once a year.

Data analysis was performed using the SPSS package. Chi-square test, t-test, ANOVA (one-way) and Kruskal-Wallis (H-test) tests were used for data analysis. All means were expressed as mean ± 1sd.

RESULTS

There were 332 (50.4%) males and 327 (49.6%) females. The mean and standard deviation of their ages were 30.3 ± 17.9 and 28.4 ± 19.1 years respectively. The combined mean and standard deviation were 29.4 ± 18.4 years. A total of 789 laboratory tests were carried out among the sample, with a mean and standard deviation of 1.2 ± 1.15 tests per patient. The range of the tests was 0 to 9.
The utilization of laboratory investigations according to the age of the patients along with means (SD) are given in Table 1. On the average, the laboratory test utilization for patients under 21 years was less than one test per patient, whereas for patients between 21 and 40 years, the average was about 1.2 tests per patient.

With advancing age, more laboratory tests were utilized with a maximum of 2.1 tests for patients above the age of 40 years. The Kruskal-Wallis method was used to test the difference in utilization of laboratory investigations in different age groups and it was found that there were highly significant differences statistically among the age groups with respect to utilization of laboratory investigations (p = 0.001).

These data were further divided into two groups to examine the pattern of utilization between age groups 40 and under and the age groups over 40. It was found that in the first set of groups, the utilization of laboratory tests varied in different age groups (Kruskal-Wallis, p = 0.002), whereas in the second group it was found that there was no statistically significant difference in the use of laboratory tests in different age groups (p=0.3410 - ANOVA one-way).

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### Table 1: Utilization of lab investigations per age

| Age (Years) | Patients (%) | Lab Tests (%) | Mean ± SD |
|-------------|--------------|---------------|-----------|
| <10         | 144 (21.8)   | 86 (10.9)     | 0.6 ± 1.2 |
| 11 - 20     | 98 (14.8)    | 69 (8.7)      | 0.7 ± 1.1 |
| 21 - 30     | 94 (14.3)    | 102 (12.9)    | 1.1 ± 1.3 |
| 31 - 40     | 133 (20.2)   | 158 (20.0)    | 1.2 ± 1.6 |
| 41 - 50     | 102 (15.2)   | 215 (27.2)    | 2.1 ± 2.0 |
| 51 - 60     | 58 (8.8)     | 113 (14.3)    | 1.9 ± 1.9 |
| > 60        | 30 (4.6)     | 46 (5.8)      | 1.5 ± 1.4 |
| **Total**   | **659**      | **789**       | **1.2 ± 1.5** |

### Table 2: Laboratory use according to diagnosis

| Diagnosis Category                      | Patients No. (%) | Lab Test No. (%) | Improper Utilization No. (%) |
|-----------------------------------------|------------------|-----------------|------------------------------|
| Respiratory diseases:                   |                  |                 |                              |
| Respiratory infection                   | 180 (27.3)       | 51 (6.5)        | 29 (16.1)                    |
| Bronchial asthma                        | 12 (1.8)         | 2 (0.3)         | 1 (0.8)                      |
| Chronic diseases:                       |                  |                 |                              |
| Diabetes mellitus (DM)                  | 85 (12.9)        | 208 (26.4)      | 84 (98.8)                    |
| Hypertension                            | 51 (7.7)         | 124 (15.7)      | 50 (98.0)                    |
| DM & Hypertension                       | 26 (3.9)         | 79 (10.0)       | 25 (96.2)                    |
| Musculo-skeletal diseases               | 71 (10.8)        | 61 (7.7)        | 19 (26.8)                    |
| Gastrointestinal tract diseases:        |                  |                 |                              |
| Peptic ulcer and gastritis              | 50 (7.6)         | 54 (6.8)        | 35 (70.0)                    |
| Diarrhea                                | 17 (2.6)         | 19 (2.4)        | 9 (52.9)                     |
| Urinary tract infection                 | 66 (10.0)        | 115 (14.6)      | 57 (86.4)                    |
| Eye & Ear diseases                      | 38 (5.8)         | 7 (0.9)         | 5 (13.2)                     |
| Skin diseases                           | 33 (5.0)         | 9 (1.1)         | 4 (12.1)                     |
| Anemia                                  | 30 (4.6)         | 60 (7.6)        | 19 (63.3)                    |
| **Total**                               | **659 (100)**    | **789 (100)**   |                              |
Again, all age groups 40 and under were combined in one group, and all those over 40 were combined in another group. It was found that there were statistically significant differences in the utilization of laboratory tests (t-test; P < 0.001). Utilization was greater on the average for patients older than 40 years and greater for females than males. The mean and standard deviation for males and females were 1.16 ± 1.62 and 1.24 ± 1.57 tests respectively but there was no statistically significant difference among males and females (t = 0.64; p = 0.525). On the average, for both males and females the mean and standard deviation were 1.20 ± 1.60 tests.

For the 496 (73.3%) Saudi and 163 (24.7%) non-Saudi patients, it was found that on the average, more tests were undertaken for non-Saudi than for Saudi patients. Their respective means and standard deviation were 1.27 ± 1.87 and 1.17 ± 1.49 tests but the difference between Saudi and non-Saudi was not statistically significant (t=0.59, p = 0.558). The mean and standard deviation for both males and females were 1.20 ± 1.65.

The proportion and the utilization of laboratory tests according to diagnostic categories is given in Table 2. There were large variations in the number of tests used for different diagnostic categories, sometimes amounting to more than tenfold. Respiratory diseases accounted for more than a quarter (29.1%) of the health problems in primary health care centers. Chronic diseases, mainly diabetes and hypertension, accounted for another quarter (24.5%). Musculo-skeletal diseases were 10.8%, and gastro-intestinal tract (GIT) disease and urinary tract infection 10.2% and 10%, respectively. Other diseases such as those of the eye, ear and skin totaled 15.4%. Even for some diseases such as diabetes, hypertension and urinary tract infection that were investigated in detail, the utilization of laboratory tests was improper. Respiratory infection, bronchial asthma, eye and ear diseases achieved a high rate of proper utilization but in most cases, no laboratory test was required to diagnose them.

A variety of tests was carried out and the distribution of the utilization of specific laboratory tests has been described in Table 3. They are grouped into four categories, i.e., Hematology, Biochemistry, Microbiology and Serology. Microbiology was the most heavily used service, comprising 43% of all the investigations, followed by biochemistry (36.1%), hematology (19.5%) and serology (1.4%). Urinalysis was the most frequently requested test making up 30.7% of all tests, followed by blood glucose (19.9%), and complete blood count (14.8%) (Table 3).

There was no statistically significant difference among the primary health care centers regarding the proper and improper utilization of laboratory tests (chi-square = 4.13 p = 0.389) (Table 4). Neither was there any significant difference in the two categories of over- and under-utilization, both of which are improper (Kruskal-Wallis = 4.13; p = 0.389). Moreover, there was no statistically significant difference between males and females regarding proper and improper utilization of laboratory tests (chi-square = 0.68; p = 0.411).

Of the 323 (40%) cases of proper utilization of laboratory tests, 168 (52%) were for males and 155 (48%) for females. Of the 336 cases of improper utilization, 164 (48.8%) were for males and 172 (51.2%) for females. However, no statistical difference was noted on the overall requests for male and female patients.

Of all those studied, 496 (75.3%) were Saudi, and of these 47.8% were identified with improper utilization. Of the 163
Table 3: The distribution of the utilization of specific laboratory tests

| Lab Test                        | Expected number of tests to be done | Tests done Number (%) | Improper Utilization Number (%) |
|--------------------------------|-------------------------------------|-----------------------|---------------------------------|
| Hematology                     | 206                                 | 154 (19.5)            | 138 (68.0)                      |
| Complete blood count           | 186                                 | 117 (66.0)            | 121 (65.0)                      |
| ESR                           | 4                                   | 7                     | 3                               |
| G6PD                           | 3                                   | 5                     | 2                               |
| Sickle cell test               | 13                                  | 25                    | 12 (92.3)                       |
| Biochemistry                   | 653                                 | 285 (36.1)            | 478 (73.2)                      |
| Blood glucose                  | 162                                 | 157 (96.8)            | 57 (35.2)                       |
| Blood urea/Creatinine          | 162                                 | 31 (18.7)             | 138 (85.2)                      |
| Cholesterol/Tri glycerides     | 162                                 | 50                    | 113 (70.0)                      |
| Serum uric acid                | 77                                  | 16                    | 73 (94.8)                       |
| Serum electrolyte              | 77                                  | 14                    | 67 (87.0)                       |
| Liver function test            | 0                                   | 17                    | 17 (100.0)                      |
| Serum iron/ferritin/TIBC*      | 13                                  | 0                     | 13 (100.0)                      |
| Microbiology                   | 371                                 | 339 (43.0)            | 216 (58.2)                      |
| Urinalysis                     | 228                                 | 242                   | 84 (36.8)                       |
| Stool analysis                 | 57                                  | 81                    | 62 (108.8)                      |
| Urine culture/sensitivity      | 59                                  | 10                    | 49 (83.0)                       |
| Stool culture/sensitivity      | 15                                  | 3                     | 12 (80.0)                       |
| Sputum culture/sensitivity     | 10                                  | 1                     | 9                               |
| Brucella titer                 | 2                                   | 2                     | 0                               |
| Serology                       | 2                                   | 11 (1.4)              | 9                               |
| Rheumatoid factor              | 1                                   | 6                     | 5                               |
| C-reactive protein             | 1                                   | 5                     | 4                               |
| **Total**                      | **1232**                            | **789 (100)**         | **841 (68.4)**                  |

* Erythrocyte sedimentation rate   † Total iron binding capacity

Table 4: The utilization pattern for laboratory tests among PHC centers

| Utilization Pattern | Bayonia | Doha | South Khobar | KGH | South West Thoughqua | Total |
|---------------------|---------|------|--------------|-----|----------------------|-------|
| Proper              | 48      | 51   | 44           | 103 | 77                   | 323   |
| Improper            | 67      | 51   | 37           | 96  | 85                   | 336   |
| **Total**           | **115** | **102** | **81**       | **199** | **162** | **659** |

(24.7%) who were non-Saudi, improper utilization was 47.2%. There was no statistically significant difference with regard to patients of a particular nationality (chi-square = 1.22; p=0.269).

DISCUSSION

The results of this study provide some information on the utilization of laboratory investigations in the primary health care centers in the Al-Khobar area. The tests were ordered for 49% of the sampled population, with an average of 1.2 tests per patient. This result may be compared with the National Ambulatory Medical Care Survey in United States. It was reported that general practitioners used laboratory tests for 34% of patients. Hartley et al found in the Greater London general practice that two-thirds of all the tests requested during the year were ordered for less than 10% of the patients. Mills and Reilly, however, reported that an average of only 12% of the patients seen in four general practices in Belfast underwent laboratory testing. Beaulieu et al studied the utilization of laboratory tests in a random sample of 1029 visits occurring over a one-year period in a family medicine clinic.
service. They found that no test was ordered in 62.5% of the visits, and that the average was 1.04 tests per visit. At a community health center in Oslo staffed by three general practitioners, Hjortdahl\textsuperscript{16} found that laboratory tests were ordered in 50% of all consultations, and an average of one test was ordered per consultation. Therefore, we can conclude that physicians are using laboratory services more frequently in recent years than before.

The utilization of laboratory services was more noticeable for patients above 40 years of age in this study, where on average 2.1 laboratory tests per patient were used. Patients under the age 20 were less likely to be investigated, where an average 0.7 laboratory tests per patient were used. This may be due to the fact that there may be an under-utilization of the services.

The utilization of laboratory tests was almost equal with respect to gender and nationality, but among diagnostic categories variation was found which was sometimes more than tenfold. For example, of the total number of laboratory tests carried out, 26.4% were for diabetes mellitus (DM) and 2.4% were for diarrhea. The variation between them was 11-fold, (diarrhea got a higher percentage of proper utilization than diabetes mellitus). This variation may be compared with that of Hartley and his colleagues\textsuperscript{13} who found more than a ten-fold variation in test use among diagnostic categories.

An actual use of diagnostic tests was measured and it was found that the pattern of practice was truly representative of the actual practice behavior of the physicians.

The utilization of laboratory investigations in primary health care centers was inappropriate in 51% of the cases, 37.8% of which was under-utilization and 13.2% over-utilization. This is proportionally close to the finding of Wheeler et al.\textsuperscript{17} They studied 258 cases of anemia in a San Francisco hospital, and found about 11% over-use and 24% under-use of laboratory investigations. Microbiology was the most heavily used service, comprising 43% of all investigations, followed by biochemistry (36.1%) and hematology (19.5%). Urinalysis was the most frequently requested test, accounting for 30.7% of all tests, followed by blood glucose (19.9%) and CBC (14.8%). In the Mills and Reilly\textsuperscript{14} study, hematology tests accounted for more than 30% of laboratory requests, followed by microbiology (25%), and biochemistry (20%). Kelly and Barber\textsuperscript{18} found that hematology was the most heavily used service (33.3%), followed by microbiology (22%) and biochemistry (18.8%). They also found that CBC was the most frequently requested test, representing 23.6% of all the investigations, followed by urinalysis (16.1%) and cervical smear (13.9%). The high percentage of microbiology in this study compared to other studies, may be due to over-utilization of urinalysis and stool analysis.

We found that the rate of inappropriate use of laboratory tests was 51%; 37.8% of which were cases of under utilization and 13.2% of over utilization. This may be due to the fact that the problem of over-utilization does not seem to be as acute in primary health care centers as has been observed in hospitals.\textsuperscript{19}

**CONCLUSION**

Laboratory tests were utilized for only half of all the patients and 84% of them had a maximum of 3 tests. The utilization was inappropriate in 51% of the cases, 13.2% of which cases were of over utilization, and 37.8% of under utilization. As age of patients increased, laboratory facilities
were used more frequently, and this almost doubled after the age of 40 years. There was no difference between primary health care centers with regard to the pattern of utilization of lab tests for males and females and for Saudi and non-Saudi patients. Respiratory diseases accounted for the majority of the health problems in primary health care centers, followed by diabetes mellitus and hypertension. Microbiology was the most heavily used mode of investigation, followed by biochemistry and hematology. Urinalysis was the test most frequently requested, followed by blood glucose and CBC.

RECOMMENDATIONS

1. Test selections and interpretation of results should be adequately taught in medical schools. This has already been proved very effective at the University of Minnesota.20

2. A handbook on appropriate test selection should be issued to encourage the proper use of laboratory testing, and a regular audit should be established to enable physicians to review their activities.

3. Continuing medical education should be directed towards investigation, indication, and rational, cost conscious utilization through a variety of approaches such as close interaction between clinical chemist and clinician, circulating laboratory newsletters, and through the organization of discussions on specific topics.

4. Undergraduate curricula of medical colleges should include courses on health economics and cost effective decision making.

5. Family health records in primary health centers need evaluation and improvement on documentation.

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