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Role of the Biochemistry Labs in Promoting the Health Care Services for the Inpatients Diabetics in a General Hospital at Kuwait

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ABSTRACT:
The health care in the State of Kuwait depends to a greater extent on the biochemical and clinical labs attached at each hospital. The data obtained from these laboratories will facilitate the process of diagnosing the disease accurately. This will have a positive impact on the selection of appropriate treatment for the patients in general and for diabetics specifically.
The main objective of this research was to build a profile for lab analysis and a database for building a comprehensive system of integrated activities to raise health care for diabetic patients in Kuwait. The study revealed the burden of admitted diabetic cases on the blood chemistry laboratory in Sabah Hospital (in relation to length of stay and total numbers of lab requests). The aim was fulfilled by designing a model of the biochemical tests for diabetics; filling in forms from the reality of patient data, completing and analyzing the results electronically.

The study showed the importance of biochemical and clinical labs since they act as the link of patient's information at the secondary health care level.

Keywords: *Biochemistry laboratory, Health care services, Inpatients Diabetics, General Hospitals, Kuwait*

I. Introduction:

Non-communicable diseases (NCDs) are currently the leading global cause of death. In 2008, of the 57 million deaths that occurred globally, 36 million – almost two thirds – were due to NCDs, comprising mainly cardiovascular diseases, cancers, diabetes and chronic lung diseases. The combined burden of these diseases is rapidly increasing in lower-income countries. About one fourth of the global NCD-related deaths occur before the age of 60 years. Diabetes Mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels. Adequate glycemic control is strongly correlated with improved clinical outcomes of diabetic patients. Diabetes is considered by the WHO as an "epidemic", and represents a huge burden worldwide. Diabetes prevalence in some countries of the Eastern Mediterranean Region is among the highest in the world (9.4% in 2007) **(1)**

In the Eastern Mediterranean Region, there has been a rapid increase in the incidence of diabetes mellitus, consisting mainly of type 2(T2D). It is now the fourth leading cause of death in the Region. An estimated 22 million people have diabetes, out of a total adult population of 290 million. Studies conducted in different populations of the region have reported high prevalence rates varying from 7% to 25% in the adult population.**(2)** According to recent studies, six countries in the Eastern Mediterranean region, namely United Arab Emirates, Bahrain, Kuwait, Saudi Arabia, Egypt and Oman, are among the world's 10 highest with regards to diabetes prevalence.**(3)**

As with many other countries with high diabetes prevalence, the onset of T2D is becoming increasingly prevalent in adolescents. Rapid economic development has been associated with extraordinary social change resulting in the adoption of an increasingly western lifestyle which is reflected in changes in diet and nutrition, a move to a more sedentary lifestyle with an increasing prevalence of smoking and obesity. These socioeconomic changes are believed to be responsible for an explosion of diabetes across the region. **(4)** According to the estimates of the World Health Organization (WHO 2003), around 194 million people suffer from diabetes. This is expected to reach 330 million in 2030 with three out of four living in developing countries. During the past

three decades, the affluence and economic inflation in the state of Kuwait has considerably influenced the lifestyle. Accordingly the prevalence of diabetes mellitus has reached 12.4% as reported by community-based national epidemiological health survey in Kuwait 2008.

Many of diabetic complications may be delayed or prevented, offering considerable opportunities for both reductions in costs and improvements in the quality of life of those affected. Identification of the specific risk factors in a defined population will allow early modification of interventions for optimal diabetes care. Primary care physicians have a leading role in ensuring that patients with diabetes receive early and optimal care. More over biochemistry laboratory also known as chemical pathology or pure blood chemistry lab plays an important, often unrecognized role, in disease diagnosis and monitoring of treatment. It is responsible for most of laboratory testing performed on samples sent to the diagnostic labs by medical practitioners. It is concerned with analysis of body fluids as the constituents of the blood and urine. Most of the laboratory testing uses sophisticated instrumentation interfaced to a laboratory information system. The laboratory results produced are used by medical staff in the diagnosis of disorders in approximately 70% of all cases.**(5)**

The National Academy of Clinical Biochemistry (NACB) issued its "Guidelines and Recommendations for Laboratory Analysis in the Diagnosis and Management of Diabetes Mellitus" in 2002.**(6)** These recommendations were reviewed and updated by a multidisciplinary guideline team using an evidence based approach, especially in key areas in which new evidence has emerged since the previous edition. This guideline focuses on the practical aspects of care in order to assist with decisions related to the use or interpretation of laboratory tests while screening, diagnosing, or monitoring patients with diabetes. The recommendations intend to supplement the American Diabetes Association (ADA) guidelines and thus do not address any issues related to the clinical management of patients**. (7)**

The health care in the State of Kuwait depends mainly on the biochemical and clinical labs attached at each hospital due to the importance of the data they provide for the process of diagnosing the disease properly and accurately. On turn it will have a positive impact on the selection of appropriate treatment for the patients.

This study aims to clarify the burden of diabetic cases admitted in Sabah hospital on the biochemical lab in terms of total number of investigation requests in relation to some personal variables as well as length of stay in the hospital.

This research is considered as a process evaluation and situation analysis of health care provided to diabetic cases in MOH hospitals in the State of Kuwait from biochemistry laboratory perspectives. It also serves as a baseline for any further future interventions.

II. Materials and methods

a- Research design:
This is a retrospective cross-sectional study of medical records and Biochemistry laboratory in Sabah Hospital, Kuwait. This design is the most suitable for short time and shortage of resources.

b- Study Sample:
Kuwait is divided into six governments: Capital, Hawally, Farwanyia, Ahmadi, Jahraa and Mubarek Alkabeer (Figure 1). Kuwait has six governmental general hospitals: Amiri, Sabah, Farwanyia, Adan, Jahraa and Mubarek Alkabeer. From the six general hospitals serving the country, Sabah Hospital was selected at random.
All the medical records of all diabetic cases admitted in Sabah Hospital according to the patient's discharge summary (appendix A) during the year 2010.

According to the data available in the National Center of Health Information (NCHI), there were 266 medical records related to diabetics. Only 232 medical records of them were accessed (79.6%). The remaining 54 records were either records of patients who died **(n=7-)** or inactive records for a deported non-Kuwaitis **(n=11-),** or medical record of a Kuwaiti who was treated abroad **(n=9-)** or a temporary transferred file for those who were treated in private sector inside the country **(n=7-).** Also 20 records were used in the pilot study. Medical files studied in the pilot were not included the study. So, 212 records constituted the sample size.

c- Research setting
The study was conducted in Sabah General Hospital.
d- Data collection tools:

A specially-designed format (Figure 2) was used to collect data from records related to: a-demographic characteristics (age, gender, nationality, education, marital status, and occupation), b-readmissions in the same year for the same cause and length of stay and c- presence of complications or other co-morbidities) and d- all lab results of Sabah Biochemistry lab during the year 2010.

Data collection:

-Pilot Study:

Before data collection phase, a pilot study was undertaken with the aims to:

- Examine the administrative system and sequential procedures of recruitment of subjects file, data collection, revision and collection of data collection format.
- Test the data tool and perform the required modification.
- Estimate the required time for completion of the format.
- Evaluate the computerized system of data entry and the time needed.
- Examine the co-operation process between different work teams.
- Identify unexpected difficulties during the various steps of the study.

The pilot study was conducted in similar circumstances of the main study on 20 medical files. Feedback from the pilot study indicated that: **a-**minor modifications were needed on the format, **b-**the time needed to complete the research tool was twelve minutes and **c-** the actual study will be carried on 212 medical records.

Ethical considerations:

-The study had been agreed upon by the Ethical Committee for Medical Researches in Kuwait, particularly in relation to the access to data from the NCHI as well as the Medical Records Department and the Biochemistry lab of Sabah Hospital.

-Absolute confidentiality was considered in dealing with the collected data and a special place for the team in Sabah Hospital was made available for receiving medical files.

Data analysis:

Data were entered utilizing a special form of Access program. Then data were transferred into SPSS for Windows version 20. Descriptive statistics were used in the form of mean ± standard deviation or Median (Interquartile range) for quantitative data and number and percentage for qualitative data. A 5% level was chosen as the level of significance in all statistical significant tests used in the study.

Results:

The present research studied 212 records of diabetic patients admitted to Sabah Hospital during 2010. Their main diagnosis in discharge summary was diabetes mellitus.

Demographic characteristics

Table (1) shows the different demographic characteristics of diabetics as recorded. Over half the patients were females (56.13%). The median age was 51.5 years. The patients' age ranged between 8 to 94 years with an average of 48.98±19.8 years.

Less than two thirds of the patients (64.62%) were Kuwaitis. Over a third of patients (38.21%) lived in Al-Farwaniya or the Capital (33.96%). Very few lived in Al-Jahara (5.19%), Hawally (4.25%), Al-Ahmadi (2.36%) or Mubark Al- Kabeer (0.94 %)

More than half the patients (50.7%) were married, 13.7% were single and only 2 or 0.94% lost their spouse. However, in 24.53 % of instances the marital status was not recorded and in 12.74% the patient below the age of marriage.

Less than a tenth of patients (8.02%) were illiterate or holding a primary/intermediate certificate (8.96%). Those who obtained a secondary certificate general or technical constituted 16.51% of the sample. A minority (1.89%) were university graduate. However, in 64.62% of instances the educational level of patients was not recorded.

In 74.06% of the records the occupation of the patient was not stated. Around a tenth the patients were a house wife (10.38%) or a student (9.43%). A minority were professionals (1.42%), semiprofessionals (1.89%) or manual workers (2.83%).

Readmissions, length of stay and presence of complications

The number of the repeated hospital admissions of the same patient in 2010 ranged between one to nine admissions in the same year with an average of 1.47±1.34 admissions. The length of stay ranged from 1 to 108 days with an average of 9.17±12.81 days indicating that their distribution was not normal. The median length of stay was 6 days and the inter quartile range was 3 days. The proportion of readmission for the same reason during the preceding year was 63.68%.Only 28.60 % of admitted diabetic patients had diabetic complications. (Table 1)

Laboratory tests

A variety of laboratory tests are routinely recommended for diabetic patients. These totaled 25 tests. The most five commonly tests carried out were those for assessing Na (1218 tests), CREA (1184 tests), K (1183 tests), Glucose (837 tests) and BUN (786 tests). The least five tests to be carried out were (TP one test), TGT (three tests), URN-MIC(three tests), AST(12 tests) and HBAIC(17 tests).

Figure 3 indicated that lab tests were more carried out for patients living in Al-Farwaniya (41.4%) and the Capitals (36.6%) than those residing in Al Jahra (4.6%), Hawalli (3.3%), Al- Ahmadi (0.5%) or Mubarak Al Kabeer (0.4%).

More than half the total numbers of laboratory tests (63.9%) were carried for female patients.

Table (2) shows the distribution of the detailed laboratory test results diabetic patients by their gender. More laboratory tests were done for female diabetics than those done for males except for the TGT and urine micro-albumin. The majority of tests of FTA (92.4%) and TSH (92.3%) were performed for females.

The highest percentage of major lab tests done were in the age group 60 to less than 70 years, followed by 50 to less than 60 years, then came 40 to less than 50 years. Those aged less than 10 years had a percentage of 2.9%, which rose to 9.7% in age group from 20 to less than 30 years, then dropped in the age group 30 to less than 40 years (5.2%), and again it increased gradually to reach the highest peak in the age group of 60 to less than 70 years old (20.2%), which gradually decreased as the age advanced.

Table (3) depicts the percentage distribution of the laboratory tests for diabetic patients according to their age and type of test.

No assessments of TP, Iron, URCA, HbAIC, TGT, FT4, TSH, CK or URNMIC were carried out for diabetics younger than 10 years. A minority of tests ranging from 1.8% for glucose up till 8.3% in case AST were carried for this age group. Also no assessments of TP, AST, Iron, TGT, FT4, TSH, CK or URNMIC were carried out for diabetics aged 10 to less than 20 years. However in the age group (10-20 years), over tenth of the tests were carried out for assessment of BUN (15.3%), HBAIC (11.8%),Na(11.5%),K(11.4%),CREA (11.3%) and glucose (10.2%). No assessments of TP, AST, Iron, HbAIC, TGT, FT4 or TSH were carried out for diabetics aged 20 to less than 30 years. The most frequent test carried out for this age group(viz 20-30 years)was that of Ca(10.6%).Less than 10th of tests were carried out for each of the following assessment :BUN(9.4%) glucose (8.0%),K(8.0%). All tests were performed for diabetics aged 30 to less than 40 years except that for TP,AST, TGT and URNMIC. Of the total tests carried out the most frequent ones was that for Iron (10.5%) and PHOS(9.5%). Only two tests were not carried out at all for patients aged 40 to less than 50 years namely TP and TGT. The highest percent observed from the total tests was that of URNMIC (33.3%), Iron (26.3%) and LDL (19.3%). All tests were done for diabetics aged 50 to less than 60 years except that for URNMIC. The proportionate percent was around a third of the totals in case of TGT (33.3%), CK (31.0%) and FT4 (30.8%) In case of 60 to less than 70 years TP and URNMIC tests were not done. The proportionate % of individual tests was higher than that of the tests done for any other age group. All tests were carried out for those aged 70 to less than 80 years except TP and UR was that for AN MIC. The highest proportionate % was that for AST test. TP, TGT, FT4,TSH, and URN MIC tests were

Table (4) illustrates the percentage distribution of the total laboratory tests for diabetic inpatients by governorate. The highest proportionate percentage of tests was carried out for those residing in the Capital and in Al Farwaniya. in Mobarek Al KabeerAl-Ahmadi

patients living in Farwaniya governorate (47.15%) and Capital (41.62%), while those living in Mubarak Al-Kabeer formed the lowest (0.42%) regarding the percentage of lab tests done. Lastly, patients with unstated place of residence formed only a small percentage (1.16%).

Table (5) shows the distribution of the laboratory tests for diabetes inpatients in Sabah Hospital in 2010 by results and nationality. Kuwaitis formed 72.3% of the total of tests. The same pattern was observed when considering the detailed laboratory tests. High blood glucose level was encountered in 50.8% and 56% of all blood glucose testing for Kuwaitis and non-Kuwaitis respectively. High creatine level was also encountered in 30.1% and 36.9% of all creatine testing for Kuwaitis and non-Kuwaitis respectively.

A seasonal pattern of total lab tests carried out is observed (Figure 4). Three peaks are detected, one in March (10.5%), the second in August (11.4%) and the third peak in October which was the highest (14.6%). The lowest percentage was observed in February (3.4%).

Table (6) shows the proportion of laboratory tests that were done for diabetic patients in relation to all tests conducted by Sabah Biochemistry Lab in 2010 by month per 1000. The overall proportion was 4.9/1000 lab test. The highest percentage was during August and October (8.2 per thousand for each). The lowest percentage was during February (2.1 per thousand).

III. Discussion:

Diabetes is a major lifestyle disorder, the prevalence of which is increasing globally. Its high prevalence, constituted chiefly by T2D (about 90-95%), is a global public health threat. The prevalence among adults aged 20-70 years is expected to rise from 285 million in 2010 to 438 million by the year 2030.[(8)]

In Kuwait, the socio-economic development which followed the discovery of oil resources brought about considerable changes in the food habits and lifestyle of the Kuwaiti population. Excessive caloric intake and decreased energy expenditure due to a sedentary lifestyle have led to a rapid increase in obesity, diabetes and other non-communicable chronic diseases in the population. The prevalence of metabolic syndrome (MetS) was 37.7% in females and 34.2% in males by the National Cholesterol Education Program (NCEP) criteria, whereas the values were 40.1% in females and 41.7% in males according to the International Diabetes Federation (IDF) criteria. The high prevalence of the MetS in Kuwaiti adults warrants urgent public health measures to prevent morbidity and mortality due to cardiovascular complications in the future [(9)] In this study, females accounted for more than half the total number of laboratory tests (63.9%). This might be due to high presentation of females of the study sample (56.13%).

In this study, the highest peak in the age group of 60 to less than 70 years old (20.2%). This might be due to the high prevalence of T2D in this age group.

In this study, the highest percentage of laboratory tests was during October (8.2 per thousand). This might be due to the coincidence of Ramadan, the Moslems' fasting month, with the possibility of increased cases necessitating hospital admission.

Kuwaitis constituted 64.62% of the sample. This might be due to prevalence of unhealthy food habits coupled with tradition of family gatherings alongside physical inactivity especially in summer times due to hot dry weather.

The average age of the studied patients was 48 years. This may explain why married formed the highest percentage (50.7%) and the undergraduates formed the lowest percentage in the sample (1.89%), although the educational level of more than three-fifth of the respondents (62.4%) was not shown.

In relation to occupation, 74.06% of the sample did not state their profession. This necessitates an action to be done to emphasize recording this important personal attribute. In relation to the governorate of the residence, patients living in Farwaniya governorate formed the highest percentage (38.21%), followed by those coming from the Capital (33.96%). These two governorates are geographically located close to Sabah Hospital.

Regarding the utilization of lab investigations, the A1C has several advantages to the fasting blood glucose (FBG) and OGTT, including greater convenience (since fasting is not required), evidence to suggest greater preanalytical stability.[(10)] In this study, only 17 times A1C has been tested, where 94.1% of them were found high.

Because A1C is thought to reflect average glycemia over several months, and has strong predictive value for diabetes complications, A1C testing should be performed routinely in all patients with diabetes as part of

continuing care. Measurement approximately every 3 months determines whether a patient's glycemic targets have been reached and maintained. For any individual patient, the frequency of A1C testing should be dependent on the clinical situation, the treatment regimen used, and the judgment of the clinician.[6,11,12]

Hyperglycemia defines diabetes, and glycemic control is fundamental to the management of diabetes. Lowering A1C to below or around 7% has been shown to reduce microvascular complications of diabetes, and if implemented soon after the diagnosis of diabetes is associated with long-term education in macrovascular disease. Therefore, a reasonable A1C goal for many nonpregnant adults is ,7%.[13,14]

Concerning serum lipids, Patients with T2D have an increased prevalence of lipid abnormalities, contributing to their high risk of CVD. The common form of T2D, associated with insulin resistance and the metabolic syndrome is characterized by a singular, non-low density lipoprotein (LDL) dyslipidemia, defined as atherogenic dyslipidemia (AD). The hallmark of AD is decreased levels of HDL together with raised triglycerides (TG). Low levels of high density lipoprotein (HDL) cholesterol, often associated with elevated TG levels, are the most prevalent pattern of dyslipidemia in persons with T2D.[15-18] In most adult patients, measurement of fasting lipid profile should be investigated at least annually.[13]

Fasting blood glucose (FBG) was used as an indicator because research has linked poor glucose control with diabetic complications. The DCCT is considered a landmark clinical study that tested the hypothesis of a direct link between the complications of diabetes and the chronic elevation of plasma glucose.[13,19] In this study, blood sugar testing was carried out in about 63.7% of the total lab tests done, out of which 52.3% were found high.
According to the ADA, for most patients with diabetes, the first priority of dyslipidemia therapy is to lower LDL cholesterol to a target goal of 100 mg/dL. Triglycerides level < 150 mg/dL and HDL cholesterol 40 mg/dL in men and 50 mg/dL in women, are desirable. The ideal level of total cholesterol is < 170 mg/dL.[13] However, the American College of Pharmacology settled certain acceptable levels of these parameters as 130 mg/dL for LDL, >35 for HDL, <200 for triglycerides, and < 200 mg/dL for total cholesterol.[20] In this research, the majority (above 88%) of Serum lipid profile were not tested, viz; Cholesterol, LDL, Triglycerides and AHDL. Among the remaining about 8% of the lab results were normal.

When assessing protein excretion, the urine dipstick is a relatively insensitive marker for initial increases in protein excretion, not becoming positive until protein excretion exceeds 300 to 500 mg/day (upper limit of normal is < 150 mg/day). Using a specific assay for albumin is a more sensitive technique. The normal rate of albumin excretion is less than 30 mg/day; persistent albumin excretion between 30 and 300 mg/day is called microalbuminuria and, in patients with diabetes, may be indicative of early diabetic nephropathy, unless there is some coexistent renal disease. Protein excretion above 300 mg/day is considered to represent macroalbuminuria. Although these cut-offs defining normoalbuminuria, microalbuminuria, and macroalbuminuria facilitate determining the risk for progression of nephropathy, the risk of developing overt diabetic nephropathy is probably directly related to albumin excretion rates at all levels. [21] In this study, urine microalbumin was measured only in three cases.

This study shows the monthly proportion of laboratory tests that were done for diabetic inpatients in relation to all tests conducted in 2010 per 1000. The overall proportion was 4.9/1000 lab test. This indicates the reliance on the OPD in the management of diabetics that would decrease the burden of their admissions to the hospital.

Conclusion and Recommendations:
Electronic linking of laboratory results with patient's medical file in all general hospitals.
Electronic linking of patient's information at his primary health care with the secondary level general hospitals with special care given to confidentiality.
Special attention should to be given for all demographic data that some of them were missing such as age, occupation, educational qualification and marital status.
Further studies should be carried out to study the relation between each of demographics (age, gender, nationality, education, marital status, and occupation), clinic-administrative (e.g. Number of previous admissions, Number of previous admissions in the same year for the same cause, length of stay, presence of complications or other comorbidities), on the qualitative and quantitative burden on the Biochemistry lab.
Further studies are needed also for the cost analysis of laboratory investigations for diabetics as well as other NCDs.

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Figure (1): Kuwait map with the location of the 6 governorates

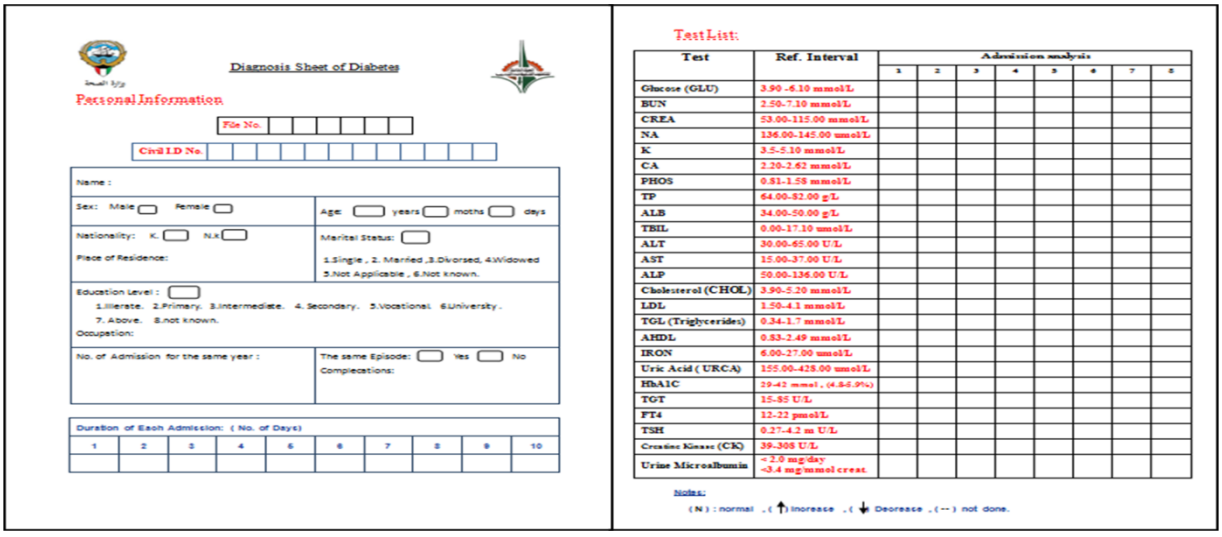

Figure (2): Data collection format

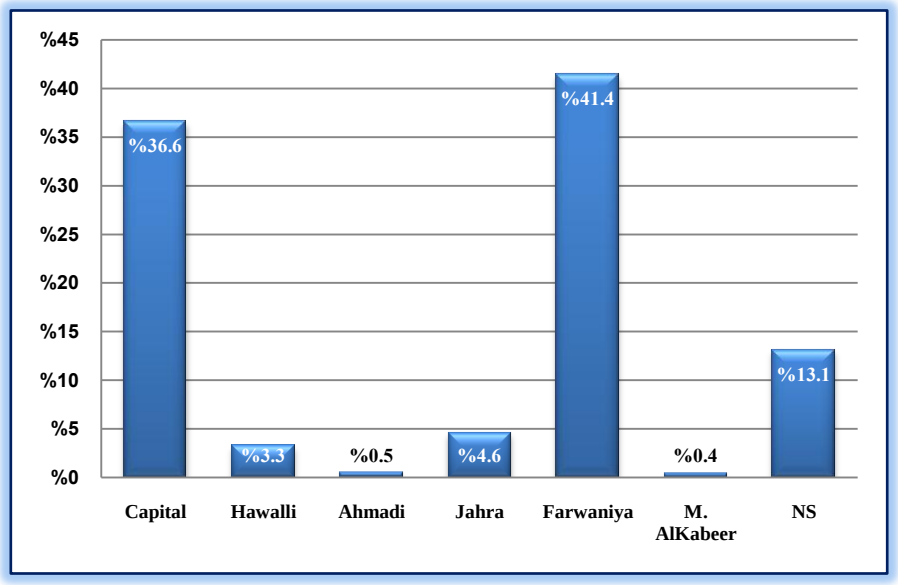

Figure 3: Distribution of laboratory tests for diabetic inpatients according to residence

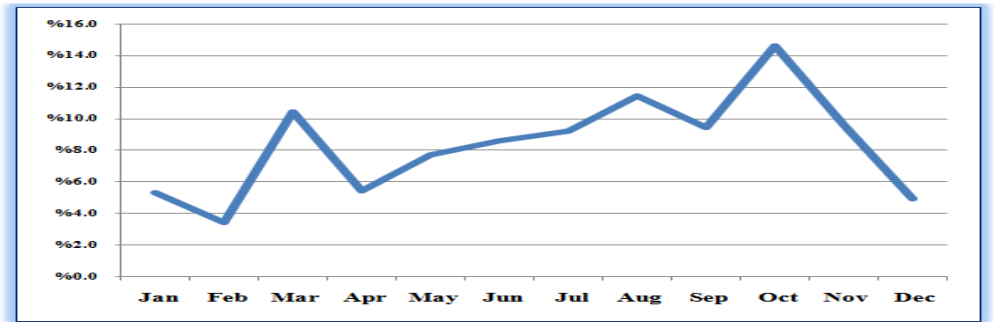

Figure 4: Distribution of laboratory tests for diabetic inpatients by months

Table 1: Demographic characteristics of diabetics (n=212), readmissions, length of stay and presence of diabetic complications as recorded in their medical files

Item	Variables		n	%
Demographic characteristics	Gender	Female	119	56.13
		Male	93	43.87
	Age (years)	Minimum-Maximum	8 – 94	
		Mean +SD	48.98±19.8	
		Median (IQR)	51.5 (32)	
	Nationality	Kuwaiti	137	64.62
		Non-Kuwaiti	75	35.38
	Governorate	Capital	72	33.96
		Hawally	9	4.25
		Ahmadi	5	2.36
		Jahra	11	5.19
		Farwaniya	81	38.21
		Mubarak Al-Kabeer	2	0.94
	Marital Status	NS	32	15.09
		Married	109	51.42
		Widow	2	0.94
		NA	22	10.38
		NS	52	24.53
	Education	Illiterate	17	8.02
		Primary	11	5.19
		Intermediate	8	3.77
		Secondary	28	13.21
		Secondary technical	7	3.30
		University	4	1.89
		NS	137	64.62
	Occupation	Professional	3	1.42
		Semiprofessional	4	1.89
		Manual	6	2.83
		Housewife	22	10.38
		Student	20	9.43
		NS	157	74.06
Clinical and administrative	Number of Readmissions	Minimum-Maximum	1 – 9	
		Mean ±SD	1.47± 1.34	
		Median (IQR)	1 (0)	
	Length of stay (days)	Minimum-Maximum	1 – 108	
		Mean ±SD	9.17+12.81	

		Median (IQR)	6 (3)	
	Re-admission for the same Cause		135	63.68
	Diabetic complications		60	8.30

Table 2: Distribution of laboratory tests for diabetics by gender

Test	Gender				Total	% of the total
	Female		Male			
	n	%	n	%		
Glucose (GLU)	490	58.5	347	41.5	837	11.1
BUN	486	61.8	300	38.2	786	10.4
CREA	769	64.9	415	35.1	1184	15.7
Na	787	64.6	431	35.4	1218	16.1
K	763	64.5	420	35.5	1183	15.7
Ca	168	61.3	106	38.7	274	3.6
PHOS	74	58.7	52	41.3	126	1.7
TP	1	100.0	0	0.0	1	0.0
ALB	181	68.0	85	32.0	266	3.5
TBIL	166	65.9	86	34.1	252	3.3
ALT	167	65.7	87	34.3	254	3.4
AST	10	83.3	2	16.7	12	0.2
ALP	147	65.9	76	34.1	223	3.0
Cholesterol (CHOL)	137	63.4	79	36.6	216	2.9
LDL	67	61.5	42	38.5	109	1.4
TGL (Triglycerides)	137	63.4	79	36.6	216	2.9
AHDL	45	60.0	30	40.0	75	1.0
IRON	14	73.7	5	26.3	19	0.3
Uric Acid (URCA)	96	68.6	44	31.4	140	1.9
HbA1C	11	64.7	6	35.3	17	0.2
TGT	1	33.3	2	66.7	3	0.04
FT4	24	92.3	2	7.7	26	0.3
TSH	24	92.3	2	7.7	26	0.3
Creatine Kinase (CK)	60	60.0	40	40.0	100	1.3
Urine Microalbumin	0	0.0	3	100.0	3	0.04

Table 3: Distribution of laboratory tests for diabetics by age of patients.

Test	Age groups (years)										Total
	<10	10-<20	20-<30	30-<40	40-<50	50-<60	60-<70	70-<80	80+	NS	
Glucose	1.8	10.2	8.0	5.1	15.2	18.3	19.1	13.6	6.7	2.0	837
BUN	2.8	15.3	9.4	5.9	13.7	16.4	19.2	11.8	4.6	0.9	786
CREA	2.9	11.3	7.6	4.9	13.1	16.6	20.8	14.4	6.1	2.4	1184
Na	2.9	11.5	8.0	5.0	13.6	16.5	20.0	14.1	5.9	2.4	1218

K	3.0	11.4	8.0	5.1	13.8	16.5	20.0	13.8	6.1	2.4	1183
Ca	2.6	6.2	10.6	3.6	15.0	20.4	19.3	12.8	7.3	2.2	274
PHOS	2.4	6.3	7.1	9.5	11.9	20.6	19.0	8.7	4.0	10.3	126
TP	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	1
ALB	4.5	4.9	4.1	6.0	15.0	19.5	20.7	17.3	4.9	3.0	266
TBIL	4.4	5.2	5.2	7.5	12.7	18.7	20.6	17.5	5.6	2.8	252
ALT	4.3	5.5	5.1	7.1	13.8	18.5	20.1	17.3	5.5	2.8	254
AST	8.3	0.0	0.0	0.0	0.0	25.0	16.7	41.7	8.3	0.0	12
ALP	4.5	6.3	4.5	4.0	14.8	18.8	21.5	18.8	4.0	2.7	223
CHOL	3.2	5.6	6.0	5.1	15.7	18.5	21.8	13.9	6.5	3.7	216
LDL	3.7	6.4	2.8	3.7	19.3	24.8	16.5	13.8	5.5	3.7	109
TGL	3.2	5.6	6.0	4.6	15.3	18.5	21.3	14.8	6.9	3.7	216
AHDL	1.3	4.0	2.7	5.3	17.3	20.0	22.7	14.7	6.7	5.3	75
IRON	0.0	0.0	0.0	10.5	26.3	21.1	15.8	21.1	5.3	0.0	19
URCA	0.0	1.4	8.6	3.6	15.0	22.1	25.0	6.4	7.1	10.7	140
HbA1C	0.0	11.8	0.0	5.9	17.6	29.4	11.8	17.6	5.9	0.0	17
TGT	0.0	0.0	0.0	0.0	0.0	33.3	66.7	0.0	0.0	0.0	3
FT4	0.0	0.0	0.0	3.8	15.4	30.8	30.8	15.4	0.0	3.8	26
TSH	0.0	0.0	0.0	3.8	15.4	30.8	30.8	15.4	0.0	3.8	26
CK	3.0	0.0	2.0	4.0	13.0	31.0	18.0	18.0	11.0	0.0	100
URNMIC	0.0	0.0	66.7	0.0	33.3	0.0	0.0	0.0	0.0	0.0	3

Table 4: Distribution of laboratory tests for diabetics by place of residence (governorate)

Test	Governorate							Total
	Capital	Hawalli	Ahmadi	Jahra	Farwaniya	Mubarak AlKabeer	NS	
GLU	40.0	2.7	0.5	4.4	40.6	0.2	11.5	837
BUN	37.8	2.3	0.1	3.1	44.4	0.0	12.3	786
CREA	36.5	2.9	0.4	4.1	43.3	0.3	12.4	1184
Na	36.5	2.9	0.4	4.2	43.1	0.3	12.6	1218
K	36.1	2.9	0.4	4.2	43.3	0.3	12.8	1183
Ca	39.1	4.4	1.1	5.5	35.4	0.7	13.9	274
PHOS	25.4	6.3	1.6	5.6	41.3	0.0	19.8	126
TP	0.0	0.0	0.0	0.0	100.0	0.0	0.0	1
ALB	32.7	4.5	0.8	7.1	39.1	0.8	15.0	266
TBIL	34.5	4.0	0.8	6.3	38.1	0.4	15.9	252
ALT	35.4	3.9	0.8	5.9	38.2	0.4	15.4	254
AST	16.7	0.0	0.0	16.7	33.3	0.0	33.3	12

ALP	35.0	2.7	0.9	6.7	38.1	0.4	16.1	223
CHOL	38.0	4.6	0.9	5.6	36.1	0.5	14.4	216
LDL	34.9	7.3	0.9	6.4	39.4	0.9	10.1	109
TGL	37.5	4.6	0.9	5.6	36.6	0.5	14.4	216
AHDL	34.7	8.0	1.3	5.3	38.7	1.3	10.7	75
IRON	42.1	0.0	10.5	10.5	31.6	0.0	5.3	19
URCA	32.1	10.0	0.0	2.9	38.6	2.1	14.3	140
HbA1C	29.4	0.0	0.0	5.9	47.1	0.0	17.6	17
TGT	33.3	0.0	0.0	0.0	33.3	0.0	33.3	3
FT4	34.6	0.0	0.0	0.0	57.7	0.0	7.7	26
TSH	34.6	0.0	0.0	0.0	57.7	0.0	7.7	26
CK	42.0	3.0	0.0	6.0	31.0	0.0	18.0	100
URNMIC	66.7	0.0	0.0	0.0	33.3	0.0	0.0	3

Table 5: Distribution of laboratory tests for diabetics by results and Nationality

Nationality / Test	Results							
	Not done		Normal		High		Low	
	K (n=946)	NK (n=366)	K (n=946)	NK (n=366)	K (n=946)	NK (n=366)	K (n=946)	NK (n=366)
GLU	38.1	31.7	9.9	10.1	50.8	56.0	1.2	2.2
BUN	38.6	44.0	27.9	24.9	21.8	21.9	11.7	9.3
CREA	10.5	8.2	58.8	54.4	30.1	36.9	0.6	0.5
Na	7.4	6.8	66.4	73.8	0.1	3.3	26.1	16.1
K	10.5	8.5	69.8	65.0	3.1	3.0	16.7	23.5
Ca	80.3	76.2	8.8	12.6	0.5	0.3	10.4	10.9
PHOS	90.8	89.3	5.6	6.3	2.5	1.9	1.1	2.5
TP	99.9	100.0	0.1	0.0	0.0	0.0	0.0	0.0
ALB	79.7	80.1	6.1	8.5	0.3	0.0	13.8	11.5
TBIL	80.7	81.4	16.6	16.9	2.5	1.6	0.2	0.0
ALT	80.7	80.9	10.8	11.7	2.9	3.6	5.7	3.8
AST	98.9	99.5	0.6	0.3	0.3	0.3	0.1	0.0
ALP	83.5	82.0	10.9	13.1	5.2	4.6	0.4	0.3
CHOL	83.9	82.8	10.4	9.3	2.4	5.5	3.3	2.5
LDL	92.5	89.9	6.1	7.7	0.2	2.2	1.2	0.3
TGL	84.0	82.5	13.2	10.1	2.6	7.1	0.1	0.3
AHDL	94.7	93.4	1.8	4.4	0.0	0.3	3.5	1.9
IRON	98.3	99.2	0.5	0.5	0.1	0.0	1.1	0.3
URCA	90.9	85.2	5.4	7.4	2.4	7.4	1.3	0.0

HbA1C	98.7	98.6	0.1	0.0	1.2	1.4	0.0	0.0
TGT	99.8	99.7	0.2	0.0	0.0	0.3	0.0	0.0
FT4	97.7	98.9	2.2	0.8	0.1	0.0	0.0	0.3
TSH	97.7	98.9	1.8	1.1	0.5	0.0	0.0	0.0
CK	93.2	90.2	6.0	8.5	0.7	1.1	0.0	0.3
URNMIC	99.7	100.0	0.1	0.0	0.2	0.0	0.0	0.0

Table 6: the proportion of tests conducted for diabetics for all tests carried out in biochemistry lab per month (per thousand)

Test	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Glucose	3.9	2.9	6.0	3.2	4.7	6.6	8.6	7.3	7.3	9.2	7.9	3.7	5.8
BUN	5.7	3.4	8.4	3.2	3.9	6.8	6.9	5.3	8.4	13.5	6.3	3.2	6.2
CREA	5.5	3.4	8.8	4.3	5.7	8.7	10.0	12.4	9.3	13.8	9.6	4.2	7.9
Na	5.8	3.5	8.9	4.3	5.8	8.8	10.2	12.7	10.0	13.8	9.5	4.7	8.1
K	5.5	3.3	8.7	4.3	5.7	8.7	9.9	12.1	9.8	13.6	9.3	4.6	7.9
Ca	1.9	1.4	3.2	1.6	3.4	3.5	4.6	5.7	4.7	6.0	4.1	2.3	3.5
PHOS	1.0	1.1	3.7	2.0	4.6	2.1	4.0	7.3	6.6	5.6	3.4	1.4	3.5
TP	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
ALB	1.7	1.4	2.6	2.4	3.6	3.4	4.1	6.5	4.2	5.1	4.9	2.9	3.5
TBIL	1.5	1.1	1.9	1.9	3.0	3.2	4.6	6.1	4.6	5.2	5.3	2.6	3.3
ALT	1.6	1.0	2.0	2.3	3.1	3.3	4.9	6.7	4.8	6.0	5.5	2.5	3.5
AST	1.5	0.0	1.4	0.0	1.7	1.4	0.0	5.3	0.0	0.0	3.2	0.0	1.1
ALP	1.4	1.0	1.7	2.3	2.9	2.9	4.1	8.7	3.7	4.1	5.1	2.5	3.1
CHOL	1.8	1.2	2.5	2.0	3.6	3.1	5.0	6.1	4.6	4.5	4.8	2.3	3.4
LDL	1.7	1.5	2.7	1.9	2.9	4.4	3.4	3.7	3.3	4.2	3.2	1.6	2.8
TG	1.9	1.4	2.2	2.0	3.5	3.5	4.6	6.1	4.8	4.8	5.0	2.6	3.5
AHDL	2.0	0.9	1.5	1.1	2.3	2.6	4.2	2.9	2.3	2.0	1.8	0.6	1.9
IRON	4.7	0.0	0.8	1.0	0.8	1.9	0.0	2.1	2.9	1.6	1.1	0.9	1.5
Uric Acid	0.6	0.6	0.8	2.0	3.9	1.2	5.0	5.9	3.4	2.8	1.8	0.3	2.2
HbA1C	2.9	0.0	4.7	7.3	2.9	7.2	4.5	0.0	3.2	10.3	7.1	0.0	4.3
TGT	0.0	0.0	1.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.3
FT4	0.0	0.0	0.9	0.5	0.7	1.3	0.9	0.0	0.6	0.5	1.5	0.0	0.6
TSH	0.0	0.0	0.8	0.5	0.7	1.3	0.9	0.0	0.6	0.4	1.5	0.0	0.6
CK	0.0	3.5	22.5	26.7	19.5	12.7	16.1	16.9	8.5	45.1	16.0	8.3	15.2
URNMIC	0.0	38.5	0.0	0.0	0.0	0.0	0.0	18.9	0.0	0.0	0.0	0.0	3.9