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ANALYSIS OF FACTORS INFLUENCING LENGTH OF HOSPITAL STAY IN DIABETIC PATIENTS

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Abstract: **Length of stay (LOS) is one of the most common predictors of increasing or decreasing medical and non-medical costs relevant to hospital care; higher the LOS is, higher will be the costs to the patients, their families and to the healthcare system. Reducing LOS saves hospitalization costs as well as intangible costs. The aim of the research was to analyze the factors influencing length of stay in hospitalized diabetes mellitus patients. In a 3-month-long observational study, 136 patients were studied. Demographic data, laboratory data and other relevant information were collected from patients' case-sheets, prescriptions and by direct interaction with patients, physicians, nurses and carers. Follow-up was conducted on a daily basis. Average length of stay (ALOS) for 136 subjects was 8.2 days. ALOS was found to be higher in females (8.41 days) than in males (7.97 days). The study also indicated an increase in LOS with increasing age. For the age-group 20-39 years, ALOS was determined as 7 days and the same for the age groups 40 - 59 years, 60 - 79 years and 80 - 99 years were 7.4 days, 8.9 days and 19.5 days, respectively. Patients with single co-morbidity had a higher ALOS (8.77 days) than that of patients with multiple co-morbidities (7.3 days). Infectious diseases (p=0.0107) and cardiovascular diseases (p=0.0371) predicted higher LOS than other co-morbidities. Logistic regression analysis also revealed significantly high odds ratio for hepatic diseases. Hyponatremic patients exhibited a significantly higher ALOS (8.5 days) than patients without hyponatremia (7.6 days). The ALOS (13.25 days) for T1DM patients was found to be higher than other groups. Newly diagnosed cases of T2DM had a shorter ALOS (7.85 days) than known cases of T2DM (8.41 days). Patients receiving only insulin had a higher ALOS of 9.2 days, while patients receiving combinations of insulin and OHA had a shorter ALOS of 6.93 days. Clinical pharmacists are not only in charge of optimizing drug therapy for the patients, but they are responsible for improving health outcomes by studying non-therapeutic aspects of hospital care as well and suggesting or implementing appropriate changes in order to reduce the costs related to therapy and to improve mental and physical status of patients. The study demonstrates the importance of clinical pharmacist's thorough examination of institutional factors, social factors and patient's individual factors for achieving improvement in therapy and reduction in length of stay.**

Keywords: **Diabetes mellitus, hyperglycemia, length of stay, hospitalization.**

I. INTRODUCTION

Uncontrolled hyperglycemia leads to the emergence of several diabetic complications. This, results in increased morbidity and mortality. Increased admissions/readmissions and prolonged length of stay due to diabetes mellitus (DM) and diabetic complications have resulted in increased social and psychological burden and massive economic losses. This makes it important to evaluate the social, medical and institutional factors influencing the average length of stay (ALOS) in diabetic patients with an aim to identify the areas that need intervention for better outcomes.

Length of stay (LOS) indicates the number of hospital days spent by the patient. Longer hospital stays are more expensive and can put patients at greater risk for hospital-associated conditions (HACs). In the geriatric population, length of stay is a particularly important indicator because many geriatric patients experience physiological, physical and mental declines

during hospitalization. Inpatients with uncontrolled DM, compared with non-diabetic patients, have an increased risk of mortality, increased incidence of complications, increased LOS, and increased costs. Inpatients are benefited when the team providing care to them are specialized in DM/hyperglycemia management. Hospitals need to have specialized management systems to ensure that hyperglycemic inpatients achieve and maintain target blood glucose levels. Reducing LOS, especially as it relates to avoiding unnecessary hospital-associated conditions (HACs), is a primary indicator of a hospital's success in achieving its goals. In addition to improving patient safety and lowering costs, reducing LOS can increase hospital capacity by making beds available for the patients in queue and increasing staff time and improve throughput, enabling the hospital to function more efficiently.

II. METHODOLOGY

This observational study was conducted in the in-patient wards of Department of General Medicine at the 500-bedded ESIC-MC PGIMSR & Model Hospital, Rajajinagar. Data was collected over a period of 3 months. Information relevant to the study was collected from all patients meeting inclusion and exclusion criteria admitted during the data collection period and documented.

STUDY CRITERIA

Inclusion criteria:

a) Patients presenting with uncontrolled DM and diabetic complications.

b) Patients admitted to the in-patient wards of Department of General Medicine.

c) ESIC card holders.

Exclusion criteria:

a) Pregnant women.

b) Out-patients and patients admitted to departments other than Dept. of General Medicine.

c) Patients who cannot respond verbally, unconscious patients and comatose patients.

SOURCE OF DATA

The data was collected from the in-patients of the Department of General Medicine. The different sources of data used were:

- Case report forms.
- Interactions with patients, carers, nurses and physicians.
- Medication charts/prescriptions.
- Laboratory reports.

STUDY MATERIALS

- Patient data collection form: Data was collected by using a self-designed data collection form. Details like unique identification number, demographic details, laboratory data, medication chart and other relevant data were captured.

III. RESULTS

Gender distribution:

In our hospital-based observational study conducted to analyze the factors influencing the length of stay (LOS) in DM in-patients, 136 in-patients with uncontrolled DM admitted to the Department of General Medicine were studied. Out of 136 study subjects, 51.5% (n=70) were females and 48.5% (n=66) were males.

Age distribution:

In our study, all subjects with uncontrolled DM admitted to the Department of General Medicine from January, 2018 to March, 2018 were included. The youngest subject was 22-year-old and the oldest subject was 88-year-old. The mean age

of the study subjects was found to be 57.63±12.22 years. The study subjects were divided into 4 different age groups as *20-39*, *40-59*, *60-79* and *80-99 years* (TABLE I).

TABLE I: Age-group distribution of study patients.

Age-group	Number (n)	Percentage (%)
20 - 39 years	10	7.35
40 - 59 years	66	48.53
60 - 79 years	58	42.65
80 - 99 years	2	1.47

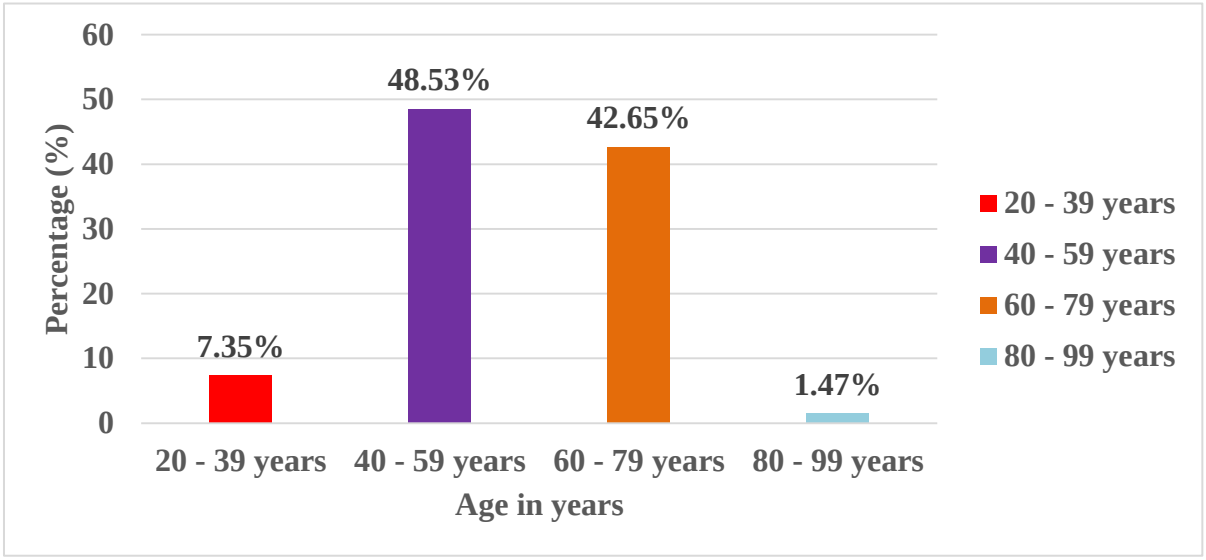

Fig. 1: Age-group distribution of study patients.

Average length of stay (ALOS):

ALOS is a mean calculated by dividing the sum of in-patient days by the number of patient admissions. The ALOS for all study subjects was found to be 8.2 days. The highest LOS was 25 days and the lowest LOS was 1 day.

ALOS based on gender classification:

The ALOS for female patients and male patients were determined (Fig. 2).

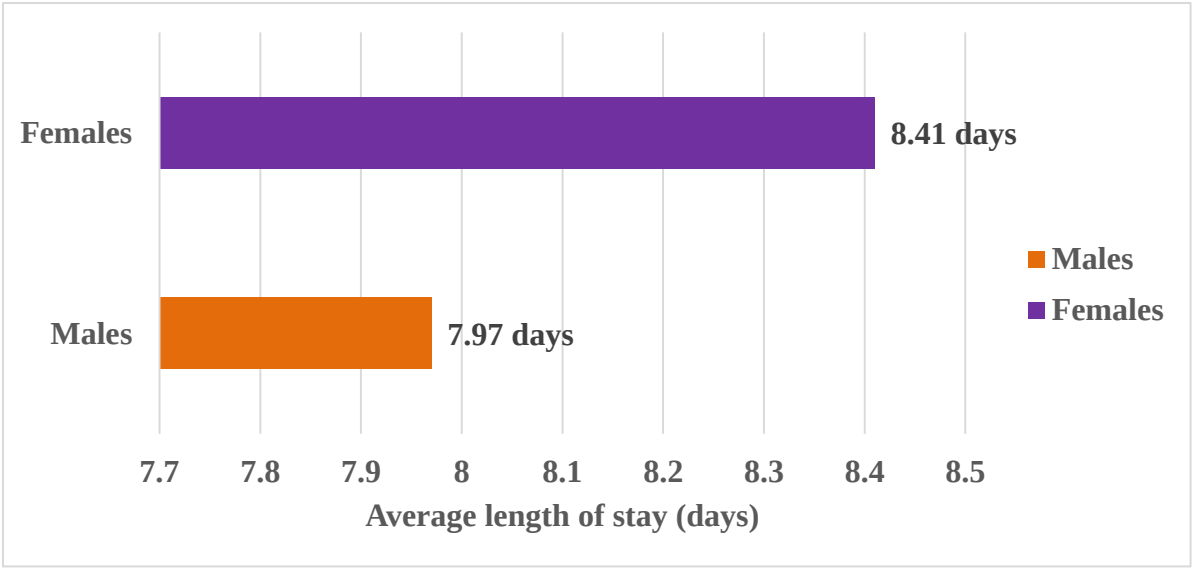

Fig. 2: ALOS based on gender classification.

ALOS based on age:

For each age-group, the ALOS was determined (TABLE II).

TABLE II: ALOS for different age-groups.

Age-group	Number (n)	ALOS (days)
20 - 39 years	10	7 days
40 - 59 years	66	7.4 days
60 - 79 years	58	8.9 days
80 - 99 years	2	19.5 days

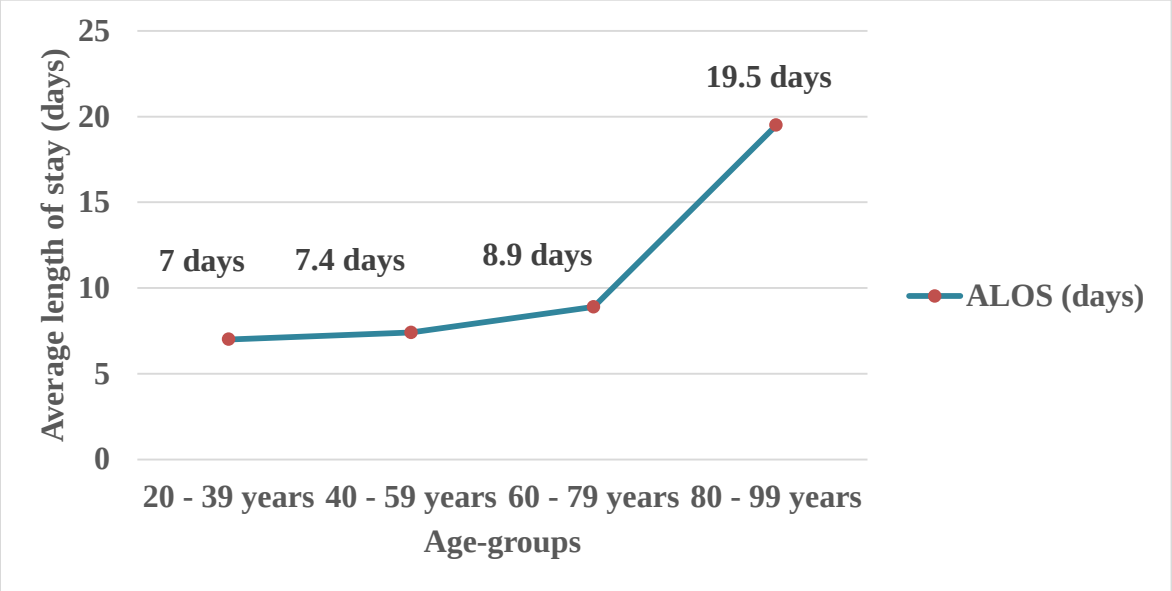

Fig. 3: ALOS for different age-groups.

ALOS based on DM type:

All patients had DM as a secondary diagnosis. Out of 136 study subjects studied, 92% (n=125) were known cases of T2DM, 5.1% (n=7) were newly diagnosed cases of T2DM and 2.9% (n=4) were known cases of T1DM. The ALOS for each group was determined (TABLE III).

TABLE III: ALOS of study subjects based on DM type

DM type	Number (n)	Percentage (%)	ALOS (days)
Known cases of T1DM	4	2.9%	13.25
Known cases of T2DM	125	92%	8.41
Newly diagnosed T2DM cases	7	5.1%	7.85

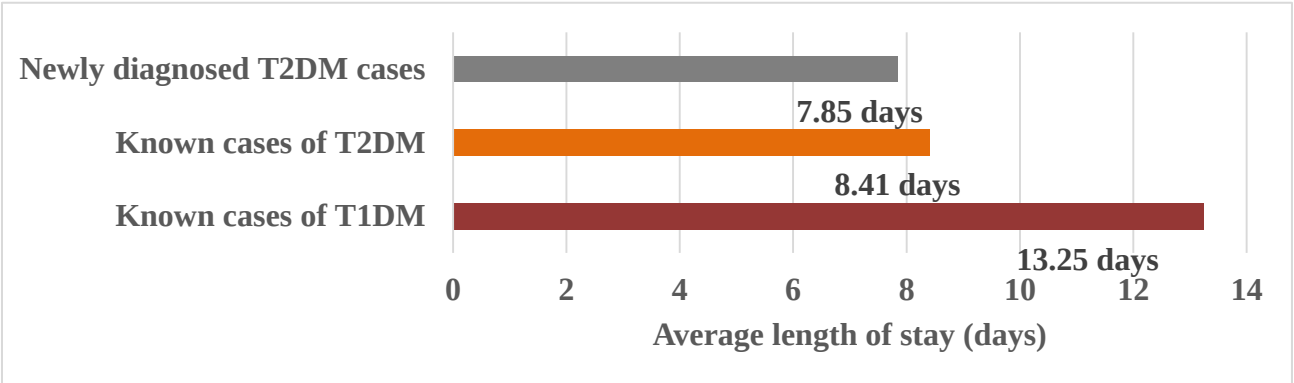

Fig. 4: ALOS of study subjects based on DM type.

ALOS among hyponatremic patients:

45% (n=61) patients had hyponatremia. A difference in ALOS was observed between eunatremic and hyponatremic patients (p=0.0213). The ALOS in hyponatremic patients was found to be higher than ALOS in patients free from hyponatremia. The ALOS in hyponatremic patients was also higher than the sample mean (8.2 days).

ALOS based on co-morbidities and/or complications:

The patients were divided based on the presence of single and multiple co-morbidities and also presence of co-morbidities and/or complications in different body systems. The underlying diseases were classified as: *anemias*, *cardiovascular diseases*, *renal diseases*, *infectious diseases*, *cerebrovascular diseases*, *thyroid dysfunction*, *hepatic diseases and respiratory diseases*. Out of 136 patients, 76 had single co-morbidity and 60 had multiple co-morbidities (TABLE IV). ALOS for each category was determined. Patients with single co-morbidity exhibited higher ALOS.

TABLE IV: ALOS of patients with single and multiple co-morbidities.

Patients with single/multiple co-morbidities	Number (n)	Percentage (%)	ALOS (days)
Patients with single co-morbidity	76	56%	8.77
Patients with multiple co-morbidities	60	44%	7.3

DM is often diagnosed along with a number of co-morbidities (DM-related or non-DM-related), which may affect the LOS. In 136 patients, the most common co-morbidities observed were renal dysfunction, liver failure, hypertension, bronchial asthma, hypothyroidism, chronic obstructive pulmonary disorder, stroke, etc. The co-morbidities were divided into 8 disease groups (TABLE V).

TABLE V: ALOS based on co-morbidities and/or complications.

Co-morbidities and/or complications	Number (n)	Percentage (%)	ALOS (days)
Anemias	59	43.4%	9.3
Cardiovascular diseases	39	28.7%	7.35
Renal diseases	35	25.7%	8.17
Infectious diseases	25	18.4%	8.32
Cerebrovascular diseases	21	15.4%	7.47
Thyroid dysfunction	16	11.8%	8.4
Hepatic diseases	15	11%	12.26
Respiratory diseases	12	8.8%	6.75

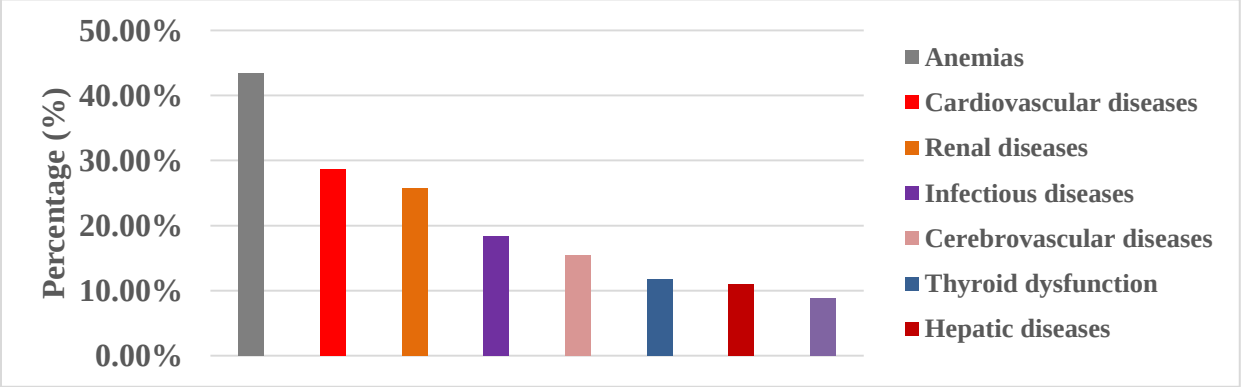

Fig. 5: Percentage distribution of patients with various co-morbidities and/or complications.

By employing multiple linear regression (TABLE VI) and logistic regression (TABLE VII) models, the co-morbidities and/or complications as predictors of LOS, were compared. While performing multiple linear regression, LOS was treated as a continuous variable.

TABLE VI: Multiple linear regression analysis performed for co-morbidities and/or complications (arranged according to ascending order of p-values).

Co-morbidities and/or complications	Co-efficient	(95% CI)		Std. Error	F-test	P-value
Cardiovascular diseases	3.548	1.216	5.88	1.178	9.0658	0.003143
Infectious diseases	2.614	0.669	4.559	0.983	7.0729	0.008834
Cerebrovascular diseases	3.083	0.765	5.401	1.172	6.9217	0.00957
Thyroid dysfunction	2.043	-0.194	4.279	1.13	3.2668	0.073062
Respiratory diseases	2.444	-0.473	5.361	1.474	2.7507	0.099682
Anemias	1.131	-0.347	2.609	0.747	2.2898	0.132714
Renal diseases	1.373	-0.81	3.556	1.083	1.6052	0.207493
Hepatic diseases	1.686	-1.4	4.771	1.559	1.1691	0.281631

As per multiple regression analysis, the p-values were significant (<0.05) for cardiovascular (p=0.00314), infectious (p=0.00883) and cerebrovascular (p=0.00957) diseases and these diseases predicted higher LOS. Hepatic (p=0.2816) and renal (p=0.20749) diseases and anemia (p=0.132714) had insignificant p-values and predicted lower LOS.

A positive correlation was found between all underlying conditions and LOS.

LOS was treated as a binary (dichotomous) variable while performing logistic regression analysis. Since the mean (ALOS for all subjects) was 8.2 days, LOS was dichotomized into two values: 1 (if LOS>8.2 days) and 0 (if LOS<8.2 days).

TABLE VII: Logistic regression analysis performed for co-morbidities and/or complications (arranged according to ascending order of p-values).

Co-morbidities and/or complications	Odds Ratio	(95% CI)		P-value
Infectious diseases	0.2331	0.0762	0.713	0.0107
Cardiovascular diseases	6.9302	1.1222	8.7969	0.0371
Cerebrovascular diseases	0.2281	0.0513	1.0153	0.0524
Anemia	1.3202	0.573	3.042	0.5143
Renal diseases	1.1299	0.3497	3.6514	0.8383
Thyroid dysfunction	1.0977	0.2784	4.3275	0.894
Hepatic diseases	4.418	1.238	5.027	0.9628
Respiratory diseases	0.8410	0.6277	1.1573	0.9673

The p-values for infectious (p=0.0107) and cardiovascular diseases (p=0.0371) were <0.05 as per logistic regression analysis and thus predicted a higher LOS. Both results indicate that infectious and cardiovascular diseases had the most profound influence on LOS. However, hepatic diseases exhibited the highest odds ratio.

ALOS based on prescribed anti-diabetic drug combinations:

The study subjects were prescribed either monotherapy or combination therapy for DM. (TABLE VIII):

- 1 insulin (e.g. regular insulin)
- 2 insulins (e.g. regular insulin + insulin detemir)
- 1 insulin + 1 oral hypoglycemic agent or OHA (e.g. regular insulin + metformin)
- 1 insulin + 2 OHAs (e.g. regular insulin + metformin + glimepiride)
- 1 insulin + 3 OHAs (e.g. regular insulin + metformin + glimepiride + voglibose)
- 2 insulins + 1 OHA (e.g. regular insulin + insulin glargine + sitagliptin)
- 1 OHA (e.g. metformin)
- 2 OHAs (e.g. metformin + sitagliptin)

TABLE VIII: Anti-diabetic drug combinations prescribed to study patients.

Anti-diabetic drug combination	Number (n)	Percentage (%)
1 insulin	69	50.7%
2 insulins	14	10.3%
1 insulin + 1 OHA	11	8.1%
1 insulin + 2 OHAs	5	3.7%
1 insulin + 3 OHAs	1	0.7%
2 insulins + 1 OHA	10	7.4%
1 OHA	15	11%
2 OHAs	8	5.9%

Based on the above data, the patients were thus broadly classified into three groups (TABLE IX) based on the anti-diabetic combinations prescribed to them and the ALOS for each patient-group was determined:

TABLE IX: Broader classification of study patients based on anti-diabetic drug combinations prescribed and the ALOS for each group.

Patient-groups	Number (n)	Percentage (%)	ALOS (days)
Patients taking only insulin(s)	86	63.2%	9.2
Patients taking at least 1 insulin + at least 1 OHA	27	19.9%	6.95
Patients taking only OHA(s)	23	16.9%	6.93

IV. DISCUSSION

LOS is one of the most common predictors of increasing or decreasing medical and non-medical costs; higher the LOS is, higher will be the costs to the patient, his or her family and to the healthcare system. Our study was performed to assess the LOS for in-patients with uncontrolled DM admitted during a specified time period. The patient-related factors as well as institutional factors were considered and weighed the influences of all determined factors on the LOS, against each other. Prior to our study, we had conducted a thorough review of scientific literature in Indian as well as global context, relevant to our study objectives. We found a dearth of credible LOS studies for DM and other common metabolic disorders conducted in India. As of 2016, India ranked among the top 3 countries with diabetic population. The growing epidemic of DM in India has been highlighted in several studies. However, the absence of well-planned nation-wide studies on DM prevalence have led to incomplete and unreliable data on the prevalence of DM in India.

Reducing LOS saves hospitalization costs as well as intangible costs. A significant section of the diabetic population in India belongs to the geriatric age group. In older patients, increasing LOS often causes a decline in mental health. Longer LOS can also put the patients at greater risk for hospital-associated conditions (HACs). Elevated blood glucose level has also been shown to be associated with increased mortality and morbidity and even prolonged hospital stay in inpatients. Reducing bed occupancy also makes more beds available for the patients in queue.

Age and gender:

ALOS was found to be higher in females (8.41 days) than in males (7.97 days). Our study also indicated an increase in LOS with increasing age. The gender-wise and age-wise prevalence of DM in our study population were found to be similar to the same in a study conducted by **Hemavathi Dasappa *et al.***, which showed a higher prevalence of DM and pre-DM in females and an increasing trend of prevalence of pre-DM and DM with increasing age. They suggested that higher prevalence of hyperglycemia in females could be explained by the fact that females were more sedentary in their habits and the prevalence obesity including central obesity was more in females.[1] The effects of DM on patients become more debilitating with increasing age. Higher age-groups, due to polypharmacy, also exhibit higher possibility of drug-interactions and adverse reactions. Older patients also have greater number of co-morbidities and/or complications All these factors may reflect the trend of increasing LOS with increasing age.

DM types:

Despite the small number of T1DM subjects, their ALOS (13.25 days) was found to be higher than the ALOS of other groups. Newly diagnosed cases of T2DM had an ALOS of 7.85 days, while known cases of T2DM had a higher ALOS of 8.41 days. The higher number of co-morbidities and polypharmacy in known T2DM cases could result in higher ALOS. In newly diagnosed T2DM cases, the co-morbidities are either lesser or undiagnosed.

Co-morbidities and/or complications:

No direct correlation was found between the number of co-morbidities (DM-related or non-DM-related) and ALOS. Patients with single co-morbidity had a higher ALOS (8.77 days) than that of patients with multiple co-morbidities (7.3 days). This could partly be supported by the following facts:

- Patients with multiple co-morbidities were previously diagnosed with all or most of the co-morbidities and were already receiving medications for the same, prior to hospital admission.
- Patients with multiple co-morbidities were more likely to discharge themselves due to the higher rate of decline of mental status, owing to prolonging hospital stay.
- Patients having higher number of co-morbidities were more likely to be sent to other specialized facilities for treatment or diagnosis of specific condition(s).

The results of our study are in conflict with the results of a study conducted by **Kazuaki Kuwabara *et al.*** in Japan, which demonstrated that the occurrence of more complications and co-morbidities caused longer LOS and higher mortality in some major disease categories.[2] However, our findings are consistent with the results of a Chinese study led by **D Chen *et al.*** in Zhongnan Hospital, which revealed that patients without complications had shorter LOS than patients with chronic or acute + chronic complications.[3] Hence, more studies in similar settings need to be conducted for better understanding of the association between number of co-morbidities and complications and LOS among DM patients. Infectious diseases (p=0.0107) and cardiovascular diseases (p=0.0371) predicted higher LOS than other co-morbidities. Logistic regression analysis also revealed significantly high odds ratio for hepatic diseases, indicating that hepatic diseases could increase the number of bed-days and increase risk for readmissions by several folds. Infectious diseases take longer to treat, owing to prolonged courses for antibiotic therapy, body fluid tests for presence of pathogens and culture sensitivity studies. Ideally, eradication of infection is ensured prior to discharge. Cardiovascular diseases have strong association with DM, both aggravating each other. Thus, special attention must be paid to patients with infections and heart and liver diseases. Anemia has a strong correlation with kidney function in diabetic patients. It is common in DM and increases morbidity and mortality. It also potentially contributes to the pathogenesis of diabetic complications. In our study, anemic patients had a higher ALOS (9.3 days) than non-anemic patients, who had an ALOS of 7.4 days. DM and thyroid dysfunction, the two endocrine disorders have found to influence each other. Though the effects are poorly understood, a study by **NZ Khan *et al.*** revealed especially high association between hypothyroidism and T2DM. In their study, the percentage of thyroid disorders in T2DM patients was 23.5%, the most frequent types in them being subclinical hypothyroidism (10.4%) and overt hypothyroidism (6.1%).[4] In our study, ALOS of hypothyroid patients (8.4 days) was found to be higher than ALOS of non-hypothyroid patients (8.2 days).

Hyponatremia:

Hyponatremic patients exhibited a significantly higher ALOS (8.5 days) than patients without hyponatremia (7.6 days). Our finding emphasizes on the need to monitor serum sodium levels closely while treating DM. Glucose is an osmotically active substance. Hyperglycemia increases serum osmolality, resulting in movement of water out of the cells and subsequently in a reduction of serum sodium levels by dilution. Uncontrolled DM can also induce hypovolemic-hyponatremia due to osmotic diuresis. Moreover, in diabetic ketoacidosis, ketone bodies obligate urinary electrolyte losses and aggravate the renal sodium wasting.[5]

Anti-diabetic drug combinations:

We have observed that by adding an oral hypoglycemic agent (OHA) to the prescription, a shorter LOS could be achieved. Patients receiving only insulin had a higher ALOS of 9.2 days, while patients receiving combinations of insulin and OHA had a shorter ALOS of 6.93 days. Insulin is prescribed in severe hyperglycemic cases to achieve a tight glycemic control. However, coupling insulin with oral hypoglycemic agents can improve outcome.

V. CONCLUSION

Our study was aimed at identifying and examining the factors influencing the length of stay (LOS) in DM in-patients. Clinical pharmacists are not only in charge of optimizing drug therapy for the patients, but they are responsible for improving health outcomes by studying non-therapeutic aspects of hospital care as well and suggesting or implementing appropriate changes in order to reduce the costs related to therapy and to improve mental and physical status of patients. LOS has a direction correlation with physical, mental and socio-economic burden on the patients and their families and also the costs to patients, their families and the healthcare system covering their medical expenses. Female patients had a higher average length of stay (ALOS) as compared to male patients. The disease in female patients was complicated by lack of adequate education related to lifestyle changes required to prevent DM and early diagnosis of DM. ALOS also increased with increasing age among our study subjects. With increasing age, the number of co-morbidities and medications increased resulting in complication of the diabetic condition. Patients with single co-morbidity exhibited a higher ALOS than patients with multiple co-morbidities. More studies are required to examine the influence of the number of co-morbidities to substantiate a meaningful conclusion. Infectious diseases and cardiovascular diseases predicted higher LOS than other co-morbidities. Logistic regression analysis also revealed significantly high odds ratio for hepatic diseases. The ALOS in hyponatremic patients was higher than the sample mean. The ALOS was higher for T1DM patients than T2DM patients in our sample. However, only 4 T1DM patients were present in our study population. Hence, studies need to be conducted with more T1DM patients to come across a credible judgment. Newly diagnosed T2DM cases had a shorter ALOS than known cases of T2DM patients. This could be attributed to a larger number of co-morbidities and polypharmacy in known cases. Patients receiving oral hypoglycemic agents alone or along with insulin had shorter ALOS than patients receiving only insulin. We thus recommend initiating DM therapy with oral hypoglycemic agents in addition to insulin, for shorter LOS.

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