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Socio-Demographic Characteristics and Drug Related Problems of Patients Presenting to the Emergency Department: General Linear Model and Factorial Analysis

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Abstract

Objectives: The paper discusses exploratory factor analysis and general linear model which gives an overview of the relationship between the drug related problems occurring during the course of study with socio-demographic profile of the patients admitted in emergency department.

Study design: Prospective observational study.

Methods: The study was conducted in the emergency department of two different hospitals located in Punjab for a period of 6 months. A total of 260 patients were included for analysis as per inclusion and exclusion criteria.

Results: it was revealed that 61.9% (161) patients were found male whereas 38.1% (99) patients were female. The value of kolmogorov-smirnov (ks) (p=0.12), shappiro-wilk (sw) (p=0.065) which confirms that normal distribution. the value of r^2 for the dependent variable that is age, weight and height was found to be r^2= 0.150^a, 0.559^b, 0.015^c respectively in linear regression model. The results shows that there was significant effect of independent variable such as number of drug per prescription and drugs from essential drug list with dependent variable such as disease state e.g. type of the disease in emergency department and emergency type as well as errors related to drug related problems (p<0.001). The values of both box's plot and levene's test can be assumed as equal multivariance because it was found to be significant as p=0.05.

Conclusion: Drugs prescribed is dependent upon disease condition but if there are comorbidities then the drug per prescription may vary. We can conclude that comorbidities even lead to polypharmacy and thereby also increasing chances of DRPs. Multiple factor is found directly correlated with the socio-demographic factor of the patients in an emergency department. During the study it was found that the burden of multimorbidity is the strongest clinical predictor of ED attendance. Another factor that contributes more is patient drug compliance, drug choice problem, drug interactions and other drug related problems.

Keywords: Drug related problems; General linear model; Factorial analysis

Introduction

Drug utilization study, as described by the WHO, is a structured process which is used to assess the quality of drug therapy by engaging in the evaluation of data on drug prescribing, dispensing and patient use in a given health care environment, against predetermined, agreed upon criteria and standards, with special emphasis on the resulting medical, communal, and financial consequences [1].

Proper drug evaluation study has a great emphasis to global minimization in morbidity and mortality with its associated medical, communal and financial benefits [2].

It is more prevalent in developing countries where health allowance is less and 30-40% of the total health allowance is spent on medicines [3,4]. World Health Organization (WHO) has formulated a set of core drug use indicators, which measure the performance of prescribers, patients experience at health facilities and whether the health personnel can function effectively. The assessment of drug use indicators according to WHO guidelines on how to investigate drug use in health facilities are prescribing indicators, patient care indicators, facility indicators and complementary indicators [3].

Emergency medicine is the specialty that cares for the care seeker, at the most vulnerable moments of their life. It faces the challenge of evaluating the early phases of the biological behaviour in diseases. Urgency, unpredictability and the need to acquire skills of the entire spectrum of age, gender and the pathology are the hallmark of the specialty [5]. Patients come to the emergency department (ED) for evaluation of emergent or urgent conditions for after- h medical care, or by referral from their primary physician. In the ED, physicians face crucial and sever cases that need to be treated quickly with high quality [6].

Aim and Objectives

This paper aims to provide the socio- demographic characteristics of patients presenting the emergency department of North India (Punjab). The aim of this study is to evaluate the relationship and

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conduct factorial analysis of drug related problem in emergency department with respect to socio-demographic profile of the patients. The another objective is to evaluate the WHO indicators i.e. average number of drugs prescribed per prescriptions, number of injections prescribed, number of antibiotics prescribed and number of drugs encountered from EDL (essential drug list).

Methods

This prospective observational study was conducted in the emergency department of three different multispecialty hospitals in Punjab for period of 6 months after getting approval from Institutional Ethical Committee. Each individual signed a consent form that outlined the aims and methodology of the study. The confidence interval of the study was selected as 95% with cut off interval *(*p=0.05*)* as significant level [7]. A sample size was calculated through software called Epiinfo (Stat Cal) [8]. The total number of patients enrolled in the study was 320 as per sample size. A total of 260 patients were included for analysis as per inclusion and exclusion criteria. Inclusion criteria: All patients irrespective of age, diagnosis admitted in emergency department were included in the study. Exclusion criteria: Patients who were critical in clinician's opinion were excluded from the study. The patients enrolled for the evaluation was grouped based on their age group and category of disease. The study was analysed by SPSS version 16. Descriptive and analytical analysis was used to describe the results. A descriptive study was conducted to describe basic features of data in the study and to provide simple summaries about the sample and the measures [9]. Descriptive analysis includes mean, standard deviation (for normally distributed data) whereas median and interquartile range (for not normally distributed data). An analytical study was conducted to find out the effect of independent variable on the dependent variable [10]. A general linear model and factorial analysis was conducted to find out the relationship and correlation as well as to predict the methods for further analysis on large number of populations [11-14].

Results

Descriptive analysis was performed to describe gender, age, locality, religion, BMI, etc. of the patients. During the study among 260 patients admitted in the emergency room, it was revealed that 61.9% (161) patients were found male whereas 38.1% (99) patients were female. In another Indian study performed by [15] Andreazza et al., male gender was more as compared to female gender which supports our study. During the study among 260 patients, the majority of patients were of age group 21-30 years that is 40.4% (105) patients and only 0.8% (2) patients were falling under 51-60 years. During the study, mean age of the patients was found to be [M=52.57, SD=16.006] years. The minimum age was found to be 16 years and maximum age was found to be 93 years. Test for normality was conducted to check the normality distribution of age of the patient [16]. It was found that as per Kolmogorov-Smirnov[a] (KS) and Shapiro-Wilk[b] (SW) was p=0.092[a], p=0.020[b] respectively. Age was found to be normally distributed because the p-value was found above the cut-off point with Skewness 0.281, Kurtosis -0.129 and standard error 0.993 [17,18]. Age of the patient is normally distributed as shown by histogram and Q-Q plot [19]. A good bell-shaped curved and straight line is observed and data points are closer to the diagonal line in Q-Q plot as shown in Figures 1 and 2. Hence mean (SD) were used to describe the measurement of central tendency [18].

Among 260 patients admitted in emergency department, majority of patients were having weight between 51-60 kgs. That is 68.1% (177) patients while 13.5% (35) patients were falling under weight category

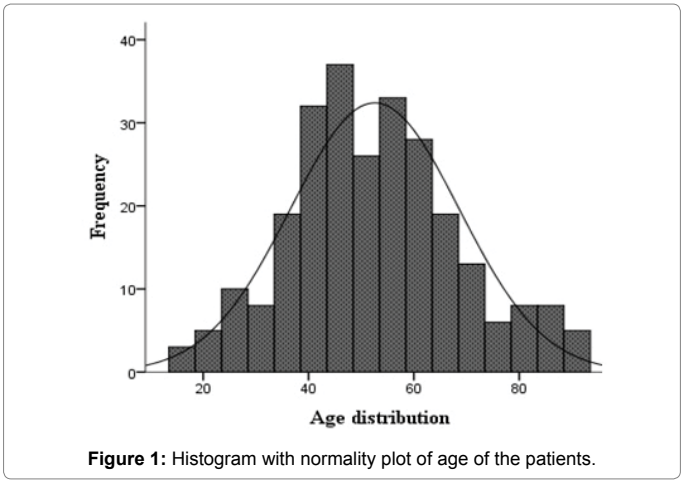

Figure 1: Histogram with normality plot of age of the patients.

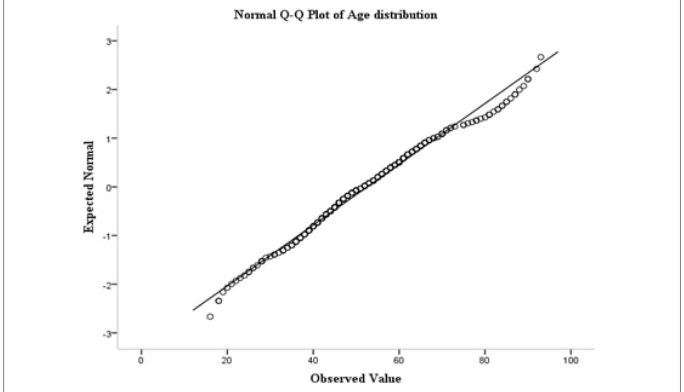

Figure 2: Normal Q-Q plot of age distribution of the patients.

61-70 kgs. During the study it was found that mean weight was found to be [M=68.76, SD=9.771]. Minimum weight was found to be 95 kg and minimum was 40 kg.

Test for normality was conducted to check the normality distribution of weight of the patient, it was found that value of Kolmogorov-Smirnov (KS) (p=0.12), Shappiro-Wilk (SW) (p=0.065) respectively [16]. Weight is found to be normally distributed because the p value was found above the cut-off point [16]. But the value of Skewness, Kurtosis and standard error was found to be 0.332, 0.019 and 0.606 respectively. The analysis showed that the weight observed in the study (68.76 kgs) is significantly higher *(*p<0.001*)* compared to the mean weight from [20] Brady et al., (259) = [6.201], p=0.001. It was found that mean difference is 3.758 when compared with the mean weight of the study conducted by Brady et al., [21]. During the study among 260 patients, 43.8% (114) patients were under BMI category 18.5-24.9 that were healthy patients. And 19.2% (50) patients were >30 that is they were obese. During the study, it was found that among 260 patients 40.8% (106) patients were falling under the moderate category of physical activity whereas 24.2% (63) patients were found to be high in physical activity. Among 260 patients admitted in the emergency department, 54.6% (142) patients were found to be non-vegetarian while remaining 45.5% (118) patients were vegetarian. During the study among 260 patients in the emergency department, it was found that 18.1% (47) patients were having metabolic disorder whereas only 4.6% (12) patients were having an infection. Other disease which was found during the study period was cardiovascular disease, metabolic

disorder, CNS disorder, traumatic, renal disorder, poisoning, blood disorder and GIT disorders. During the study a test was conducted to compare number of injections prescribed in emergency department and nature of emergency. The means of number of injections prescribed for different types of emergency were: medical emergency 3.93 (2.52), trauma 1.00 (0.05), accidental 5.53 (1.625). The difference of significance was (F (df=2.257=7.080, p= 0.001). Among total 260 prescriptions analysed, the total number of drug of prescribed were 1449. Out of total number of drugs i.e. 1,449 prescribed, 71.35% (1,034) of the drugs were administered through injectable form. Injectable were followed by oral administration contributing 28.64% (415) of total drugs encountered. Out of total 1,449 drugs prescribed, 18.70% (271) of the drugs were antibiotics while 45.34% (657) drugs were from essential drug list (EDL). (Table 1) A total of 63.5% (N=165) of patients were on polypharmacy. The distribution of the drugs among patients included in this study was: 20.4% (53) patients received 8 drugs, 7.3% (19) patients received 9 drugs, 4.2% (11) patients received 10 drugs, 1.2% (3) patients received 11 drugs, 0.8% (2) patients received 12 drugs, 0.4% (1) patients received 13 drugs and 5.0% (13) patients were there who received 14 drugs. There was no such patient who does not receive any drug (Table 1). In this study, antibiotics (N=164), diuretics (N=114), PPIs (N=104) and analgesics (N=102) were the more often encountered drugs among 260 total prescription evaluated in Table 1.

S. No.	Type of disease	Frequency
1	Metabolic disorder	47
2	Cardiovascular disorder	44
3	CNS* disorder	38
4	GIT# disorder	31
WHO indicators used in the study		
1	Number of drugs encountered during the study	1449
2	Number of antibiotics prescribed	271
3	Number of injections prescribed	1,034
4	Number of drugs from EDL (Essential Drug List)	657
Types of therapy given during the study		
1	Monotherapy	17
2	Dual therapy	28
3	Triple therapy	50
4	Polytherapy	165
Most commonly prescribed drugs		
1	Antibiotics	164
2	Diuretics	114
3	Proton pump inhibitors	104
4	Analgesics	102
* CNS: Central Nervous System Disorder, # GIT: Gastro Intestinal Tract Disorder.		

Table 1: Disease type, WHO indicators, Therapy type and commonly prescribed drugs.

A linear regression was performed to predict dependent variable (body mass index) based on the independent variable (age, weight, height). A significant regression equation was found F (3, 256) =7326.099, p=0.001 with an R^2 of 0.988. All independent variables that is age, weight and height were significant predictors of the dependent variable that is body mass index (BMI). ANOVA test indicates that the model is good because the sum of squares for regression (4081.087) is more than residuals (F (3,256)=7326.099, p<0.001). Coefficients shows that BMI= 52.244–(-0.004) for age, 52.244–0.393 for weight and 52.244–(-0.326) for the height of the patient. A negative coefficient indicates that the association is negative [18]. While positive coefficient shows that the association is positive that is if weight increases BMI of the patient also increases [18]. The value of R^2 for the dependent variable that is age, weight and height was found to be R^2= 0.150[a], 0.559[b], 0.015[c] respectively. Case wise diagnostics shows that following case number 21, 40,143,146,152 were found outliers because the standard deviation was > +3 or -3.

General linear model

General linear model (GLM) was performed to test null hypothesis about the effects of factor variables on means of various groupings of a joint distribution of dependent variables [18]. The tests of between subject's effects estimates provide detailed effect of each independent variable to different outcomes [18]. Here it was found that there was significant effect of independent variable such as number of drug per prescription and drugs from essential drug list with dependent variable such as disease state e.g. type of the disease in emergency department and emergency type as well as errors related to drug related problems (p<0.001). Detailed representation is given in Table 2.

Both Box's test and Levene's test homogeneity of variance [18]. Here the values of both box's plot and levene's test can be assumed as equal multivariance because it was found to be significant as p=0.05 as shown in Table 3.

Factorial analysis

Before performing the factorial analysis it was found that, there was a univariate and multivariate normality within the data [19,20].

Source	Dependent variable	Type III sum of squares	*df*	Mean square	F	Sig.
Corrected model	No. of drug per prescription	1139.395[a]	11	103.581	13.583	0.001
	Drugs from essential drug list	155.657[b]	11	14.151	7.883	0.001
Intercept	No. of drug per prescription	157.989	1	157.989	20.718	0.001
	Drugs from essential drug list	29.184	1	29.184	16.259	0.001
Disease	No. of drug per prescription	991.875	9	110.208	14.452	0.001
	Drugs from essential drug list	108.866	9	12.096	6.739	0.001
Emergency type	No. of drug per prescription	169.182	2	84.591	11.093	0.001
	Drugs from essential drug list	38.363	2	19.182	10.686	0.001
Error	No. of drug per prescription	1891.205	248	7.626		
	Drugs from essential drug list	445.155	248	1.795		
Total	No. of drug per prescription	11478	260			
	Drugs from essential drug list	2261	260			
Corrected Total	No. of drug per prescription	3030.6	259			
	Drugs from essential drug list	600.812	259			

Table 2: Tests of between-subjects effects.

The major purpose of factor analysis is to summarize the data so that relationships and patterns can be easily interpreted and understood [22]. It was performed to shrink a mass of data to smaller set of data that is more manageable and understandable. The correlation matrix shows an abridged version of R-matrix. Top half of table contains the Pearson's correlation coefficient between all pairs of question whereas the bottom half contain one-tailed significance of these coefficient. Here the value of significance was scanned. Table 4 shows both the correlation and significance.

Kaiser-Meyer-Olkin close to 1 indicates that pattern of correlation and relatively compact and so factor analysis should yield distant and reliable fact. Here value of KMO is 0.6 indicates mediocre value. Bartlett's test of sphericity measure test the null hypothesis that original correlation matrix is an identify matrix and here it is significant because p=0.001.

The table of communalities before and after extraction the principle component works on the initial assumption that all variance is common, therefore before the extraction the communalities are all 1. Communalities in column labelled extraction reflect the common variance in data structure. Here, Table 5 shows that 59.7% of variance associated with parameter 1 is common followed by 78.4% of variance associated with parameter 2 is common.

The scree plot indicates point of inflexion on the curve. Curve begins to tail off after 1 factor but there is just another drop after 2 factor before a stable plateau is reached. The representation of scree plot is given in Figure 3.

Factor analysis

Here, in correlation matrix table top half of table contains the Pearson's correlation coefficient between all pairs of question whereas the bottom half contain one-tailed significance of these coefficient. Here the value of significance was scanned. Table 6 shows both the correlation and significance [23].

The Kaiser-Meyer Olkin (KMO) and Bartlett's Test measure of sampling adequacy was used to examine the appropriateness of Factor Analysis]. Kaiser-Meyer-Olkin close to 1 indicates that pattern of correlation and relatively compact and so factor analysis should yield distant and reliable fact [24]. Here value of KMO is 0.5. Table 7 indicates acceptable value. Bartlett's test of sphericity measure test the null hypothesis that original correlation matrix is an identify matrix and here it is significant because p=0.001.

The table of communalities before and after extraction the principle component works on the initial assumption that all variance is common, therefore before the extraction the communalities are all 1. Communalities in column labelled extraction reflect the common variance in data structure. Here, Table 8 shows that 60.8% of variance associated with parameter 1 is common followed by 67.9% of variance associated with parameter 2 is common.

Correlation matrix: Here in Figure 4 and Table 9, the scree plot indicates point of inflexion on the curve. Curve begins to tail off after 1 factor but there is just another drop after 2 factor before a stable plateau is reached.

Box's M	169.32			
F	7.76			
df1	21			
df2	42559.3			
Sig.	0.02			
Variable	**F**	***df1***	***df2***	**Sig.**
No. of drug per prescription	10.661	11	248	0.05
Drugs from essential drug list	16.827	11	248	0.05

Table 3: Box's test of equality of covariance matrices and levene's test of equality of error variances.

Kaiser-Meyer-Olkin measure of sampling adequacy		**0.631**
Bartlett's test of sphericity	**Approx. Chi-square**	257.45
	df	21
	Sig.	0.001

Table 4: KMO and Bartlett's test.

Parameters	**Initial**	**Extraction**
Weight category	1	0.597
Body mass index	1	0.784
Gender of the patient	1	0.7
Physical activity of the patient	1	0.705
Eating habit of the patient	1	0.635
Type of disease	1	0.439
Nature of emergency	1	0.571

Table 5: Communalities.

Discussion

The analysis showed that the age in this study (52.27 years) is significantly higher than (p<0.001) compared to the mean age [20] Sharma et al., (47.30 years). The mean difference of age is found to be 5.273 when compared with the study conducted by (Sharma et al.,). Among total 260 prescriptions analysed, the total number of drug of prescribed were 1449. Out of total number of drugs prescribed i.e. 1,449, 71.35% (1,034) of the drugs were administered through injectable form. Injectable were followed by oral administration contributing 28.64% (415) of total drugs encountered. During the study among 260 patients in the emergency department, it was found that 18.1% (47) patients were having metabolic disorder whereas only 4.6% (12) patients were having an infection. Other disease which was found during the study period was cardiovascular disease, metabolic disorder, CNS disorder, traumatic, renal disorder, poisoning, blood disorder and GIT disorders. During the study a test was conducted to compare number of injections prescribed in emergency department and nature of emergency.

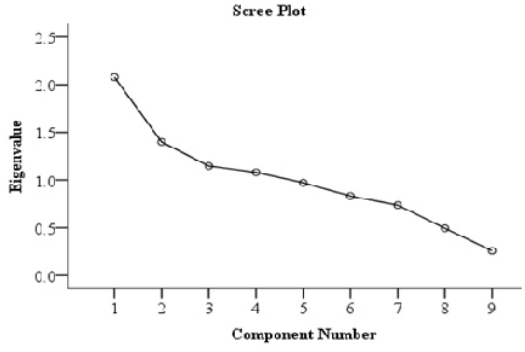

Figure 3: Scree plot shows that curve begins to tail off after 1 factor but there is just another drop after 2 factor before a stable plateau.

Parameters		Weight category	Body mass index	Physical activity of the patient	Eating habit of the patient	Type of disease	Nature of emergency
Correlation	Weight category	1	0.541	0.389	0.18	-0.044	-0.041
	Body mass index	0.541	1	0.628	0.122	-0.08	-0.074
	Physical activity of the patient	0.389	0.628	1	0.007	-0.142	0.018
	Eating habit of the patient	0.18	0.122	0.007	1	0.041	-0.111
	Type of disease	-0.044	-0.08	-0.142	0.041	1	-0.054
	Nature of emergency	-0.041	-0.074	0.018	-0.111	-0.054	1
Sig. (1-tailed)	Weight category	-	0	0.001	0.002	0.241	0.255
	Body mass index	0.001	-	0.001	0.024	0.1	0.117
	Physical activity of the patient	0.001	0.001	-	0.454	0.011	0.387
	Eating habit of the patient	0.002	0.024	0.454	-	0.256	0.037
	Type of disease	0.241	0.1	0.011	0.256	-	0.193
	Nature of emergency	0.255	0.117	0.387	0.037	0.193	-

Table 6: Correlation Matrix of socio-demographic factor of the patients in emergency department.

Kaiser-Meyer-Olkin measure of sampling adequacy		0.5
Bartlett's test of sphericity	Approx. Chi-square	156.553
	df	36
	Sig.	0.001

Table 7: KMO and Bartlett's Test.

Parameters	Initial	Extraction
Type of disease	1	0.608
Nature of emergency	1	0.582
Type of therapy	1	0.679
Drug interaction	1	0.458
Drug choice problem	1	0.39
Dosing problem	1	0.836
Other DRP	1	0.734
Patient drug compliance	1	0.59
Morisky scale reading	1	0.83

Table 8: Communalities.

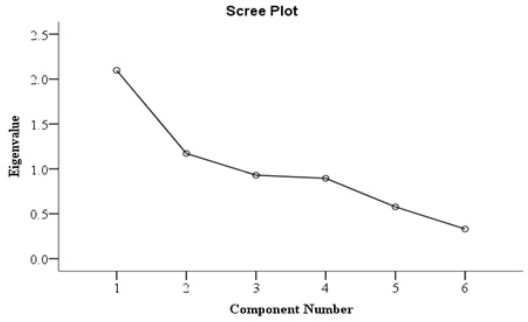

Figure 4: Scree plot indicates point of inflexion on the curve.

Out of total 1,449 drugs prescribed, 18.70% of the drugs were found antibiotics and only 45.34% drugs were from essential drug list (EDL). A total of 63.5% of patients were on polypharmacy. The distribution of the drugs among patients included in this study was: 20.4% patients received drugs. There was no such patient who does not receive any drug. In this study, antibiotics, diuretics, PPIs and analgesics were the more often encountered drugs among total prescription evaluated.

The analysis showed that the weight observed in the study 68.76 kgs is significantly higher compared to the mean weight from [21] Brady et al., It was found that mean difference is 3.758 when compared with the mean weight of the study conducted by Brady et al., [21].

The results of linear regression show that all independent variables that is age, weight and height were significant predictors of the dependent variable that is body mass index (BMI). The value of R^2 for the dependent variable that is age, weight and height was found to be R^2=0.150[a], 0.559[b], 0.015[c] respectively. The results of GLM was found that there was significant effect of independent variable to different outcomes as the ($p<0.001$). In factor analysis the scree plot indicates point of inflexion on the curve. Curve begins to tail off after 1 factor but there is just another drop after 2 factor before a stable plateau is reached. In correlation matrix table top half of table contains the Pearson's correlation coefficient between all pairs of question whereas the bottom half contain one-tailed significance of these coefficient. The value of KMO is 0.5 which indicates acceptable value. Bartlett's test of sphericity measure test the null hypothesis that original correlation matrix is an identify matrix and here it is significant because p=0.001. The communalities data shows that 60.8% of variance associated with parameter 1 is common followed by 67.9% of variance associated with parameter 2 are common. In correlation matrix and scree plot indicates point of inflexion on the curve. Curve begins to tail off after 1 factor but there is just another drop after 2 factor before a stable plateau is reached.

Conclusion

From this study, we concluded that general linear model shows strong correlation between types of disease and type of emergency with number of drugs prescribed per prescription and number of drugs prescribed from essential drug list that is drugs prescribed is dependent upon disease condition that is if there are comorbidities then the drug per prescription may vary. More the severity of the disease, more drugs will be prescribed to the patient for early recovery. Even we can conclude that comorbidities even lead to polypharmacy and thereby also increasing chances of DRPs (drug related problems). The facilities available in the hospitals which are given by healthcare providers were the factors that had the greatest impact on overall satisfaction of the patient's in emergency department. Multiple factor is found directly correlated with the socio-demographic factor of the patients in an emergency department. During the study it was found that the burden of multimorbidity is the strongest clinical predictor of ED attendance. Another factor that contributes more is patient drug compliance, drug choice problem, drug interactions and other drug related problems. The GLM explains about the relationship of number of drug per prescription and number of drugs from essential drug list is directly correlating with the type of disease and type of emergency which were found highly significant. The data of this study can be useful for

Test		Type of disease	Nature of emergency	Type of therapy	Drug interaction	Drug choice problem	Dosing problem	Other DRP	Patient drug compliance	Morisky scale reading
Correlation	Type of disease	1	-0.054	0.246	0.077	0.141	-0.083	-0.08	0.039	-0.059
	Nature of emergency	-0.054	1	0.005	-0.126	-0.13	0.039	-0.09	0.059	-0.045
	Type of therapy	0.246	0.005	1	-0.014	0.043	0	0.021	-0.095	-0.055
	Drug interaction	0.077	-0.126	-0.014	1	0.051	-0.03	-0.09	0.037	-0.066
	Drug choice problem	0.141	-0.13	0.043	0.051	1	-0.11	-0.06	-0.103	-0.219
	Dosing problem	-0.083	0.039	0	-0.03	-0.11	1	-0.19	-0.115	0.219
	Other DRP	-0.082	-0.087	0.021	-0.09	-0.061	-0.189	1	0.426	0.599
	Patient drug compliance	0.039	0.059	-0.095	0.037	-0.103	-0.115	0.426	1	0.478
	Morisky scale reading	-0.059	-0.045	-0.055	-0.066	-0.219	0.219	0.599	0.478	1
Sig. (1-tailed)	Type of disease	-	0.193	0	0.195	0.012	0.09	0.093	0.266	0.173
	Nature of emergency	0.193	-	0.471	0.081	0.018	0.265	0.08	0.17	0.234
	Type of therapy	0	0.471	-	0.44	0.245	0.499	0.366	0.064	0.188
	Drug interaction	0.195	0.081	0.44	-	0.284	0.37	0.158	0.342	0.233
	Drug choice problem	0.012	0.018	0.245	0.284	-	0.038	0.164	0.048	0
	Dosing problem	0.09	0.265	0.499	0.37	0.038	-	0.001	0.032	0
	Other DRP	0.093	0.08	0.366	0.158	0.164	0.001	-	0	0
	Patient drug compliance	0.266	0.17	0.064	0.342	0.048	0.032	0	-	0
	Morisky scale reading	0.173	0.234	0.188	0.233	0	0	0	0	-

Table 9: Correlation Matrix.

preparing National Health Policies towards emergency care as well as for clinical guideline development. This study is planned to benefit the policy makers and healthcare providers of India to promote and define the area of ED and to assign resources more efficiently to address country's acute care needs.

Limitations of our Study

A limitation of this study is that we sampled only three hospitals emergency departments with largely Punjabi populations, thus limiting the generalizability of these findings. Relatively less number of patients was studied and they were not followed after their discharge from the ward. A second limitation is that this study may underestimate the prevalence of diabetes in ED patients as some patients may have forgotten about this diagnosis while many others may yet be undiagnosed. The study can be expanded in future including other departments to evaluate drug utilization in vulnerable groups like children and pregnant women.

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