6. DISCUSSION

This study was planned to evaluate the quality of prescribing for chronic conditions in the outpatient setting of primary, secondary and tertiary level health care facilities in the western part of India with the help of PQI tool. This tool has been developed by Hassan et al. in 2010. The PQI tool is a comprehensive tool covering multidimensional criteria of prescribing process. It has been validated and claimed to be reliable by the developers. (8). As there is no study reporting use of this tool, this prospective, cross sectional study was planned to assess prescribing quality at primary, secondary and tertiary health care facilities using PQI tool and its reliability in Indian setting.

The study was carried out at seven different health care facilities near Anand town in Gujarat state of India, which included four Primary Health Centers (PHC), two Secondary Health Center (SHC) facilities including one Community Health Center and one District Civil Hospital and one Tertiary Health Center (THC) - a teaching hospital. Primary Health care facilities include primary health centers of villages Changa, Dabhov, Karamsad and Bandhani. The secondary health care facilities selected were Community health center at Mehlav and Civil hospital at Petlad. Shree Krishna Hospital affiliated to Pramukhswami Medical College at Karamsad was selected as Tertiary care health facility of Anand District in Gujarat state.

India has a nation-wide network of health services based on the primary health care approach. Services are organised in a bottom up fashion, with a strong rural focus to attend to the needs of the underserved majority. The primary tier has three types of health care institutions namely, a Sub-Centre (SC) for a population of 3000 to 5000, a Primary Health Centre (PHC) for 20,000 to 30,000 population and a Community Health Centre (CHC) for every 1,00,000 population. The district hospitals function as the secondary tier of care for the rural population. Tertiary health care is provided by highly specialised hospitals and health care institutions that are well equipped with sophisticated diagnostic and investigative facilities. The number of government health facilities at each level in Gujarat state is shown in Fig.18. (144)
Anand district of Gujarat state has 1 District Hospital, 11 Community Health Centres and 46 Primary Health Centres (Health services NHRM Gujarat). Considering this structure of health care services four PHCs, one CHC and one District hospital were selected for study. One tertiary care hospital also was selected to have comparative profile of prescribing quality in the district. Although Shree Krishna Hospital is not a state run facility it was selected due to absence of government tertiary hospital in the district considering that being a teaching hospital, the quality of prescribing would be superior to the lower level facilities. At different health care levels patients’ demographical characteristics (age, gender) were comparable. (P >0.05)

The Prescription Quality Index (PQI) tool contains 22 criteria in questionnaire form. The PQI was developed with a strong structural foundation and claims to capture clinical, clerical and legal requirements of a prescription. The PQI is also claimed to capture the multidimensional criteria of prescription quality. The PQI incorporates the concept of rational drug therapy, evidence based approach and other criteria required for prescription quality. Furthermore, PQI was able to discriminate between the proportion of good prescriptions and prescriptions with problem. The developers of
this tool believe that the use of this tool will enable the quality of prescription to be measured, analyzed and monitored. Therefore, the benefits of interventions can be examined for further improvement in patient care (8).

As it is obvious, prescribing problems are likely to be more in chronic illnesses. In the same way, higher incidence of inappropriate prescribing is expected in geriatric patients due to multiple morbidities and polypharmacy. Researchers and quality improvement programs have often established a set number of medications beyond which prescribing is considered to be “polypharmacy” and to merit extra attention for potential quality problems (145). A study of prescription database, which stated that as age increases, there is higher risk of complications and more drugs required for treatment (146). Several studies have demonstrated that the frequency of unnecessary or non-recommended medication use is higher in patients taking many medications than in those taking few medications (147-149).

The study focuses on two chronic illnesses namely hypertension and bronchial asthma. As the reliability of PQI in Indian setting is not confirmed, therefore two diseases were selected to begin with. Other chronic diseases or conditions could also be evaluated with help of PQI tool. It was observed in pilot study that elderly patients form a sizable proportion of attendees seeking care at various facilities. Hence it was planned to evaluate the quality of prescribing in elderly patients specifically at THC where adequate number of elderly patients would be available in stipulated time period.

The mean age of all patients was 57.7±14.7 years. Approximately 36% of patients were above age 65 years. Eighty percent of total patient populations were above 45 years age. However, chronic diseases/conditions were generally common with aging. The presence of hypertension is strongly associated with aging (150).

Male preponderance was observed at every health care facility except at civil hospital (SHC1). This finding is expected due to neglect of health related problems by women, although they seek medical treatment during acute conditions or medical emergency. Furthermore, it would be due to male dominance in India and the male female ratio disparity. Therefore male patients seem to attend to health care facilities more often than female counterparts. This finding is in accordance with a Tamil Nadu study
which showed male attendance higher as compared to female (151). The reasons for reverse gender ratio of patients at SHC1 are not clear. However these findings are in accordance with a study from Nepal which reported that female patients made more visits than males (121) and a Brazilian study reporting 70.4% female patients (152).

Total 356 prescriptions were collected- 66 from four PHCs, 68 from two SHCs and 222 from THC during the study period. The selected sample size is calculated assuming a difference of mean scores of 1.34 and the sample size for 80% power is 356 patients (Alpha = 0.05 SD = 5.06 Based on pilot study)

At PHC 3 only 8 prescriptions of defined diseases were collected during stipulated defined study period. It could be due to less patient turnover at particular center during study time period. Other primary health care facilities had average 16 patients per stipulated study duration. At PHCs only about 8% of patients were found with 3 diseases/conditions per prescription. This is due to practice of referring the patients with complicated disease conditions to higher health care level. Approximately 23% of patients were prescribed ≥ 3 drugs. Complex prescribing with polypharmacy is directly related to patient’s disease condition and associated co-morbidity. (153,154). At PHCs, relatively simple conditions were primarily treated with limited number of available drugs.

At SHC level, the two facilities included were SHC 1 (district civil hospital) and SHC 2 (community health center). At SHC 1 total 44 prescriptions were collected whereas, at SHC 2, 24 prescriptions were collected during study period. Patient attendance at civil hospital (SHC1) is higher as compared to community health center (SHC1) because of better facilities including specialty services. Approximately 35% of patients were above 65 years of age. Around 32% of the prescriptions contained more than 6 drugs. Polypharmacy was more common at SHC1 as compared to SHC2. At civil hospital patients are referred from PHCs and have greater number of associated illness. WHO has suggested that average number of drug per prescription should be 2.0 (155). In chronic clinical conditions like hypertension, the patients may require more drugs. In such cases polypharmacy can be acceptable (156). The results of our study at SHC 1 showed that around 96% prescriptions had more than 2 drugs (mean 4.7) which reflects high prevalence of polypharmacy. This is higher than the
WHO recommended limit of 2.0 (155) and also somewhat higher than reported by a Nigerian study of prescribing pattern of antihypertensives in a secondary care institution wherein an average of 3.64 drugs were prescribed per patient (157).

At THC facility two outpatient departments were included in the study, namely internal medicine and pulmonary medicine. Approximately 31% of patients were above age 65 years. Male to female distribution was about equal. Approximately 50% of the patients were suffering from more than one diseases / conditions. Altogether at both the OPDs only about 5% prescription contained one drug per prescription while around 72% were prescribed ≥4 drugs. Mean number of drugs prescribed was 4.8± 2 which was expected because of co-morbidities being present in around 50% of cases. One study from India showed that polypharmacy provides a fertile ground for drug-drug interactions, toxic effects and high cost treatment and reported average number of drugs per prescription was 3.7 which is lower than present study (158). A study from Nepal by Sarkar C and Das B reported mean number of drugs was ≤3 which is again less than that in the present study (159). One of the reasons for this difference could be inclusion of two chronic conditions which may need greater number of medicines compared with other studies which included wide variety of disease conditions both acute and chronic.

**Prescribing quality**

At THC there was no significant difference in prescribing quality in terms of PQI score between hypertension and bronchial asthma prescriptions (P > 0.05). For both the conditions, the quality of prescribing is better at THC than primary and secondary health care facilities. At THC 46.4% (high quality) prescriptions had PQI score ranging from 34 to 43 compared to only 27% and 25% prescriptions (high quality) at PHC and SHC facilities respectively. There could be certain factors that may affect the quality of prescribing like; patients’ illness status including higher associated co-morbidities, qualifications and experience of prescriber, number of drugs prescribed and patients flow at health care center (160). PQI score at THC showed that out of 222 prescriptions 80 (36%) were of poor quality with PQI score ≤31. The proportion of total high and poor quality of prescription did not differ significantly. (Chi square test, P=0.2029). There was no significant difference in proportion of high (P=0.6080), medium (P=0.1633) and poor (P=0.6660) quality prescriptions between hypertension
and bronchial asthma. Around 66% of prescriptions scored as medium to high for bronchial asthma at pulmonary medicine OPD compared to 62.3% for hypertension at internal medicine OPD. At the tertiary care teaching hospital prescriptions are written by consultant physicians as well as post graduate students. Hence, it would be possible to modify the prescribing quality by communicating the results to them. One of the important factors is the practice of electronic prescribing (E-prescribing) at pulmonary medicine OPD which is expected to improve the quality of prescribing. Health information technology, particularly E-prescribing, is a potentially powerful tool for improving safety (161). However, this influence was not observed in this study as prescribing quality did not differ between hypertension and asthma. Furthermore, the prescribers possess higher qualifications being specialists or super specialists which can make a sizable difference in prescribing quality compared to PHC and SHC.

Prescribing quality in terms of PQI score showed highly significant difference between PHC, SHC and THC (P<0.0001). The prescribing quality between PHCs and SHCs did not differ significantly (P>0.05). This is unexpected as we expected better quality at SHCs. One of the reasons for this finding could be majority of patients present with simple problems without/ with minimum complications or co morbidities at PHC. Hence polypharmacy was less frequent at PHC as compared to SHC and THC. Polypharmacy could be lower at PHC also due to lesser availability of medicines, the once which doctors would otherwise have prescribed, as compared to in SHC or THC. The number of drugs per prescription was 2.9 ± 1.2 and 4.8± 1.7 at PHC and SHC respectively. The study carried out by Kumari R et al at Lucknow reported that polypharmacy (>2 drugs) was evident in a majority of the prescriptions at all the public health facilities in India (4). Moreover, larger turnover of patients may make prescribing complex and varied at SHC. This is expected to some extent to be attenuated by higher qualifications of prescribers at SHC which would improve the prescribing quality. Absence of significant difference in quality of prescribing between PHC and SHC is suggestive of absence of impact of the differences in prescribers’ qualifications on prescribing behavior. The reasons for poorer prescribing quality at SHC1 which is a district level hospital equipped with specialists are not clear. However, less exposure to continuous professional updates and influence of drug promotional activities by pharmaceutical companies might have affected
prescribing quality. In this context, the World Health Organization defines drug promotion as all informational and persuasive activities by manufacturers and distributors, the effect of which is to influence the prescription, supply, purchase or use of medicinal drugs (162). It is known that inaccurate and selective information is effective for drug promotion (163). It is also known that the quality of the drug information given to Indian doctors is poorer than that given to western counterparts (164). In India, there is, at present, no legal requirement of continuing medical education or periodic recertification. In India, Medical Council of India (MCI) is in process of mandating it. In fact, some states have made certain hours of CME compulsory for recertification. Gujarat Medical council is in process of implementing it. Medical representatives are often the doctor's only source of information on the latest developments in therapeutics (165).

The Prescription Quality Index score
The mean PQI total score was 28.9±8.1 which falls in category of poor quality prescribing as about 50% of total prescriptions were found to be poor (PQI score ≤31). The PQI total scores were not normally distributed. There were four (1.12%) prescriptions with a minimum score of ‘11’, whereas two (0.6%) prescriptions scored a maximal of ‘43’, indicating the absence of floor effects. These findings differed from that of Hassan et al, who reported that the two criteria (generic prescribing and diagnosis) were normally distributed, while the other criteria displayed skewed distribution with the absence of floor or ceiling effects (8).

When mean scores for each PQI criterion were calculated for all prescriptions (n=356), criteria such as correct dosage- max score 4 (2.69 ± 1.80), some criteria with maximum score 2 like correct administration- 1.61 ± 0.52, clinically significant drug-drug interaction- 1.69 ± 0.56, clinically significant drug-disease/condition interactions-1.57 ± 0.70, adverse drug reaction- 1.52 ± 0.62, medication’s name- 1.60 ± 0.55, legibility-1.87 ± 0.35, Prescriber’s information- 1.87 ± 0.29, Patient’s information-1.51 ± 0.54 and other criteria with maximum score 1 like cost -1.04 ± 0.76, generic prescribing 1.02±0.79 scored well and contributed to good quality of prescribing, while indication (max score assigned 4), effectiveness (max score assigned 2), evidence-based(max score assigned 2), practical administration (max score assigned 2), unnecessary duplication (max score assigned 2), duration of therapy (max score assigned 2), formulary/essential drug list (max score assigned 2), compliance (max
score assigned 2), diagnosis (max score assigned 2), requirement for drug therapy (max score assigned 2) and patient’s improvement (max score assigned 2) criteria scored low and had negative impact on total PQI score.

Criteria wise mean PQI score and comparison between facilities

When PQI criteria wise score between various health care levels were compared, criteria like indication and dosage (max score assigned 4), effectiveness (max score assigned 2), evidence based (max score assigned 2), unnecessary duplication (max score assigned 1), duration of therapy (max score assigned 2), compliance (max score assigned 2) and patient’s improvement (max score assigned 2) scored low at PHC and SHC level. These all criteria accounted for low score. For THC, majority of critically important criteria like indication (criterion 01), dosage (criterion 02), effectiveness (criterion 03), evidence-based (criterion 04), correct directions (criterion 05), practical directions (criterion 06), drug-drug interaction (criterion 07), drug-disease interaction (criterion 08), adverse drug reaction (criterion 09), unnecessary duplication (criterion 10), duration of therapy (criterion 11), formulary/essential drug list (criterion 14), compliance (criterion 15), medication’s name (criterion 16), legibility (criterion 17), prescriber’s information (criterion 18), patient’s information (criterion 19), requirement for drug therapy (criterion 21) and patient’s improvement (criterion 22) performed well leading to higher score and thus the better quality of prescribing while few of the criteria such as cost and generic prescribing scored lower than for PHC and contributed to lowering the quality of prescribing. As the tertiary care hospital is a non government organization, there is no binding for the prescribers to prescribe generic low cost drugs leading to prescribing costlier brands of medicines.

Additionally, when PQI criteria wise scores were compared between THC and Hassan et al study, this study showed better score in these criteria- indication, dosage, correct administration, duration of therapy, compliance, diagnosis and patient’s improvement as compared to Hassan et al study (8). In our study mean PQI score was 32.2± 5.07 while in Hassan et al. study reported 31± 5.2. There was significant difference between both study PQI total score (P=0.034). However, it seems that mean total score in both studies was apparently equal.
Each criterion scores for the three health care facilities were compared with the help of Kruskal Wallis test (one way regression analysis). Post hoc test Dunns Multiple comparison was applied as Kruskal wallis test shows significance difference (P<0.05).

When comparison was made between PHC and SHC facilities, criteria such as 1 (Indication) to 7 (Drug –drug interactions), 15(compliance), 17(legibility), 20(diagnosis) and 22 (Patients’ improvement) showed no significant difference (P>0.05). On the other hand criteria like drug disease/condition interactions (criterion 08), ADR (criterion 09), unnecessary duplication (criterion10), duration of therapy (criterion 11), cost minimization (criterion12), generic prescribing (criterion 13), formulary/ essentials drug list (criterion 14), medication name(criterion 16), prescriber’s information (criterion 18), patient’s information (criterion 19) and requirement for drug therapy(criterion 21) showed significant difference (p<0.05). This finding highlights the difference between two facilities in prescribing behavior related to these aspects of prescribing.

The comparison between PHC and THC showed that there is no significant difference (P>0.05) for criteria 8(disease/condition interactions) to 10 (unnecessary duplication) and 16(compliance), 17(legibility), 21(requirement for drug therapy). The criteria like indication (criterion 01), dosage(criterion 02), effectiveness (criterion 03), evidence-based(criterion 04), correct directions (criterion 05 ), practical directions (criterion 06), drug- drug interactions (criterion 07), duration of therapy (criterion 11), cost minimization (criterion 12), generic prescribing (criterion13), formulary/ essentials drug list (criterion14), compliance (criterion 15), prescriber’s information (criterion 18), patient’s information (criterion 19), diagnosis(criterion 20) and patient’s improvement (criterion 22) showed significant difference (p<0.05). This difference is obviously due to highly qualified (all specialists or postgraduate students in specialties) prescribers at the teaching hospital who would expectedly be logical and updated in process of selection and prescribing leading to use of appropriate drug therapy compared to prescribers at PHC who are less qualified(medical graduates).

When criteria wise mean scores of SHC and THC were compared, criteria like 9(), 13 and 19 exhibit no significant difference (P>0.05). Subsequently majority of criteria like indication (criterion 01), dosage (criterion 02), effectiveness (criterion 03),
evidence-based (criterion 04), correct directions (criterion 05), practical directions (criterion 06), drug-drug interactions (criterion 07), drug disease interaction (criterion 08), ADR (criterion 09), unnecessary duplication (criterion 10), duration of therapy (criterion 11), cost minimization (criterion 12), formulary/essentials drug list (criterion 14), medication name (criterion 16), compliance (criterion 15), legibility (criterion 17), prescriber’s information (criterion 18), diagnosis (criterion 20) and patient’s improvement (criterion 22) showed significant difference in sores (p<0.05).

It was assumed that the quality of prescribing between SHC and THC would not differ. However, long list of criteria showing significant difference in scores indicated that quality of prescribing was poorer at SHC compared to THC and as good as at PHC. The comparison between these facilities for prescriptions with high, medium and poor quality scores also reflected the same differences.

**Exploratory principle component analysis**

Often the instruments that have been tested in the same population might not need further testing, but further psychometric testing is necessary if differences exist between the study population and the population sampled when the instrument was developed and tested. Psychometric properties of tools used in the current study are necessary to report because they are specific to the sample of participants (166). Exploratory factor analysis is a variable reduction technique from which one can find out effect of selected group of variables out of larger number. Eigen value indicates the amount of variance explained by each principle component (167). In this study total 7 centers were included. It was found that the exploratory principal components analysis of the PQI total scores exposed a six to eight factor solution using the minimum Eigen value criteria of ≥1. These factors accounted for 64.8% to 95.9% of the total variance at various health care facilities. Hassan et al reported an eight-factor solution and these eight factors accounted for 66% of the total variance (8). Index of reliability of any tool could be derived from Cronbach’s α value. It reflects internal consistence and reliability of criteria with the total score (168). In this study Cronbach’s α for the entire 22 criteria was between 0.68 to 0.89, while Cronbach’s α for the entire 22 criteria was reported as 0.60 in previous study, a figure that is somewhat lower than that in the present study (8). This finding suggests that the PQI tool is reliable for use in our setting also.

**PQI total score correlation with individual PQI criteria and other parameters**
The PQI total scores of all together for three facilities- PHC, SHC and THC were strongly correlated with indication (criterion 01), effectiveness (criterion 03), dosage (criterion 02), evidence based prescribing (criterion 04) (P<0.01). The criteria including correct directions (criterion 05), practical directions (criterion 06), unnecessary duplication (criterion 10), duration of therapy (criterion 11) and Patient’s improvement (criterion 22) showed moderate correlations. There was a weak correlation with remaining criteria. Furthermore, Drug–drug interactions (criterion 07), Generic prescribing (criterion 13), Formulary or essential drug list (criterion 14) and legibility (criterion 17) did not show correlation with total PQI scores.

Hassan et al reported that the PQI total scores were strongly correlated with drug indication and drug dosage. For the other criteria, there were moderate (practical administration) to weak (unnecessary duplication) correlations. There was no correlation between the PQI total scores and four criteria: unnecessary duplication, formulary/essential drug, medication’s name, and adequate patient information. Although these four criteria did not meet the selection criteria, these criteria were still retained by Hassan et al in the PQI for content validity, clinical and legal significance (8). Unnecessary duplication correlated with total PQI score in our study proving that its retention by the developers was appropriate.

The results suggested poor quality of prescribing at PHC and SHC facilities of public health system of India in the region under study. The first four criteria- correct indication for drug, correct dosage, effectiveness and evidence base which contribute to 12 points out of maximum 43 points in PQI, scored lower compared to previous study(8). The other criteria- unnecessary duplication, adequate duration and prescribing by generic names also exhibited lower score compared to Hassan et al (8). Low scores in these seven criteria contribute to poorer quality prescribing at PHC and SHC in our setup. Based on our findings of prescription quality using PQI tool at THC about half of prescriptions for hypertension and bronchial asthma at the tertiary care hospital selected for our study are of good quality. At THC PQI criteria like Compliance, Diagnosis and Patient’s improvement scored better as compared to Hassan et al study (8).

At THC, our study has demonstrated negative correlation of PQI total score with patient’s age and number of drugs per prescription while weak positive correlation
with number of diseases per prescription. This finding is correlated with the results of Hassan et al (8). However the inverse correlation of PQI score with patient’s age in study by Hassan et al was not a strong one. An inverse correlation of prescription quality with the number of drugs in the prescriptions was observed. The higher the number of drugs prescribed in a prescription, the lower the prescription quality. This finding is in accordance with Hassan et al and another study, which reported that inappropriate prescribing was significantly correlated with polypharmacy (169). At PHCs and SHCs both showed negative correlation of PQI total score with number of drugs per prescription.

Prescribing Pattern
The different prescribing parameters and the distribution of different categories of drugs in the prescriptions analyzed in this study provided an insight into the prescribing behavior of the physicians at various levels of health care facilities and quality in Anand town in Gujarat state of India.

Prescribing Pattern of hypertension at PHCs, SHCs and THC
At PHC, total 66 prescriptions were collected. It was observed that beta blockers (Atenolol) (78.6%) followed by loop diuretic (Furosemide) (39.3%) as antihypertensive were the most commonly prescribed drugs at PHCs. As per essential drug list details only limited number of drugs were available at primary health care level. This is the reason for only atenolol prescribing on the other hand furosemide was also prescribed higher. These findings are similar to the study of Jassim al Khaja KA et al who reported that among the monotherapy category, the maximum antihypertensive drugs used were the beta-blockers (65.5%), diuretics ranked second (27.4%), followed by ACE inhibitors (20.6%), calcium channel blockers (19.9%) and alpha-methylldopa (8.5%) (170). It differs from Wallenius S. et al study where Calcium channel blockers were the most commonly prescribed drugs among the antihypertensive. Also our finding differs from the reports of other countries like Canada, Italy, South Africa and Britain where thiaizide diuretics were popular treatment for hypertension (171). Use of furosemide in hypertension is surprising as the first choice drugs are thiaizide and not furosemide, which is a loop diuretic (172).
Approximately 37.9% of the patients had one or more associated co-morbidity at PHCs. Regarding the co-morbidity pattern in hypertension patients in the study, asthma and joint pain were found to be the most common types of associated co-morbidity. These co-morbidities were effectively managed with antiasthmatic drugs and analgesics. No fixed dose combinations were prescribed at PHCs for hypertension. Unfortunately, irrational prescribing is a global problem. In the majority of developing countries, the quality of health services at peripheral health centers is considered to be unsatisfactory. Patients prefer to visit referral hospitals even for minor ailments which could be easily treated at a primary health center (PHC) (173). At PHC 80% of the expenditure is incurred on medicines. Because of the limited overall health budget for medicines, it is vital that medicines are prescribed rationally. Studies on medicine prescribing in India have concluded that much of it is irrational (174,175).

At SHCs, tablet amlodipine (85.7%) in a dose of 5 mg was the drug of choice in hypertension treatment at SHC 2(n=7). Loop diuretic (furosemide) was prescribed at both the centers. The findings are in agreement to some extent with results of Nigeria study (157). They reported that Calcium Channel Blockers (CCB) were the most frequently prescribed class of antihypertensives (33.5%) followed by Angiotensin Converting Enzyme Inhibitors (ACEIs) 26.7% and Diuretics (16.7%). Although the favoured use of Calcium Channel Blockers was not in accordance with the JNC 7 guidelines that supported diuretics as first line therapy for the treatment of hypertension. Their use may be due to the fact that Calcium Channel blockers have been found to lower blood pressure more than diuretics when both were used as monotherapy (156). Although, thiazide diuretics are generally recommended as first line therapy for treatment of hypertension (JNC V and VII), utilization of thiazide diuretics in this present study was nil and loop diuretic was prescribed. On the other side, at SHC 1, tablet atenolol (71.8%) in dose range of 10 mg to 50 mg was the drug of choice in treatment of hypertension followed by CCB (51.3%), ACE inhibitors (28.2%) and loop diuretics (23.1%). Beta blockers were the most commonly prescribed drugs among the antihypertensives which disagreed with the result published by Tiwari et al and Manolio et al (176, 177).

At THC total 122 patients with hypertension were enrolled during study period. A total of 65.6% of the patients had one or more associated co-morbidity. Regarding the
co-morbidity pattern in hypertension patients in the study, we observed cardiovascular conditions (27.9%) were found to be most common type of associated illness followed by diabetes mellitus (25.4%), thyroid disorder (7.4%) and joint disorders (4.9%). Study by Mohammad Arief et al (178) showed that the maximum number of hypertensive patients had cardiovascular disease associated with severe chest pain, the figure was 129 (32.25%) out of 400 patients. It was followed by 19.25%, 15.75%, and 11.25% patients with shortness of breath, lower limb edema, diabetes, respectively.

Tablet amlodipine (27 %) in a dose of 5 mg was most preferred drug as monotherapy followed by metoprolol (14%) and atenolol (12.3%). Tablet amlodipine + atenolol (24.6 %) in the dose of 5+50 mg and losartan + hydrochlorothiazide (10.7%) were most commonly prescribed fixed dose drug combination. Other drugs such as clonidine (4.1%) and prazosin (4.1%) were also prescribed. The study carried out by R. Neal Axon et al reported that Beta blockers (60.7%) and ACE inhibitors (39%) were most commonly prescribed antihypertensives (179). Study by Mohammad Arief et al on prescribing for hypertension reported that monotherapy ACE-inhibitors (38.25%) were the most commonly prescribed antihypertensives followed by calcium channel blockers (19.25%), diuretics (13.25%). Among combination therapy often 2 drug combinations were prescribed, the most common combination being ACE-inhibitors + CCB (5%), followed by beta-blocker+CCB (3.5%) (178).

Prescribing Pattern in Bronchial Asthma at different health care facilities

Prescription analysis of bronchial asthma patients at PHCs depicted that most preferred drug was oral salbutamol (30.3%) in a dose of 4mg followed by theophylline (13.6%) and dexamethasone (13.6%). Antihistamines (16.7%) were also prescribed along with anti-asthmatic medicine. It was observed that only oral formulations were prescribed rather than inhalation route. This was due to the fact that only oral formulations were available at PHCs. One study carried out at retail pharmacy outlet of rural & urban area of Saurashtra region- Gujarat, reported inhalation route more preferred than oral route because of targeted delivery and less systemic side effects (180). It may be due to non availability of inhalation medications in PHCs. In general practice, on the management of asthma patients, it showed that despite the availability of effective therapies and development of international guidelines to assist in the management of asthma patients, the prescribing practices of many of the doctors do not conform to internationally
recommended guidelines. This finding is in agreement with previous studies in other countries, which have revealed a poor quality of drug prescription for asthma by doctors (181-184).

It was observed that, oral Salbutamol was prescribed to patients with acute or chronic asthma in combination with oral theophylline and/or dexamethasone by the doctors. This practice was in sharp contrast to the international guidelines. Once the asthma treatment has been started, ongoing decisions are based on a cycle to assess, adjust treatment and review response. The step wise approach should be preferred moreover Short Acting Beta Agonist (SABA) is selected as first step (185,186). Another study (187) showed that intravenous methylxanthines are still commonly used in emergency treatment of asthma even in combination with SABA. As they were prescribed with SABA by 56.3% of the doctors, it meant the doctors did not prescribe it because SABA was not available. Oral SABA was also commonly prescribed by the doctors. Oral administration of SABA is not recommended, as it has not been shown to be more effective than inhaled SABA and is associated with an increased frequency of side effects (188). Actually it was observed in this study, at PHCs level only limited class of drugs and formulations were available which catered as essential medicines and assigned as per level of health care facility. Hence the prescribers had no option but to use oral salbutamol.

Total 68 prescriptions of chronic diseases were collected from two SHCs during study period. In case of bronchial asthma, theophylline (83.3%), dexamethasone (66.7%) and salbutamol (33.3%) were most commonly prescribed drugs at SHC 2, whereas salbutamol (100%), theophylline (100%) and dexamethasone (33.3%) were prescribed at SHC1. It was observed that, mucolytic agents were given along with asthma treatment at both SHC 1 and SHC 2. In general, results reflect that oral antiasthmatics were prescribed to patients with acute asthma. The difference in choice of drug between PHC and SHC facilities (salbutamol vs theophylline) is not understandable.

Prescribing of anti-asthmatic drugs at THC reveals salbutamol as the most preferred drug in form of Metered Dose Inhaler (MDI) (40%) or tablet (22%). Theophylline+etophylline (61%) was most common FDC followed by Budesonide + Formoterol
(61%) rotacap. Oral prednisolone, a glucocorticoid was prescribed to approximately 19% patients.

The findings are in agreement with drug utilization study by Awanish Pandey et al which showed β agonists (40%) was the maximum used category (189). The study by Anil Kumar et al. also showed similar trend (190).

**Geriatric Patients – Quality of Prescribing**

Total 67 out of 222 patients at tertiary health care facility were ≥65 years old. Looking into the demographics of the patients, mean age of the elderly population was 72 ± 5.4 years (Range- 65 to 87 years). Approximately 97% patents were found to suffer from more than one disease. Regarding gender distribution, males dominated the study population, as 43(64.2%) out of total 67 patients were male patients and 24(35.8%) were females. Moreover polypharmacy status showed that total 60 (89.5%) patients had received more than 2 drugs (mean 4.97) per prescription due to co morbidities.

The PQI score for geriatric group did not differ from the overall PQI score at THC. (p>0.05) Criteria wise scores also were similar. However looking at the difference between hypertension and bronchial asthma, considering proportions of good quality prescriptions (56% vs 27%), the prescribing quality was better for elderly patients with hypertension. Calcium channel blocker amlodipine (28%) as monotherapy and as combination therapy were found to be most common drugs in hypertension patients. Bronchodilators -tablet theophylline (57%) was the drug of choice prescribed to asthma patients. The second most commonly prescribed drug was salbutamol (46.4%). It was prescribed as tablet salbutamol (32.1%), salbutamol rotacap (17.9%), and FDC form including Salbutamol + Ipratropium bromide rotacap (21.4%) Budesonide rotacap (17.9%) was also prescribed.

**Potentially Inappropriate Medicines (PIM) prescribed to geriatric patients**

Avoiding the use of inappropriate and high-risk drugs is an important, simple, and effective strategy in reducing medication-related problems and adverse drug events in elderly persons. Several stakeholders, including Centers for Medicare and Medicaid Services (CMS), National Committee for Quality Assurance (NCQA) and the Pharmacy Quality Alliance (PQA) have identified the Beers Criteria as an important quality measure(102). Hence Beers criteria updated in 2012 by American Geriatrics
Society (102) were included in this work although they are not part of PQI tool. Out of 67 elderly patients, 30 (44.7%) received at least one PIM while 3(4.5%) patients received two PIMs.

Prazosin is a selective alpha 1 receptor antagonist associated with high risk of orthostatic hypotension; not recommended as routine treatment for elderly hypertensive patients. Clonidine, a centrally acting alpha receptor agonist is to be avoided due to high risk of adverse CNS effects and also bradycardia and orthostatic hypotension. Hence it is not recommended as routine treatment for hypertension. Carbamazepine is to be used with caution in elderly as it may exacerbate or cause syndrome of inappropriate antidiuretic hormone secretion or hyponatremia; if prescribed it would be required to monitor sodium level closely when starting or changing dosages in older adults due to increased risk. Digoxin in dose exceeding 0.125mg is reported to be associated with no additional benefit and may increase risk of toxicity. In elderly slow renal clearance may lead to risk of toxic effects. Alprazolam is a benzodiazepine and belongs to ‘Avoid’ category in Beers criteria of PIM. Older adults have increased sensitivity to benzodiazepines because showing slower metabolism of alprazolam due to pharmacokinetic changing associated with aging. All benzodiazepines can increase risk of cognitive impairment, delirium, falls, fractures, and motor vehicle accidents in older adults. Spironolactone is aldosterone antagonist used in heart failure with hyperkalemia as one of the side effects (191). In elderly the risk of hyperkalemia is higher especially if taking> 25 mg/day or taking concomitant NSAID, angiotensin converting-enzyme inhibitor, angiotensin receptor blocker, or potassium supplement.

Theophylline has been used in bronchial asthma. However due to its CNS stimulant effects it is contraindicated in patients with insomnia (102). Older adults are more likely to have associated insomnia which can be aggravated by methyl xanthines like theophylline and caffeine.

It should be noted that the goal of the 2012 AGS Beers Criteria is to improve care of elderly by reducing their exposure to PIMs. These criteria are not meant for application in a punitive manner. Prescribing decisions are not always clear cut, and clinicians must consider multiple factors while prescribing. According to the panel of experts involved in revising Beers criteria, the list of PIMs is not meant to supersede
clinical judgment or an individual patient’s values and needs. Prescribing and managing disease conditions should be individualized and involve shared decision-making (102).

When frequency of PIM was examined, 30 patients received at least one PIM out of 7 drugs listed in Beers criteria (102). Of these seven drugs, clonidine, prazosin, digoxin, alprazolam and spironolactone belong to ‘to be avoided’ in this age group. Theophylline was prescribed to 20 patients and fell under the category of PIM in older adults due to drug-diseases or drug – syndrome interactions that may exacerbate the disease or syndrome. Carbamazepine was prescribed to one patient categorized as PIMs to be used with caution in older adults. About 45% of elderly receiving at least one PIM is higher than that in previous study from India reporting use of PIM in 24% of elderly attending medicine outpatient department of a tertiary care teaching hospital (192). The reason for higher frequency of use of PIM in the present study could be due to difference in study population. The present study was restricted to hypertension and bronchial asthma patients while Zaveri et al. (192) included all types of patients attending medicine outpatient department.

**Strength and limitations of this study** Hassan et al developed and validated PQI retrospectively which may have retrospective bias. In this study data were collected prospectively for a fixed period with the advantages of completeness of data and proper sampling. In present study only two chronic conditions were selected so as to minimize disease/condition variation which is reflected in better internal consistency in form of higher value of Cronbach’s α as compared to previous study (8). Moreover, rather than selecting one facility per health care level, data were collected from more than one facilities to incorporate any inter-facility differences in the prescribing behavior. Sample size is statistically sufficient at 80 % power to derive conclusion. To our knowledge no other study has used PQI tool for assessment of quality of prescribing in any health care level settings. However further studies in different health care settings and in conditions other than hypertension and bronchial asthma would be needed for proving the usefulness of PQI for assessment of prescribing quality in differing therapeutic situations.

At THC prescribing quality is better than in PHC and SHC as suggested by mean PQI total score 32.2± 5.07. However, considering overall the prescriptions were of medium quality. PQI scored somewhat lower for elderly patients at THC with 38%
poor quality prescriptions compared to 36 % overall at THC. The factors contributing to this problem should be identified and interventions to improve be undertaken.

Limitations-
It would have been better if the PQI tool was validated. However as the study was aimed at assessing prescription quality at different levels of health care in the region, validation was not considered for this already validated tool. A government run tertiary care hospital would be more appropriate selection for comparison of prescribing quality. However in absence of such a facility a teaching hospital run by private trust was considered as the option.