Title

The Aston Medication Adherence Study – mapping the adherence patterns of an inner-city population

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Abstract

Background

The Aston Medication Adherence Study was designed to examine non-adherence to prescribed medicines within an inner-city population using general practice (GP) prescribing data.

Objective

To examine non-adherence patterns to prescribed oral medications within three chronic disease states and to compare differences in adherence levels between various patient groups to assist the routine identification of low adherence amongst patients within the Heart of Birmingham teaching Primary Care Trust (HoBtPCT).

Setting

Patients within the area covered by HoBtPCT (England) prescribed medication for dyslipidaemia, type-2 diabetes and hypothyroidism, between 2000 and 2010 inclusively. HoBtPCT's population was disproportionately young, with seventy per cent of residents from Black and Minority Ethnic groups.

Method

Systematic computational analysis of all medication issue data from 76 GP surgeries dichotomised patients into two groups (adherent and non-adherent) for each pharmacotherapeutic agent within the treatment groups. Dichotomised groupings were further analysed by recorded patient demographics to identify predictors of lower adherence levels. Results were compared to an analysis of a self-report measure of adherence (using the Modified Morisky Scale© (MMAS-8)) and clinical value data (cholesterol values) from GP surgery records.

Main outcome

Adherence levels for different patient demographics, for patients within specific long-term treatment groups.

Results

Analysis within all three groups showed that for patients with the following characteristics, adherence levels were statistically lower than for others; patients: younger than 60 years of age; whose religion is coded as "Islam"; whose ethnicity is coded as one of the Asian groupings or as "Caribbean", "Other Black" and "African"; whose primary language is coded as "Urdu" or "Bengali"; and whose postcodes indicate that they live within the most socioeconomically deprived areas of

HoBtPCT. Statistically significant correlations between adherence status and results from the self-report measure of adherence and of clinical value data analysis were found.

Conclusion

Using data from GP prescribing systems, a computerised tool to calculate individual adherence levels for oral pharmacotherapy for the treatment of diabetes, dyslipidaemia and hypothyroidism has been developed. The tool has been used to establish non-adherence levels within the three treatment groups and the demographic characteristics indicative of lower adherence levels, which in turn will enable the targeting of interventional support within HoBtPCT.

350 Words

Impact of findings on practice

- The adherence status of patients taking oral pharmacotherapy for dyslipidaemia, type-2 diabetes and hypothyroidism can be predicted by analysis of medication issue data from general practice (GP) surgeries.
- It is possible to identify specific patient demographic factors indicative of lower adherence levels by analysis of recorded demographic data from GP prescribing systems.
- By using information on adherence status and indicative patient demographic groupings, targeted support can be provided to patients to help address barriers to medication adherence.
- Where adherence problems are suspected, a validated self-report adherence questionnaire (the Modified Morisky Scale© (MMAS-8)) could be used within healthcare locations (general practice surgeries, community pharmacies, etc.) to assist in the identification of low adherence levels in patients taking oral pharmacotherapy for dyslipidaemia, type-2 diabetes and hypothyroidism.

Keywords

Diabetes, Dyslipidaemia, Hypothyroidism, Medication adherence, Modified Morisky Scale, United Kingdom.

Introduction

Adherence is "*the extent to which the patient's behaviour matches agreed recommendations from the prescriber*".[1] While the accurate measurement of adherence may be complex, in developed nations it is estimated that 30-50% of all prescription medicines for long-term conditions are not taken as prescribed.[2] As the scale of non-adherence to prescribed medicines, and the personal, social and financial costs resulting from this non-adherence have become more apparent, healthcare organisations have placed an increasing focus on obtaining rigorous data to inform both commissioning decisions and the development of suitable policies designed to ameliorate the impact of non-adherence.

A number of approaches to measuring adherence have been adopted. Subjective (or 'indirect') strategies for measuring medication adherence focus largely on patient self-reporting. However, interpreting such reports is often problematic. Cramer and Mattson[3] reported that patients who 'admit' to not following recommendations tend to describe their behaviour accurately, whereas, patients who deny a failure to follow treatment advice have a tendency to report their behaviour inaccurately.[4] Both 'adherence diaries' kept by patients and visual analogue scales of adherence overestimate adherence when compared to adherence measured objectively by electronic monitoring devices.[5-6] Other indirect measures include pill counts and clinician assessments but these have been found to overestimate adherence and are impractical for large populations.[7-8] Objective (or 'direct') strategies usually involve the measurement of a chemical (i.e. a marker or metabolite) in a bodily fluid (i.e. blood or urine). However, such measurements are not available for all medications, are expensive and are also impractical in large populations.[9]

Healthcare databases can be used to check when, for example, prescriptions are initially filled, refilled over the duration of treatment or are prematurely discontinued. Limitations associated with the use of such databases include an inability to determine if the patient actually consumed the prescribed medicine (i.e. obtaining the medicine does not ensure its use) and the potential for incomplete data sets (data may not be routinely captured and patients are free to use more than one pharmacy). However, the efficiency of using such databases for studies of adherence in large populations is highly advantageous where data is deemed to be complete and GP prescribing data appears to be predictive of subsequent pharmacy-based dispensing data with 93% of prescriptions issued by GPs being dispensed within seven days.[7, 10]

A combination of methods is often used in the study of adherence. Farley *et al* examined adherence rates as measured by an electronic monitoring device (Medication Event Monitoring System – MEMS) and pharmacy refill rates alongside measurement of viral load in HIV-infected children.[11] Both MEMS and pharmacy refill adherence rates were associated with virologic response (with MEMS providing the more robust measure).

No single method of measuring adherence has been deemed optimal although in a 2008 Cochrane Review, Haynes *et al* stated *"although objective measures are more expensive, they provide a more accurate measure of true adherence and should be incorporated into studies whenever possible*".[12] Furthermore, the WHO advocate a multi-method approach as the state-of the-art measurement of adherence behaviour.[13]

The accurate measurement of adherence can be problematic, particularly amongst large populations. It was against this background that the healthcare organisation responsible for primary care services (at the time of the study) for approximately 300,000 people within the centre of Birmingham, UK (the Heart of Birmingham teaching Primary Care Trust; HoBtPCT), commissioned a study to establish the extent of non-adherence to medication within their geographical area of responsibility (since 31st March 2013, National Health Service restructuring has seen the abolition of Primary Care Trusts). HoBtPCT proposed to utilise the findings from the study to influence the design of newly commissioned healthcare interventions to maximise the impact any intervention can have on overall medication adherence levels.

HoBtPCT's population was disproportionately young; almost a third of the resident population was under 19 years of age.[14] Seventy per cent of people in HoBtPCT were from Black and Minority Ethnic (BME) groups; the highest proportion of people from BME groups of any PCT in England.[15] According to the Indices of Multiple Deprivation 2010 (IMD 2010), HoBtPCT was the most socioeconomically deprived PCT in England with two thirds of the population living in neighbourhoods that are in the most deprived quintile of neighbourhoods in England.[14] Unemployment rates, particularly for men, were high. Religious belief played an important part in the lives of a large number of HoBtPCT residents and there were differences in the religious make-up of the population when compared to national (England) statistics. For example, according to 2001 Census data, 41% of HoBtPCT residents identified themselves as Christian (nationally, 72%), 29% identified themselves as Muslim (nationally, 3%), 7% as Sikh (nationally, 0.7%) and 4% as Hindu (nationally, 1.1%) (the remaining groups being either Buddhist, Jewish, "other" religions or where religion was not stated).[16] Therefore, it was imperative that HoBtPCT based any commissioning decisions on data relevant to its specific

population, rather than relying on published studies undertaken within demographically-different populations.

Migration has been a feature of Birmingham life for generations and it continued to be a prominent aspect of life within HoBtPCT making language a major barrier to accessing services.[15] A 'language barrier' did not present exclusively among 'recent' arrivals to HoBtPCT however. One fifth of adults within the parliamentary constituencies in the HoBtPCT area could only read and write English to pre-GCSE level (General Certificate of Secondary Education (GCSE) examinations are taken by students aged 14-16 in secondary education in England, Wales and Northern Ireland) and approximately 64% of dependent children aged 0-15 were estimated to have 'language needs' (an indicator of the proportion of individuals where it is likely that the first language spoken at home is not English).[15] At the time of the study, life expectancy in HoBtPCT was shorter than the England average (76 years for men and 81 years for women versus 78 years and 82 years respectively (2006/8 figures)).[17]

Aim of the study

The aim of the Aston Medication Adherence Study (AMAS) was to examine non-adherence to prescribed medicines in the Heart of Birmingham teaching Primary Care Trust (HoBtPCT).

This paper presents an overview of the results from the part of the AMAS designed to analyse general practice (GP) surgery prescribing data, which had the following objectives:

- To establish the extent of non-adherence to prescribed medication in three treatment groups across HoBtPCT.
- To assess variations in levels of adherence between various patient groups in HoBtPCT.
- To design a system for the routine identification of low adherence amongst patients in HoBtPCT.

Method

Database construction

The methodology involved the analysis of aggregated prescribing data, electronically transferred to Aston University via a secure electronic link, from HoBtPCT. In total, 76 General Practice (GP) surgeries within HoBtPCT supplied data to the interim electronic patient record (iEPR) which was collated at HoBtPCT. The data retrieved related to patients who had any contact with contributing practices within the period between 2000 and 2010 and who were coded within one of three

condition Read codes (dyslipidaemia, C32%; diabetes type-2, C10%; and hypothyroidism, C0%). Read codes are the standard classification used within UK general practice and provide a hierarchical system of coding for multiple patient phenomena including diagnosis, medication prescribed and a variety of different patient demographic factors (religion, smoking status, etc.). The data extract for transfer was undertaken by the Senior Database Administrator at HoBtPCT who verified the extract by comparison with the iEPR. During subsequent analysis, it was noted that for certain patient factors, complete data were not available (where applicable, this is discussed further below).

A software programme was devised to calculate individual patient Medication Possession Ratios (MPRs) for all medication periods of interest. A medication possession ratio (MPR) is a measure of whether a patient has been issued with sufficient prescriptions to last them over a specific period of time. It is calculated as follows:

> Amount of medication supplied (i.e. prescription quantity)/Amount required over a particular period

Although not a definitive indicator of adherence to a medication regimen (as outlined above), previous research has shown that a low MPR value is a valid indicator of non-adherence.[7, 18] For this project, adherence was taken as MPR ≥0.8.

Owing to the large time period covered by the data extraction, it was possible for patients to have more than one episode of a particular presentation of a medication (i.e. two or more separate periods of administration with a period of non-administration of that medication in between). To accommodate this, MPRs were calculated in "runs". For each patient, a run commenced when an individual patient was first prescribed a medication for a relevant condition (or were being prescribed the medication at the start of the study period). The time between the first prescription and last prescription in the run (within the study period) was calculated and this was compared to the amount of medication prescribed. A run continued as long as subsequent prescriptions were present for the medication unless:

- the dosage frequency of the prescribed medication was changed;
- there was a gap of 252 days between prescriptions for the medication of interest. This was to ensure that if a patient stopped and restarted a medication, this medication gap was accounted for. This figure was chosen because some patients had prescriptions issued to cover up to a six-month period;
- no other prescriptions were found; or

- the patient was prescribed an alternative medication for their condition.

The run was only reported if the patient was prescribed the medication for greater than 84 days (a three month period, based on a pharmaceutical month of 28 days).This was to allow for an initial period of adjustment time when the patient started the medication.

Analysis of the data

For all three conditions, the computer model was able to generate MPRs for each individual patient run and link each MPR to individual patient demographics. Over one million individual prescription issues were analysed to generate the patient runs (as described above) for these three conditions as follows:

- Diabetes 489,379 prescription issues; 30,949 runs from 9,445 unique patients.
- Dyslipidaemia 278,894 prescription issues; 17,606 runs from 8,568 unique patients.
- Hypothyroid 239,609 prescription issues; 16,942 runs from 5,674 unique patients.

For each of the three datasets, a single output was assembled detailing each individual run alongside extracted patient demographics and calculated MPR values. For some patient medication runs within the diabetes dataset (n=238) it was not possible to calculate an MPR owing to unclear dosage information in the database for medication where multiple dosing frequencies are possible. For subsequent analysis, these patient runs were removed from the database.

For analysis by individual demographic values (gender, age, religion, ethnicity, language and socioeconomic deprivation), calculated MPR values for last medication runs were analysed by recorded patient characteristics. Owing to variations in the level of recording of certain patient factors within the general practice databases, some data were missing from the analysis and so relevant patients were excluded from certain analysis; therefore, within the Results, individual “n” values are provided for each comparison as analysed populations varied. All primary analysis was repeated firstly limiting by gender group and secondly limiting the length of time the patient had been taking the medication (i.e. those patients who had been on the medication in question a minimum of one, two, three and four years). This enabled the identification of any gender effect on any statistically significant differences to be identified and to ascertain whether any identified factors remain if patients are taking the medication long-term.

Owing to space constraints, results are presented at the condition-level only, with graphical representation of the data for the analysis of the diabetes data. Further detailed analysis by individual pharmacotherapeutic agent and graphical presentation of the data analysis from the

dyslipidaemia and hypothyroid databases can be found within the project report.[19] Results from the demographic analysis are presented for last patient runs only. The Chi-square test of association was used to assess the significance of any correlations between variables ($p<0.05$).

Data comparison

The calculated MPRs were investigated further by triangulation of a selection of the results with available corresponding clinical values from the supplied data, and self-report medication adherence as measured by the 8-item Modified Morisky Scale© (MMAS-8).

The MMAS-8 was included in a questionnaire which was distributed to a sample of 4,000 patients for whom their last run extended into 2011 (the time of the study). These patients were selected in order to reduce the likelihood that their medication had been stopped in the interregnum between transfer of the prescribing data and distribution of the questionnaire. Patients within the sample were stratified by treatment group and adherence status (dichotomised into adherent and non-adherent groups). Questionnaire packs were assembled containing the MMAS-8 questionnaire in four languages (English, Punjabi, Urdu and Bengali; the four most common first languages (in order) according to analysis of the datasets transferred from HoBtPCT), along with a covering letter (in all four languages) and reply-paid envelope, and mailed via HoBtPCT to preserve patient anonymity. Unique database numbers were used to link questionnaire returns with database entries. Questionnaire translation was undertaken by a specialist translation service and translation validity was verified via reverse translation using a different specialist translation service.

Ethical approval

Approval was obtained from the Local NHS Research Ethics Committee, the Aston University Research Ethics Committee, NHS Research and Development, and the local NHS Caldicott Guardian prior to commencing data collection or analysis.

Results

Database analysis

Overall patient adherence levels (examining all patient runs across the period covered by the data) varied by condition; over three quarters of patients were identified as being adherent to hypothyroid medication (78.4% (n=13,279/16,942)), with the adherence rates for diabetes medication and dyslipidaemia medication being similar to each other at around two thirds (67.5% (n=20,885/30,949) and 67.0% (n=11,796/17,606) respectively). When patient adherence levels were

limited to last patient runs (which were utilised for subsequent analysis to provide one run per relevant patient), similar patterns were observed - hypothyroid medication, 82.1% (n=4,658/5,674), diabetes medication, 68.6% (n=6,480/9,445) and dyslipidaemia medication, 71.0% (n=6,080/8,568) - indicating that there were no marked differences in overall adherence levels when last medication runs were compared to all patient runs.

Further analysis was then undertaken by different demographic factors. Analysis by gender did not show any statistically significant differences between female and male patients for two conditions (diabetes, female=69.4% (n=3,165/4,558), male=69.0% (n=3,208/4,649); hypothyroid, female=82.1% (n=3,670/4,469), male=82.0% (n=988/1,205)). For dyslipidaemia medication, differences were seen between female and male patients, with female patients showing a small but statistically significant higher level of adherence (72.5% (n=2,972/4,101)) when compared to males (69.6% (n=3,108/4,467)).

Age analysis of the data indicated that for all three conditions, the proportion of adherent patients increased by age group up to the 60-69 age group (see Figure 1).

Figure 1 Here

The majority of patients within the database did not have a religion coded (or were coded for the absence of a religion, i.e. 'atheism'). In the analysis of all three databases, the large number of possible codes for religion had to be recoded into a smaller number of categories to enable suitable analysis to take place. This includes an aggregate category (termed "Less than 1%") comprising of all small groupings. The analysis is therefore based on those patients where religion (or absence of religion) was coded in the database and differences were seen between the major religious groupings (see Figure 2).

Figure 2 Here

Ethnicity analysis of the data from the diabetes database indicated statistically significant variations in adherence between the major ethnic groupings used in the analysis (diabetes, range 86.8% ("Irish"; n=112/129) to 58.3% ("African"; n=116/199); dyslipidaemia, 86.2% ("Irish"; n=133/161) to 54.1% ("African"; n=66/122); hypothyroid, 93.1% ("Irish"; n=162/174) to 70.9% ("Mixed"; n=39/55)). Statistically significant differences remained when the analysis was limited by gender and by length of run.

When considering diabetes medication, adherence rates did not vary by language spoken. However, differences were seen when the analysis was limited to females and by length of run. No statistically

significant differences were noted for the analysis of language within the dyslipidaemia database (range 73.8% ("Bengali"; n=200/271) to 69.5% ("Unknown"; n=2,105/3,027)) or when limiting by gender. However, statistically significant differences were seen when analysis by length of run was undertaken. Finally, the analysis of the hypothyroid medication indicated statistically significant differences (range 84.7% ("English"; n=1,734/2,048) to 76.6% ("Urdu"; n=308/402)), which remained when analysis was undertaken by females and runs limited to one and two years of length.

Analysis of the IMD2010 quintiles from the diabetes database compared to adherence levels indicated that in general, lower levels of adherence were observed in patients living in more deprived areas (see Figure 3).

Figure 3 Here

Correlation with clinical values

From the dataset, it was only possible to extract sufficient data for one relevant clinical value to enable comparison with the data analysis and MPR values. The total cholesterol values for patients taking simvastatin (20 mg (n=814) and 40 mg (n=2,730)) were present in sufficient quantity and in both cases, correlation (R^2=0.131 and 0.159 respectively) between percentage reduction and MPR of last medication run was observed, and analysis by Spearman's rank correlation (Kolmogorov-Smirnov for Percentage reduction and MPR of last medication run; 20 mg, p<0.0001; 40 mg, p<0.0001) indicated significance (20 mg, p<0.0001; 40 mg, p<0.0001).

Further analysis for both 20 mg and 40 mg simvastatin patients, examining the percentage adherence levels within the dichotomised groups relating to a percentage cholesterol reduction of 5% and greater and less than 5% respectively, indicated a statistically significant difference (20 mg, n=814, 77.1% compared to 45.5%; 40 mg, n=2,730, 76.2% compared to 37.7%; Chi, p<0.0001 in both cases). This difference remained when increasing to a 10% reduction (20 mg, 78.9% compared to 48.9%; 40 mg, 78.3% compared to 39.3%), a 20% reduction (20 mg, 84.1% compared to 56.3%; 40 mg, 82.4% compared to 49.2%) and a 30% reduction (20 mg, 87.5% compared to 66.9%; 40 mg, 87.3% compared to 60.2%) (n=814 (adherent, n=600; non-adherent, n=214) and n=2,730 (adherent, n=1,940; non-adherent, n=790), Chi, p<0.0001 in all cases).

Correlation with self-report measure of adherence

Results from the MMAS-8 questionnaire allowed comparison of the results from the analysis of the data (i.e. the calculation of MPRs) with a self-report measure of adherence (overall response rates: diabetes, 28.1% (n=321/1,144); dyslipidaemia, 29.4% (n=338/1,151); hypothyroid, 23.9%

(n=332/1,138)). Analysis of the questionnaires categorised patients into one of three groups: High, Medium or Low adherence. To allow for those patients categorised as Medium adherence levels to be considered as either adherent or non-adherent, two sets of analysis were undertaken. The first compared patients' dichotomised adherence status against dichotomised MMAS-8 status of either High or non-High (i.e. Medium or Low), and secondly against patients' dichotomised MMAS-8 status of Low or non-Low (i.e. High or Medium). In all cases, statistically significant correlations were seen between a patient's self-report of adherence status and the adherence status from the data analysis (see Table 1).

Table 1 Here

Discussion

It has been established that for patients taking oral pharmacotherapy for diabetes, dyslipidaemia and hypothyroidism, it is possible to calculate their adherence status to prescribed medication using medication issue data from general practice surgeries. These results have been found to correlate with both a self-report measure of medication adherence and analysis of clinical values from the data. Further analysis has indicated a number of patient factors indicative of lower adherence levels.

From the analysis, patients who were less than 60 years of age were likely to exhibit lower levels of adherence. Age is a factor reported as affecting adherence and in developed countries adherence to treatment by children and adolescents varies from 43% to 100% with an average of 58%.[20] It has also been reported that adolescents are less adherent to prescribed medication regimens than younger children.[21] The relationship between age and adherence is complicated but a number of studies have suggested that younger patients (those aged under 40 years[22-23], under 44 years[24], under 55 years[25], under 60 years[26], under 65 years[27] and those with a mean age of 52 years versus 56 years[28]) have lower adherence. These published findings correlate with the findings from the present study and, when considered alongside the disproportionately young population within HoBtPCT, the findings indicate that specific targeting of any healthcare intervention to patients below the age of 60 within HoBtPCT would be beneficial.

Patients coded with "Islam" as their religion were found to be less adherent to their medication than other patients in all three treatment groups. The literature exploring the effects of religious belief on adherence is sparse. A Birmingham-based study highlighted problems with medication adherence associated with the dietary requirements of Muslim patients.[29] A total of 64% of patients and 56% of GPs sampled either stated that Muslims could not, or were unsure as to whether Muslims could take

haraam (i.e. non-halaal) medicines (such as those containing pork gelatine or alcohol) for treating major illnesses thus highlighting the need for further education of both Muslim patients and health care professionals on such matters. NICE Guidance highlights that an individuals' religious beliefs (i.e. fasting behaviour) may make adherence to a regimen very difficult if not impossible.[1] Therefore, in addition to highlighting this patient group as one which would particularly benefit from targeted intervention, we believe that this study provides important novel data relating to adherence levels across different religious groupings.

The analysis of the data relating to ethnicity revealed statistically significant differences between different ethics groups. Various studies have highlighted race as a factor that affects levels of adherence.[30-32] This issue assumes particular pertinence within HoBtPCT where seven out of ten of the population that HoBtPCT provides healthcare services to are black or Asian.[14] Lawton *et al* explored the beliefs of diabetic patients of South Asian origin living in the UK prescribed oral hypoglycaemic medicines.[33] These patients distrusted the healthcare systems in their countries of origin but admired the NHS. They consequently considered that the medicines available in the UK would be more efficacious than those available in their country of origin and therefore ingested reduced doses of their prescribed medications. Studies on the influence of ethnicity on adherence rates from the US suggest that black people (most commonly described in the literature as 'African Americans') are less likely to adhere to antidiabetic agents[34-36] and statins[25, 37] than white people. It would appear that the results from the present study are consistent with previously published studies and owing to the make-up of HoBtPCT's population, strengthen the need to provide targeted adherence support to certain ethnic groups.

Finally, a correlation was observed between adherence levels and socioeconomic deprivation, with those in less-deprived areas showing greater adherence levels. Lower income is a further factor that affects levels of adherence.[31-32] As the geographical area covered by HoBtPCT includes some of Birmingham's and England's poorest, most deprived neighbourhoods this again is an issue of salience to this research.

The AMAS has successfully demonstrated how a computerised tool can be employed to identify patients with low adherence levels to oral pharmacotherapy for the treatment of diabetes, dyslipidaemia and hypothyroidism and identify specific patient characteristic which may be indicative of lower adherence levels. Knowledge of the individual indicative factors for low adherence will help commissioners target specific support interventions to those patients most in need. However, further work is required to expand this tool into other therapeutic areas and to

understand further the complex interaction between the different factors to develop an even more in-depth understanding of the patient factors affecting adherence patterns.

Limitations

The project does have a number of limitations which need to be taken into consideration when interpreting the potential impact of the results:

- The quality of the data analysis relied on the quality of the coding of the data present in the database and in the reliability of the data extraction at the PCT. Whilst the project team have no reason to doubt the quality of either, the team was not in a position to be able to check data coding quality owing to the requirement to maintain patient anonymity.
- Parts of the data manipulation relied on the interpretation of "as directed" doses and their conversion into dosage and frequency values for the calculation of individual MPRs.
- As discussed above, the specific patient demographics which have been identified as being indicators of lower adherence levels are likely to be linked rather than discreet indicators. Therefore, although each in itself is useful in assisting in the targeting of any intervention or support provided, further work is required to understand the complex interplay between the individual demographic factors.
- The model has been designed to identify a specific group of patients who are non-adherent to this medication; namely those who are collecting prescriptions for their medication at a minimum frequency. Therefore, the figures for adherence levels within the populations examined have not taken into consideration low or non-adherence arising from other parts of the medication supply chain.

Conclusion

Using currently available aggregated data from GP prescribing systems, it is possible to develop a computerised tool to calculate individual patient MPRs for oral pharmacotherapy for the treatment of diabetes, dyslipidaemia and hypothyroidism. The effectiveness of the developed methodology has been validated by triangulation with both a self-report measure of adherence and through the analysis of specific clinical values.

The developed tool has been employed to examine the adherence levels and patterns of HoBtPCT patients who take oral pharmacotherapy for the treatment of diabetes, dyslipidaemia and hypothyroidism. This analysis has identified specific patient demographics which can be used as

indicators of potential low adherence and has highlighted specific patient groups to target with any support interventions. These groups are:

- Patients younger than 60 years of age.
- Patients whose religion is coded as 'Islam'.
- Patients whose ethnicity is coded as one of the Asian groupings or coded as 'Caribbean', 'Other Black' and 'African'.
- Patients whose primary language is coded as Urdu or Bengali.
- Patients whose postcodes indicate that they live within the most socioeconomically deprived areas of HoBtPCT.

Awareness of these individual patient factors will to enable the targeting of interventional support within HoBtPCT.

4,264 Words

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Conflicts of Interest

The authors have no conflicts of interest to declare.

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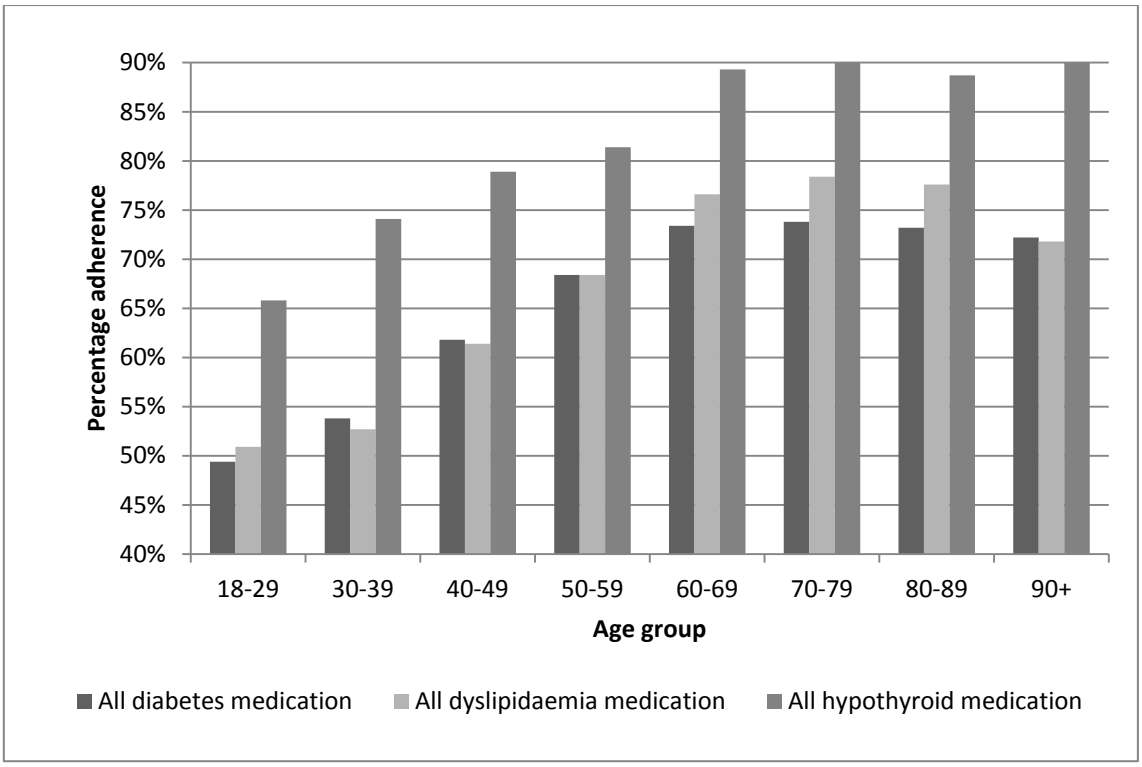
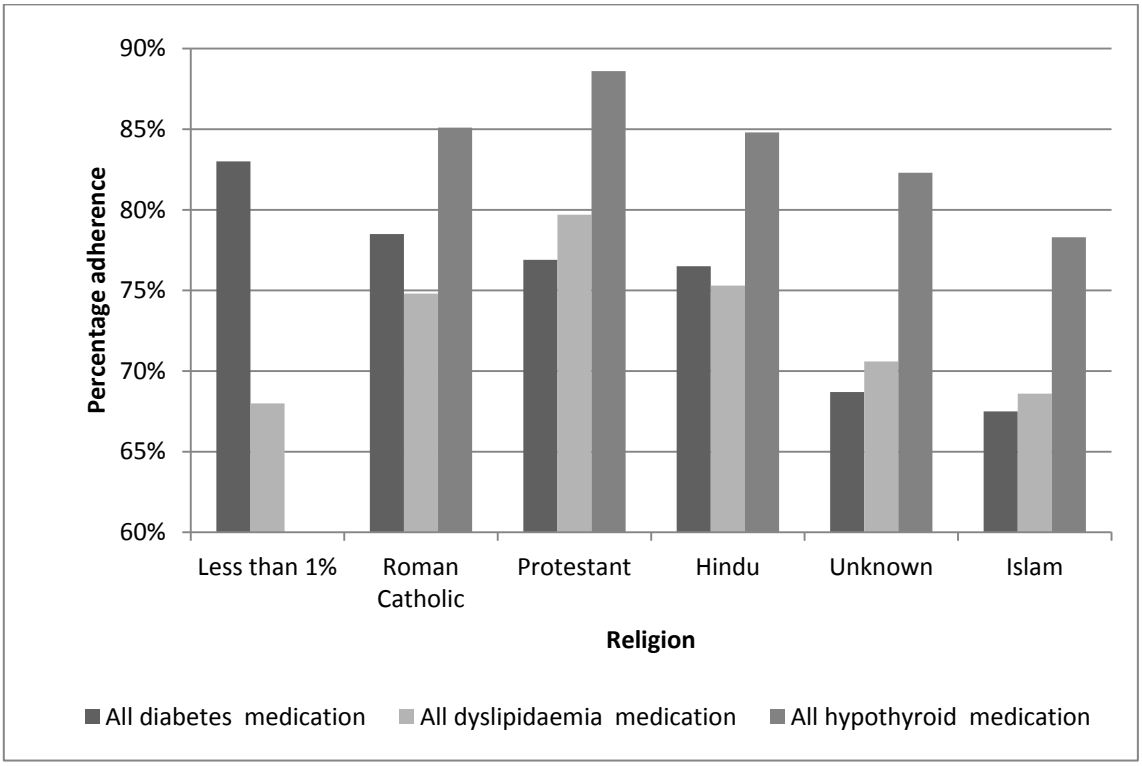
Figures

Figure 1: Adherence patterns by age group[a]



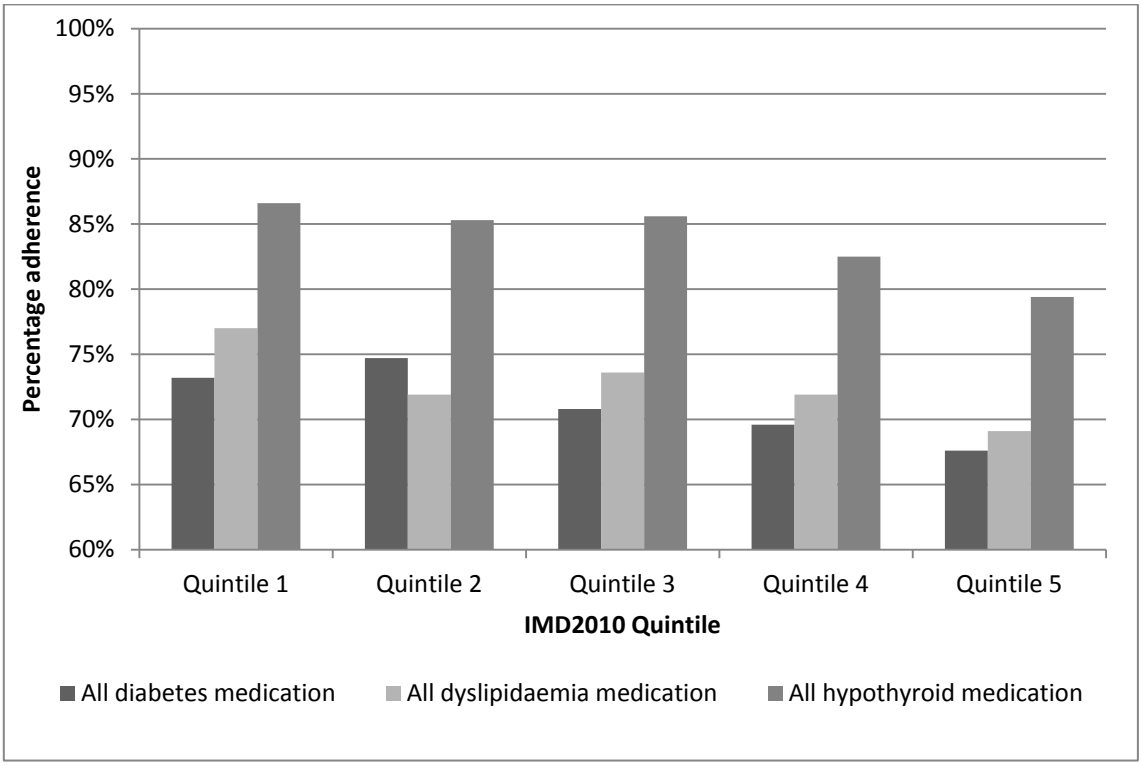
[a] Within Figure 1, for diabetes medication, adherence levels increase from around a half (49.4% (n=44/89)) for the 18-29 age group to around 73% (73.4% (n=1,470/2,004)) for the 60-69 age group. For dyslipidaemia medication, adherence levels were around half (50.9% (n=28/55)) for the 18-29 age group, increasing to around three-quarters (76.6% (n=1,530/1,998)) for the 60-69 age group. For hypothyroid medication, adherence levels were around two-thirds (65.8% (n=287/436)) for the 18-29 age group, increasing to around nine-tenths (89.3% (n=891/998)) for the 60-69 age group. For all three conditions, statistically significant differences remained when the analysis was limited by gender and by length of run.

Figure 2: Adherence patterns by religious group[b]



[b] Within Figure 2, for diabetes medication, adherence ranged from 83.0% ("Less than 1%"; n=39/47) to 67.5% ("Islam"; n=1,664/2,465). For dyslipidaemia medication adherence ranged from 79.7% ("Protestant"; n=419/526) to 68.0% ("Less than 1%"; n=34/50). For hypothyroid medication, adherence ranged from 88.6% ("Protestant"; n=226/255) to 78.3% ("Islam"; n=791/1,010). For all three conditions, significant differences were seen between the "Islam" group when compared to each other individual religious grouping. Statistically significant differences remained for all three conditions when the analysis was limited by gender (only female for hyperthyroid) and by length of run (only up to greater than two years for diabetes medication).

Figure 3: Adherence patterns by IMD2010 quintile (Quintile 1 least deprived – Quintile 5 most deprived)[c]



[c] Within Figure 3, for diabetes medication, adherence ranged from 74.7% (quintile 2; n=694/929) to 67.6% (quintile 5; n=3,299/4,877). For dyslipidaemia medication, adherence levels ranged from 77.0% (quintile 1; n=268/348) to 69.1% (quintile 5; n=2,616/3,784). For hypothyroid medication, adherence ranged from 86.6% (quintile 1; n=253/292) to 79.4% (quintile 5; n=1,841/2,318). For all three conditions, statistically significant differences remained when the analysis was limited by gender and by length of run.

Tables

Table 1: Comparison of data analysis and Morisky Score categories[d]

Questionnaire result	Adherent	Non-adherent	Statistical result (Chi)
Diabetes (1)			
Low/Medium (n=210)	53.8% (n=113)	46.2% (n=97)	P=0.010 (n=321)
High (n=111)	69.4% (n=77)	30.6% (n=34)	
Diabetes (2)			
Low (n=82)	48.8% (n=40)	51.2% (n=42)	P=0.036 (n=321)
Medium/High (n=239)	62.8% (n=150)	37.2% (n=89)	
Dyslipidaemia (1)			
Low/Medium (n=200)	49.5% (n=99)	50.5% (n=101)	P<0.0001 (n=338)
High (n=138)	75.4% (n=104)	24.6% (n=34)	
Dyslipidaemia (2)			
Low (n=103)	36.9% (n=38)	63.1% (n=65)	P<0.0001 (n=338)
Medium/High (n=235)	70.2% (n=165)	29.8% (n=70)	
Hypothyroid (1)			
Low/Medium (n=211)	48.3% (n=102)	51.7% (n=109)	P<0.0001 (n=332)
High (n=121)	81.0% (n=98)	19.0% (n=23)	
Hypothyroid (2)			
Low (n=115)	35.7% (n=41)	64.3% (n=74)	P<0.0001 (n=332)
Medium/High (n=217)	73.3% (n=159)	26.7% (n=58)	

[d] High is defined as =8, Medium 6-<8, Low <6.