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# Copayment Level and Drug Switching: Findings for Type 2 Diabetes

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## ABSTRACT

**Objective:** To assess the relationship between copayment level and drug switching among insured patients who initiated a medication regime for treatment of type 2 diabetes.

**Study Design:** Retrospective observational study.

**Methods:** Medical claims data were used to examine continuous periods of use for therapeutic classes of drugs within formulary tiers. Switching to more expensive drugs or drugs of equal or lesser cost was based on the relevant out-of-pocket costs to the patient for the initial drug versus the drug the patient switched to. Data were analyzed using multistate proportional hazards models.

**Results:** A total of 9260 participants met the inclusion criterion. Each \$5 increase in copayment was associated with decreased rates of switching to a relatively more expensive drug (hazard ratio [HR] = 0.49, 95% confidence interval [CI] = 0.43, 0.56) and an increased rate of switching to drugs of equal or lesser cost (HR = 1.04, 95% CI = 1.03, 1.05). Patients with better glycemic control were more likely to switch to relatively less expensive drugs in response to increased copayments (HR = 1.10, 95% CI = 1.07, 1.13). Compared with Japanese patients, Filipinos and Native Hawaiian or Pacific Islanders had the greatest difference in rates of drug switching at lower copayments, whereas Chinese patients had the greatest rates of switching at higher copayments.

**Conclusions:** Cost sharing can shift patients with diabetes toward use of less expensive drugs. Clinical and sociodemographic factors affect the rates of switching. Clinical implications of drug switches should be examined.

(*Am J Pharm Benefits*. 2010;2(6):412-420)

As healthcare expenditures continue to rise, insurers seek to slow the rate of growth through the implementation of cost-containment measures. A common cost-containment measure is the incentive formulary, which attempts to disincentivize patients from choosing more expensive brand-name drugs.<sup>1,2</sup> Previous studies have shown that cost-containment measures including tiered formularies succeed in reducing overall consumption of prescription drugs by health plan members, reducing health plan spending on pharmaceuticals, and encouraging the choice of less expensive over more expensive medications.<sup>3-6</sup> Possible effects of cost sharing include switching to lower-cost drugs, treatment interruptions, and taking medications less frequently than prescribed to extend the period of use for prescription drugs.<sup>7-9</sup> The majority of studies to date have focused on only a few therapeutic classes of drugs, most notably angiotensin-converting enzyme inhibitors, proton pump inhibitors, and statins.<sup>10-12</sup> Several studies have examined hypertension,<sup>7,13,14</sup> although other diagnoses have not been adequately considered.

Diabetes mellitus, with an estimated total prevalence of 7% and medical expenditures totaling \$174 billion,<sup>15</sup> is a serious public health problem that disproportionately affects ethnic subgroups such as non-Hispanic blacks, American Indians, Alaska Natives, Native Hawaiians, and Filipinos.<sup>16,17</sup> In Hawaii, the setting of this study, the prevalence of diabetes among Native Hawaiians is 11.5% and 10.4% among Filipinos.<sup>16</sup> Although previous studies have examined the relationship between cost sharing and medication use among diabetic patients,<sup>5,18</sup> to our knowledge, no studies to date have looked at the interaction between drug switching and cost sharing, an issue with potential implications for diabetes management.

To address this gap, we examined the relationship between copayment level and drug switching among patients who newly initiated a medication regime for the treatment of type 2 diabetes. The conceptual model guiding this investigation was

the economic framework for healthcare demand proposed by Gibson et al.<sup>1</sup> According to this framework, raising the cost-sharing level for prescription drugs is expected to result in (1) reduced consumption of drugs overall; (2) substitution of less expensive, equivalent drugs; and (3) a decrease in consumption of “nonessential” drugs (eg, discretionary drugs like antihistamines).<sup>1</sup> We hypothesized that higher copayments would increase the rate of switches to drugs with lower copayments, and also that copayment levels might have a differential effect on drug switching depending on disease severity.

## METHODS

### Study Design and Population

The design was a retrospective observational study. The study population was drawn from members of a single health plan in the state of Hawaii that provides coverage to approximately 650,000 members, or about 50% of the state’s total insured population.<sup>14</sup> Inclusion in the study required patients to have (1) a diagnosis of type 2 diabetes and (2) a first filled prescription for a diabetes-related medication after at least 1 full year of prior enrollment. Patients were excluded if (1) they had type 1 diabetes or (2) they filled 2 different prescription diabetes medications on their first or index date. A small number of patients (n = 779) began on polytherapy and were excluded from the final study sample. Data were extracted for eligible members during the study period from January 2002 through August 2007. No universal changes in copayments occurred for this insured population during the study period. However, the study population was limited to patients who newly initiated pharmacologic treatment of their diabetes, in order to isolate “new” diabetes patients using antidiabetic medications from chronic antidiabetic medication users.

As previous studies have documented a lack of communication between patients and providers about the out-of-pocket costs for medications, we did not assume that discussions about cost occurred prior to the time the first prescription was filled.<sup>19,20</sup> In addition, other studies have shown that clinicians often are unaware of the cost of different medications and therefore do not take cost into account when prescribing.<sup>21</sup> A patient’s data were included from the date of the first prescription until the end of the study period or the end of continuous enrollment, whichever was sooner. This study was approved by the University of Hawaii Committee on Human Studies.

### Data Sources

The medical claims database provided a limited data

## PRACTICAL IMPLICATIONS

This study found that copayments, clinical characteristics, and sociodemographic factors may influence drug switching among type 2 diabetics.

- For each \$5 increase in copayment, patients were less likely to switch to drugs with higher copayments and more likely to switch to drugs of equal or lesser cost than the initial drug.
- The effect of copayment on patterns of drug switching varied between patients with high versus low hemoglobin A1C levels.
- Increases in copayments affected specific ethnic groups differently.

set on diagnoses, patient utilization, type of insurance plan (fee-for-service or HMO plan), demographic information, and morbidity levels (Johns Hopkins Adjusted Clinical Groups Case-Mix System; see [www.acg.jhsph.edu](http://www.acg.jhsph.edu)) for the 3-month period preceding the index prescription.<sup>22</sup> The pharmacy claims database provided data on medications including prescription fill dates, days of supply, copayment (out-of-pocket cost to the patient), and formulary tier. Medications were categorized by therapeutic class (all classes of oral hypoglycemics as well as insulins) within formulary tier (generic, preferred brand, and nonpreferred brand). Glycosylated hemoglobin (A1C) levels were obtained from laboratory reports from the various diagnostic laboratories. The laboratory value that most closely followed the index prescription was included in analyses. Ethnicity and education were obtained from member satisfaction surveys that are mailed annually to a random sample of the insurer’s members with response rates of 40% to 50%.

### Variable Definitions

Patients were considered to have switched drugs if they discontinued use of the starting drug *and* filled a prescription either (1) for a drug in a different diabetes therapeutic class or (2) for a drug in the same therapeutic class but in a different tier. Discontinuation was defined as having a gap between prescriptions greater than twice the length of the first prescription. Similarly, the study window to switch to a second drug was twice the length of the first prescription. Patients who discontinued therapy completely (ie, stopped filling their current prescription drug without adding another drug) were treated as censored from the end date of their last prescription. Gaps were calculated as the difference between the end date of the first prescription (based on the days

**Table 1. Demographic Characteristics of Study Participants (n = 9260)**

Characteristic	No. (%)	Characteristic	No. (%)
Age, y		Initial drug, formulary tier	
<45	1742 (18.81)	Biguanide, generic	3831 (41.37)
45-64	5322 (57.47)	Biguanide, other brand	317 (3.42)
65+	2196 (23.71)	Dipeptidyl peptidase-4 inhibitor, other brand	30 (0.32)
Sex		Dipeptidyl peptidase-4 inhibitor/biguanide, other brand	2 (0.02)
Female	4353 (47.01)	Glucosidase inhibitor, preferred brand	37 (0.40)
Male	4907 (52.99)	Insulin, generic	187 (2.02)
Ethnicity <sup>a</sup>		Meglitinide, other brand	233 (2.52)
Caucasian	371 (10.49)	Sulfonylurea, generic	1395 (15.06)
Chinese	283 (8.00)	Sulfonylurea, other brand	438 (4.73)
Filipino	650 (18.38)	Sulfonylurea/biguanide, generic	356 (3.84)
Japanese	1413 (39.95)	Sulfonylurea/biguanide, other brand	248 (2.68)
Native Hawaiian or Pacific Islander	634 (17.92)	Thiazolidinedione, other brand	1877 (20.27)
Other	186 (5.26)	Thiazolidinedione/biguanide, other brand	294 (3.17)
Education <sup>a</sup>		Thiazolidinedione/sulfonylurea, other brand	15 (0.16)
High school or less	1021 (37.27)	Distribution of initial copayment	
Some college	886 (32.35)	<\$5	1409 (13.26)
College/postgraduate degree	832 (30.38)	\$5	4922 (49.34)
Insurance type		>\$5 and <\$15	1187 (11.17)
Fee-for-service	7335 (79.21)	\$15	1414 (13.31)
HMO	1925 (20.79)	>\$15	1690 (15.91)
Morbidity level <sup>a</sup>		Distribution of copayment for second filled prescription <sup>a</sup>	
Low	3061 (33.33)	<\$5	1402 (13.39)
Medium	3519 (38.19)	\$5	4461 (45.78)
High	2605 (28.36)	>\$5 and <\$15	1037 (10.64)
A1C <sup>a</sup>		\$15	1299 (13.33)
≥7%	3445 (48.14)	>\$15	1545 (15.86)
<7%	3711 (51.86)		

A1C indicates glycosylated hemoglobin.

<sup>a</sup>Missing values were omitted.

of supply) and the fill date for the second prescription. Similar definitions of drug switching have been used in previous studies.<sup>7,23</sup>

This study focused on switching patterns related to the patient's initial drug. If patients subsequently added drugs of a different diabetes therapeutic class while continuing use of the starting drug, the additional drugs were not examined for switches. Drugs added after the patient discontinued use of their initial drug, however, were followed for switches. Multiple drug switches were included in the analyses for such patients.

Copayments were continuous and were standardized in units of \$5 per 30-day period. Glycosylated

hemoglobin values were reported as a continuous variable in units of percent hemoglobin that was glycosylated, as a dichotomy between A1C ≥7% and A1C <7%, or in more refined categories with unit increases from 6% to 10%. Switches to more expensive drugs or drugs of equal or lesser cost were based on the difference between the out-of-pocket copayment for the initial drug and the out-of-pocket copayment of the drug the patient switched to. In other words, they were based on the relevant out-of-pocket costs to the patient.

### Statistical Analysis

Data were analyzed using multistate proportional

**Table 2. Rates of Drug Switching by Copayment and A1C Levels<sup>a</sup>**

Covariate	Hazard Ratio	95% Confidence Interval
<b>Copayment level</b>		
<\$5	1.00	–
\$5	1.34	1.04, 1.71 <sup>b</sup>
>\$5 and <\$15	1.49	1.11, 2.00 <sup>b</sup>
\$15	1.76	1.34, 2.30 <sup>b</sup>
>\$15	1.95	1.50, 2.53 <sup>b</sup>
<b>A1C level</b>		
<6%	1.00	–
≥6% and <7%	1.13	0.88, 1.47
≥7% and <8%	1.53	1.18, 1.98 <sup>b</sup>
≥8% and <9%	1.79	1.35, 2.36 <sup>b</sup>
≥9% and <10%	2.10	1.54, 2.86 <sup>b</sup>
≥10%	2.31	1.70, 3.14 <sup>b</sup>

A1C indicates glycosylated hemoglobin.

<sup>a</sup>The model included indicators for copayment, A1C, age, sex, morbidity level, insurance type, and calendar year.

<sup>b</sup>P < .05

hazards models.<sup>24,25</sup> The multistate model extends the traditional proportional hazard model by allowing transitions from multiple starting to multiple ending states. “States” were defined as periods of continuous drug use as specified above. Drug switches were modeled as changes in states. Copayment amounts and prescription drug choice were reset in the data set at the date of each drug switch. The effect of covariates on a transition such as from state *i* to state *j* assumed a proportional hazards model on the transition hazards. The transition hazard  $\lambda_{ij}$  (*t*;*z*) for transition from state *i* to state *j* is given by

$$\lambda_{ij}(t; z) = \lambda_{ij,0} t \exp(\beta_1 z_1 + \dots + \beta_p z_p),$$

where  $\lambda_{ij,0} t$  is the baseline hazard for an individual with covariates of 0 for the transition from state *i* to state *j*, and *z* is a vector of covariates (ie,  $z_1, \dots, z_p$ ).

Interactions between A1C levels and copayment were modeled using A1C dichotomized between ≥7% and <7%, and continuous copayment amounts. Interactions between certain ethnicities and copayment also were examined and are illustrated by a graph of hazard ratios (HRs) by copayment amounts. All analyses were completed using SAS version 9.1 (SAS Institute Inc, Cary, NC).

## RESULTS

### Demographic and Clinical Characteristics

A total of 9260 adults with diabetes were included in this study; analyses by ethnic subgroup included the 3537 members with ethnicity data available. Nearly 60% of the patients were between 45 and 64 years of age and 53%

were male (Table 1). Of participants with known ethnicity, the majority (40%) self-identified as Japanese, with Filipinos (18%) and Native Hawaiian or Pacific Islanders (18%) comprising the next largest ethnic subgroups. Although exact comparisons are difficult, this ethnic breakdown is roughly consistent (both in rank and percentage) with the general population of diabetic patients in the state of Hawaii, with the exception of a higher proportion of patients with self-reported Japanese ethnicity.<sup>26</sup> However, it is unclear whether this discrepancy represents a higher response rate from this ethnic group or a greater proportion of Japanese enrollees within this insured population. Most Caucasians (47%) and Chinese (42%) reported having at least a college degree, while the majority of Filipino (46%), Native Hawaiian or Pacific Islanders (49%), and those choosing other ethnicities (51%) reported having a high school diploma or less (data not shown). Educational attainment was approximately evenly distributed for Japanese, with 31% reporting a high school diploma or less, 35% reporting some college, and 35% reporting at least a college degree. Almost 80% of patients had fee-for-service insurance.

Morbidity among study participants was nearly equally distributed between low, medium, and high levels, with slightly fewer patients having high morbidity levels (28%) and slightly more having medium levels (38%). More than half (52%) of all diabetic patients were at target A1C levels of less than 7%. Approximately 90% of all copayments fell within the range of \$5 to \$35. The most common

**Table 3. Two Models of the Direction of Drug Switches<sup>a</sup>**

Model and Outcome State	Hazard Ratio	95% Confidence Interval
<b>Model 1: associations between copayment and drug switching</b>		
Switch to more expensive drug <sup>b</sup>	0.49	0.43, 0.56 <sup>c</sup>
Switch to drug of equal or lesser cost <sup>d</sup>	1.04	1.03, 1.05 <sup>c</sup>
<b>Model 2: associations between copayment and drug switching by patient's A1C levels<sup>e</sup></b>		
Effect of copayment when A1C was <7%		
Switch to more expensive drug <sup>b</sup>	0.46	0.37, 0.58 <sup>c</sup>
Switch to drug of equal or lesser cost <sup>d</sup>	1.10	1.07, 1.13 <sup>c</sup>
Effect of copayment when A1C was ≥7%		
Switch to more expensive drug <sup>b</sup>	0.51	0.33, 0.69 <sup>c</sup>
Switch to drug of equal or lesser cost <sup>d</sup>	1.03	1.02, 1.04 <sup>c</sup>

A1C indicates glycosylated hemoglobin.

<sup>a</sup>Both models were adjusted for age, sex, morbidity level, insurance type, A1C, and calendar year.

<sup>b</sup>Switch to a drug with a copayment greater than the copayment for the initial drug.

<sup>c</sup> $P < .001$ .

<sup>d</sup>Switch to a drug with a copayment less than or equal to the copayment for the initial drug.

<sup>e</sup>For model 2, hazard ratios for switching to drugs of equal or lesser cost differed significantly by A1C levels ( $P < .001$ ); however, rates of switching to more expensive drugs were not significantly different ( $P = .78$ ).

copayment amount for either the first (49%) or second (46%) filled antidiabetic prescription was \$5. More than 15% of antidiabetic medications prescribed (either first or second filled prescription) had out-of-pocket costs at the highest copayment tier of more than \$15. Participants initially filled prescriptions for 1 of 14 drugs. Therapeutic classes of drugs utilized by participants during the study period were as follows: sulfonylureas, sulfonylureas/biguanides, biguanides, thiazolidinediones, thiazolidinediones/biguanides, thiazolidinedione/sulfonylureas, incretin mimetics, dipeptidyl peptidase-4 inhibitors, dipeptidyl peptidase-4 inhibitor/biguanides, meglitinides, glucosidase inhibitors, and insulins. A total of 1376 patients switched to different drugs (13%), and 4408 (48%) discontinued therapy completely by the end of the study period.

### Copayments and A1C

Compared with the lowest copayment level (<\$5) for the initial antidiabetic medication, higher copayment levels were associated with increased rates of drug switching, with an almost 2-fold increased rate seen for copayments of more than \$15 (HR = 1.95, 95% confidence interval [CI] = 1.50, 2.53) (Table 2). Similarly, increasing A1C levels were monotonically associated with increased rates of switching drugs. Compared with patients who had A1C values of less than 6%, patients with A1C values of 10% or greater had a more than 2-fold increased rate of switching drugs (Table 2).

Table 3 shows the direction of switches to drugs with higher copayments or copayments of equal or lesser cost

relative to the cost of the starting drug (model 1) and stratified by A1C values (model 2). For each \$5 copayment increase over a standard 30-day period, study participants were significantly less likely to switch to a more expensive drug (HR = 0.49, 95% CI = 0.43, 0.56) and significantly more likely to switch to a drug of equal or lesser cost (HR = 1.04, 95% CI = 1.03, 1.05) (Table 3). The relationship between copayment and drug-switching rate also was examined within subgroups by levels of glycemic control. Patients with optimal glycemic control (A1C <7%) were more likely to switch to a drug of equal or lesser cost (HR = 1.10, 95% CI = 1.07, 1.13). A similar relationship on a reduced scale (HR = 1.03, 95% CI = 1.02, 1.04) also was found for patients with suboptimal glycemic control (A1C ≥7%). Comparisons of the HRs for patients with optimal versus suboptimal glycemic control revealed that switches to drugs of equal or lesser cost differed significantly ( $P < .001$ ), suggesting that patients with A1C ≥7% were less affected by increases in copayment than patients with A1C <7%. The results from the above models were not significantly altered when patients on insulin were excluded from the data set.

### Ethnicity and Education

In analyses by ethnic subgroup, Japanese, Caucasian, Chinese, Filipino, and Native Hawaiian/Pacific Islander populations did not differ significantly in their rates of drug switching ( $P > .05$ ), and rates of drug switching were not significantly influenced by educational attainment (Table 4). However, compared with Japanese (the largest

**Table 4. Rates of Drug Switching by Ethnicity and Educational Attainment<sup>a</sup>**

Covariate	Hazard Ratio	95% Confidence Interval
<b>Ethnicity</b>		
Japanese	1.00	—
Caucasian	0.94	0.58, 1.51
Chinese	1.46	0.94, 2.25
Filipino	1.13	0.80, 1.58
Native Hawaiian or Pacific Islander	1.32	0.96, 1.81
Other	1.65	1.01, 2.69 <sup>b</sup>
<b>Education</b>		
High school or less	1.00	—
Some college	0.94	0.71, 1.24
College degree	0.94	0.69, 1.26

A1C indicates glycosylated hemoglobin.

<sup>a</sup>The model included ethnicity and education and was adjusted for age, sex, morbidity level, insurance type, copayment, A1C, and calendar year.

<sup>b</sup>*P* < .05.

ethnic group among study participants) as the referent group, significant interactions were detected between copayment level and indicators of Chinese (*P* = .04), Filipino (*P* < .0001), and Native Hawaiian or Pacific Islander (*P* = .01) ethnicities. The modifying effects were in different directions. Filipino and Native Hawaiian or Pacific Islander patients had the greatest difference in rates of drug switching compared with Japanese patients at low copayments (Figure). Interestingly, for Chinese patients, the pattern was reversed and Chinese participants had the greatest rates of switching at higher copayment amounts.

## DISCUSSION

Understanding the health impact of drug switching and cost sharing is a topic of ongoing interest among patients, providers, and healthcare insurers, particularly within the context of escalating healthcare and pharmaceutical costs. In this study, higher copayments were associated with increased rates of drug switching even after adjusting for other covariates. As expected, participants were more likely to switch to a drug that was less expensive than their first prescription. Our findings are consistent with other studies that have found that increases in cost-sharing are associated with decreased use of higher-cost diabetes medications.<sup>27-30</sup>

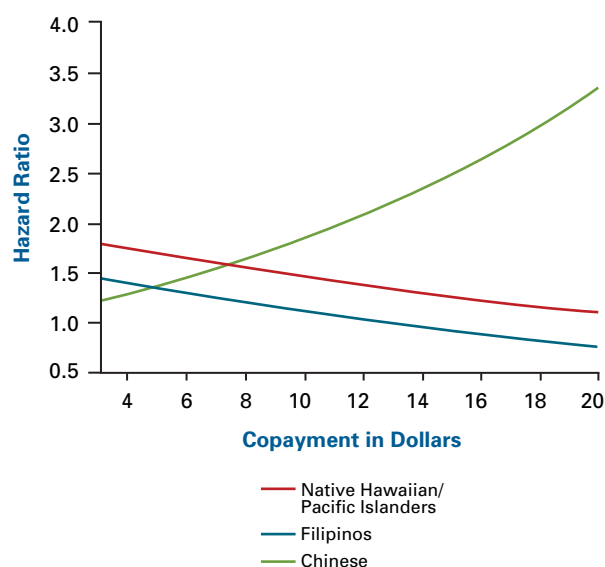
Previous studies also have found that patients may exhibit different patterns of drug switching depending on whether their medications fall into the “essential” versus “discretionary” therapeutic class.<sup>18,29,31</sup> In this study, we examined only patients who were taking antidiabetics,

an essential class of medications, and found that the associations between copayment amounts and drug-switching patterns were associated with A1C levels and patient ethnicity. Patients with higher A1C levels were significantly more likely to switch drugs than patients with lower A1C levels. However, this relationship may be influenced by other unmeasured variables such as healthcare providers who may switch patients’ therapies to improve glycemic control rather than because of cost alone (ie, copayments).

When the relationship was examined between cost sharing and switches to drugs with more or less expensive copayments (relative to the cost of the starting drug), significant associations were found between copayment level and both decreased rates of switching to more expensive drugs and increased rates of switching to drugs of equal or lesser cost. Although the increased rate of switching to drugs of equal or lesser cost was modest (HR = 1.04, 95% CI = 1.03, 1.05), the magnitude of this effect must be evaluated within the larger context of the number of patients enrolled in various health systems nationally rather than solely within the limited scope of an individual insurer.

Another finding of this study was the varied effect of copayment level on drug switches between patients with high versus low A1C values. For each \$5 difference in out-of-pocket costs, patients with better glycemic control (A1C <7%) were 7% more likely to switch to drugs with equal or lesser copayments in the next 30-day period than patients with poorer glycemic control (A1C ≥7%). This effect was magnified as copayment amounts increased.

**Figure.** Hazard Ratios by Copayment Amount Comparing Native Hawaiian, Filipino, and Chinese Ethnicities With Japanese Ethnicity<sup>a</sup>



A1C indicates glycosylated hemoglobin.

<sup>a</sup>Analysis was adjusted for age, sex, morbidity level, and A1C.

Patients with a \$20 higher copayment were 28% more likely to switch to a drug of equal or lesser cost. These results may reflect differences in the willingness of patients with less controlled disease to disrupt their existing therapy by switching to a new drug, even within an essential class of medications. Conversely, the findings also may suggest that patients with well-controlled diabetes are considering factors such as long-term costs and exploring less expensive alternatives.

Multiple clinical trials have established the importance of optimal glycemic control in preventing microvascular complications<sup>32</sup>; thus, the clinical implications of these findings are relevant to the long-term management of type 2 diabetes. In addition, the variation in drug-switching patterns by levels of glycemic control suggests that other studies might have been strengthened by examining similar markers of disease severity, for example, blood pressure in studies of antihypertensives.

Patterns of medication use are significantly affected by a number of different factors at multiple different levels including the individual, physician, and health plan. A 2004 study found that patient attitudes and physician prescribing patterns may significantly influence the decision to change medications.<sup>33</sup> Ethnic subgroups also may respond differently to cost pressures.<sup>6,34</sup> For example, Steinman et al reported that nonwhite Americans were

more than 3 times as likely to have taken less medication than prescribed because of cost (relative risk = 3.4, 95% CI = 2.4, 4.7), even after controlling for age, sex, income, education, marital status, out-of-pocket prescription drug costs, and 3 measures of health status.<sup>34</sup> Our study found that copayment level had a differential effect on Chinese, Filipino, and Native Hawaiian or Pacific Islander patients compared with Japanese patients. Given the increasing body of literature on the role of ethnicity in health and disease,<sup>35</sup> the results of this study suggest that further analyses of the influence of these important factors on drug switching should be considered.

Finally, regarding methodology, previous studies examined drug switches either in terms of differences in the proportion of participants who were on a particular drug in a pre/post comparison,<sup>11,27,29</sup> or in terms of the length of time that patients remained on their initial drug in survival analyses.<sup>7,36</sup> This study used a more powerful multistate methodology that modeled multiple drug switches over time. Thus, our findings extend the existing literature by providing confirmatory evidence of trends over time for multiple successive drug switches rather than restricting the event of interest to the first drug switch only.

This study has a number of limitations. Using data from a single insurer limits the generalizability of the findings. In addition, although the study included A1C as a measure of disease severity, only initial A1C values were included; thus, the effects of changing A1C levels over time were not addressed. In addition, the data did not include the dates of diagnosis of diabetes and consequently did not allow a consideration of differences in the length of time between the diagnosis and the first filled prescription. Data on income levels were not available in this administrative data set, although models with ethnicity were adjusted for education as a proxy measure for income. We also chose to exclude patients who did not initiate therapy, although the choice not to initiate pharmacologic treatment also is an important aspect of patient behavior and may be influenced by issues related to cost sharing. Finally, data were not available on the clinical appropriateness of drug switching. Thus, it is unclear whether drug switches were positive or negative events, an issue that might be addressed in the future.

Strengths of this study include the availability of data from approximately half of the insured population in a state that has a stable, ethnically diverse patient population with little out-migration. In examining only new initiators of medication regimes for the treatment of diabetes, the study design avoided mixing new and

continuing users, groups that may have different responses to cost sharing. The use of multistate modeling allowed the separate investigation of drug switches to more expensive drugs or to drugs of equal or lesser cost. In addition, the analyses considered the influence of A1C levels, ethnicity, education, and interactions between these variables and copayment amount on the rates of drug switching. Previous studies of drug switching have seldom examined the importance of sociodemographic factors other than age and sex.

## CONCLUSIONS

This study provides confirmatory evidence that copayments are associated with changes in patterns of drug switching. It also extends the existing literature by examining drug switching within a previously understudied disease, diabetes, and among understudied populations of Native Hawaiians and Asian/Pacific Islanders. Although an understanding of the direct clinical implications of this study requires further exploration of the consequences of drug switches, clinicians should be aware that prescribing more costly medications may influence patients' desire to switch drugs. Thus, accurate, accessible prescribing guides and other related materials are needed to aid physicians in making these decisions. Future research should consider clinical and sociodemographic factors including measures of disease severity over time, ethnicity, and income, as well as the clinical implications of drug switches such as effects on medication adherence and glycemic control.

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**Funding Source:** This work was supported in part by the Master and PhD in Clinical Research programs at the University of Hawaii, R25RR019321 and K07GM072884; the Center for Native and Pacific Health Disparities Research, P20MD000173; the Myron "Pinky" Thompson Endowed Chair; and the Department of Native Hawaiian Health, John A. Burns School of Medicine, University of Hawaii at Manoa.

**Author Disclosures:** The authors (EPS, JWD, RCH, DJ, MKM) report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

**Authorship Information:** Concept and design (EPS, JWD); acquisition of data (EPS, JWD); analysis and interpretation of data (EPS, JWD, RCH, DJ); drafting of the manuscript (EPS, RCH, DJ, MKM); critical revision of the manuscript for important intellectual content (EPS, JWD, RCH, DJ, MKM); statistical analysis (EPS, JWD); administrative, technical, or logistic support (MKM); and supervision (JWD, MKM).

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