USE OF THE ADJUSTED CLINICAL GROUP TO DETERMINE MORBIDITY BURDEN, HEALTHCARE RESOURCE USE, AND QUALITY OF CARE IN DIABETIC PATIENTS AT BUDDHACHINARAJ HOSPITAL, PHITSANULOK

ROONGKARN PANNARUNOTHAI

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…….……..……..….
Mrs. Roongkarn Pannarunothai
Candidate

…….
Assoc. Prof. Petcharat Pongcharoensuk,
Ph.D. (Pharmacy Administration)
Major advisor

……..……
Lect. Nilawan Upakdee,
Ph.D. (Health Systems and Policy)
Co-advisor

…….
Miss Oraluck Pattanaprateep,
Ph.D. (Pharmacy administration)
Co-advisor

……..…
Prof. Banchong Mahaisavariya,
M.D. Dip. Thai Board of Orthopedics
Dean
Faculty of Graduate Studies
Mahidol University

……..……..
Assoc. Prof. Arthorn Riewpaiboon,
Ph.D. (Pharmacy)
Program Director
Master of Science in Pharmacy Program
in Pharmacy Administration
Faculty of Pharmacy
Mahidol University

Thesis
entitled

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for the degree of Master of Science in Pharmacy
(Pharmacy Administration)
on
November 22, 2012

……..……..
Mrs. Roongkarn Pannarunothai
Candidate

……..…
Assoc. Prof. Petcharat Pongcharoensuk,
Ph.D. (Pharmacy Administration)
Member

……
Assist. Prof. Nattiya Kapol,
Ph. D. (Social and Administrative Pharmacy)
Chair

……..……
Lect. Nilawan Upakdee,
Ph.D. (Health Systems and Policy)
Member

……..…….
Miss Oraluck Pattanaprateep,
Ph.D. (Pharmacy Adminstration)
Member

……..……
Prof. Banchong Mahaisavariya,
M.D. Dip. Thai Board of Orthopedics
Dean
Faculty of Graduate Studies
Mahidol University

……..……..
Assoc. Prof. Chuthamanee Suthisisang,
Ph.D. (Pharmacology)
Dean
Faculty of Pharmacy
Mahidol University

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ROONGKARN PANNARUNOTHAI 5336309 PYPA/M

M.Sc. in Pharm. (PHARMACY ADMINISTRATION)

THESIS ADVISORY COMMITTEE: PETCHARAT PONGCHAROENSUK, Ph.D., NILAWAN UPAKDEE, Ph.D., ORALUCK PATTANAPRATEEP, Ph.D.

ABSTRACT

This was a retrospective, longitudinal cohort study of a regional hospital's electronic databases for four consecutive years (2008-2011). The objective was to determine morbidity burden, resource use, and quality of care for patients with diabetes, using the Adjusted Clinical Group (ACG) methodology. Electronic data on demographics, clinical conditions, resource utilization, and pharmacies were analyzed.

A total of 5,535 diabetic patients who made at least one diabetes- related visit per year between 2008 and 2011 were recruited. Two-thirds were females and there was an average of 8.5 outpatient visits per person per year. One-fifth (21-23%, depending on year) of patients had at least one emergency visit, and one-sixth (14-18%, depending on year) had at least one hospitalization each year. More than half of the patients were categorized in the Resource Utilization Band (RUB) 3 or moderate morbidity group, but with an upward trend for the higher morbidity groups, RUB 4 and 5.

For pharmacy data, the average number of unique Medication-Defined Morbidity Groups (Rx-MGs) was 6.6. The top three most assigned Rx-MGs were Endocrine (diabetes without insulin), Cardiovascular (high blood pressure), and Cardiovascular (hyperlipidemia). Medication accounted for three quarters of total expenditures with an average of 18,700 baht (SD 30,224) per person per year in 2008, but with a downward trend during 2009 and 2011.

For process measures of diabetes management, more patients were monitored in each subsequent year with HbA1c but with less favorable results; 42% reached target HbA1c (< 7%) in 2008, but only 38% in 2011. More patients in each subsequent year were monitored that had lipid profiles with higher favorable results; 76% to 82% of diabetic patients were tested depending on year, with 61% to 72 % reaching the target of < 100 mg/dl. For renal function assessment, only 19-35% of diabetic patients had an annual protein urine test.

This study demonstrated the feasibility of using the ACG system to determine morbidities in patients with diabetes and monitor their healthcare utilizations in comparison with outcomes.

KEY WORDS: ADJUSTED CLINICAL GROUP / DIABETIC PATIENT / MORBIDITY BURDEN / QUALITY OF CARE / RESOURCE USE

142 pages

การประยุกต์ใช้ระบบกลุ่มโรคร่วมปรับค่าคลินิกเพื่อประเมิน ภาระโรค การใช้ทรัพยากรทางสุขภาพ และคุณภาพของการรักษา ในกลุ่มผู้ป่วยเบาหวานของโรงพยาบาลพุทธชินราช พิษณุโลก

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รุ่งกานต์ พรรณารุโณทัย 5336309 PYPA/M

ภ.ม. (บริหารเภสัชกิจ)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์: เพชรรัตน์ พงษ์เจริญสุข, Ph.D., นิลวรรณ อยู่ภักดี, Ph.D.,
อรลักษณ์ พัฒนาประทีป, Ph.D.

บทคัดย่อ

การศึกษานี้เป็นการเก็บข้อมูลย้อนหลังจากฐานข้อมูลอิเล็กโทรนิกส์ของโรงพยาบาลศูนย์ โดยมีวัตถุประสงค์เพื่อประเมิน ภาระโรค การใช้ทรัพยากรทางสุขภาพ และคุณภาพของการรักษา ในกลุ่มผู้ป่วยเบาหวานของโรงพยาบาลพุทธชินราช พิษณุโลก ช่วงเวลา 4 ปี (2551-2554) โดยใช้ซอฟแวร์ของระบบการจัดกลุ่มโรคร่วมปรับค่าคลินิกของมหาวิทยาลัยจอนห์ฮอบกินส์วิเคราะห์ข้อมูล

ผลการศึกษาพบว่า มีผู้ป่วยเบาหวานเข้าร่วมในการศึกษา 5,535 คน เข้ารับบริการที่แผนกผู้ป่วยนอกในช่วงเวลา 4 ปีติดต่อกัน สองในสามเป็นเพศหญิง รับบริการในแผนกผู้ป่วยนอกเฉลี่ย 8.5 ครั้งต่อคนต่อปี หนึ่งในห้าของผู้ป่วยรับบริการในแผนกฉุกเฉินอย่างน้อย 1 ครั้งต่อปี และหนึ่งในหกของผู้ป่วยเข้ารับการรักษาแบบผู้ป่วยในอย่างน้อย 1 ครั้งต่อปี มากกว่าครึ่งหนึ่งของผู้ป่วยถูกจัดอยู่ในกลุ่มกลุ่มภาระโรคปานกลาง แต่จำนวนผู้ป่วยในกลุ่มภาระโรคสูงและสูงมากมีแนวโน้มสูงขึ้นในช่วง 4 ปี ข้อมูลการใช้ยา ผู้ป่วยมีค่าเฉลี่ยของจำนวนกลุ่มยาตามระบบกลุ่มโรคร่วม 6.6 กลุ่มต่อคนต่อปี โดย 3 กลุ่มยาที่มีการใช้สูงสุดคือ กลุ่มต่อมไร้ท่อเบาหวานซึ่งไม่ใช้อินสุลิน กลุ่มหลอดเลือดหัวใจความดันโลหิตสูง และกลุ่มหลอดเลือดหัวใจไขมันในเลือดสูง สัดส่วนค่าใช้จ่ายด้านยาคิดเป็นสามในสี่ของค่าใช้จ่ายทั้งหมดแต่มีแนวโน้มลดลง ในช่วง 4 ปีผู้ป่วยจำนวนมากขึ้นได้รับการตรวจระดับน้ำตาลสะสม (ร้อยละ 74 ในปี 2551- ร้อยละ 80 ในปี 2554) แต่ผลการตรวจที่ได้ตามเป้าหมายต่ำลง (ร้อยละ 42 ในปี 2551- ร้อยละ 38 ในปี 2554) ผู้ป่วยจำนวนมากขึ้นได้รับการตรวจระดับไขมัน LDL (ร้อยละ 76 ในปี 2551- ร้อยละ 82 ในปี 2554) และผลการตรวจได้ตามเป้าหมายสูงขึ้น (ร้อยละ 61 ในปี 2551- ร้อยละ 72 ในปี 2554) สำหรับการตรวจการทำงานของไต มีผู้ป่วยเพียงร้อยละ 19 ในปี 2551- ร้อยละ 35 ในปี 2554 ที่ได้รับการตรวจไมโครอัลบูมินในปัสสาวะ

การจัดกลุ่มผู้ป่วยนอก ของระบบจัดกลุ่มโรคร่วมปรับค่าคลินิกสามารถนำมาประยุกต์ใช้ในการประเมินภาระโรค ในกลุ่มผู้ป่วยเบาหวาน รวมถึงวิเคราะห์การใช้ทรัพยากรทางสุขภาพ และคุณภาพของการรักษา

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(A-Z)

ACEI	=	Angiotensin converting enzyme inhibitor
ACG	=	Adjusted Clinical Group
ADA	=	American Diabetes Association
ADG	=	Aggregated Diagnosis Groups
ARB	=	Angiotensin receptor blocker
ATC	=	Anatomical Therapeutic Chemical classification
CADG	=	Collapsed Aggregated Diagnosis Group
CHEM	=	Centre for Health Equity Monitoring
CSMBS	=	Civil Servant Medical Benefit Scheme
DSME	=	Diabetes self management education
EASD	=	European Association for the Study of Diabetes
FPG	=	Fasting plasma glucose
GDM	=	Gestational diabetes mellitus
GDP	=	Gross domestic product
ICD	=	International Classification of Diseases
IDF	=	International Diabetes Federation
IFG	=	Impaired fasting glucose
MAC	=	Major ambulatory Category
MNT	=	Medical nutrition therapy
NHES	=	National Health Examination Survey
RUB	=	Resource Utilization Band
Rx-MG	=	Rx-Defined Morbidity Group
SMBG	=	Self- monitoring of blood glucose
SSS	=	Social Security Scheme
UC	=	Universal Coverage Scheme

CHAPTER I
INTRODUCTION

Background and Rationale

Diabetes has become a major global public health burden. It has been estimated that the number of people with diabetes worldwide was 285 million in 2010 and will increase to 439 million in 2030, with the majority of increase (69%) occurring in developing countries (1). The estimated number of individuals with diabetes in Asia was 113 million in 2010 and will increase to 180 million in 2030 (2). In Thailand, diabetes is one of the important public health concerns which has been a major cause of morbidity and mortality in the past decade (3). Diabetes alone is responsible for 3.3 and 8.3% of total deaths in Thai men and women, respectively (3). In 2009, the National Health Examination Survey (NHES) IV reported a prevalence of 10.6 and 7.5% for impaired fasting glucose (IFG) and diabetes, respectively. Of all diabetes diagnoses, 35.4% were not previously diagnosed, and the proportion was higher in men than in women (47.3 vs. 23.4%, P = 0.05) (4). The hospitalization rate for diabetes in Thailand had shown a rising trend over the years, from 33.3 per 100,000 population in 1985 to 91.0 in 1994 to 380.7 in 2003 and 586.8 in 2006 (5). Hence, Thailand is inevitably moving towards the burden of such a public health problem.

People with diabetes are prone to consequences in both short-term and long-term complications. The chronic nature of diabetes and its devastating complications make it a very costly disease. People with diabetes have more outpatient visits, use more medications, have a higher probability of being hospitalized, and are more likely to require emergency and long-term care than people without the disease. In the United States, people with diabetes, on average, spent 2.5 times more on medical care than people without the condition (6). The global health expenditure on diabetes was expected to be at least US$ 376 billion in 2010 and US$ 490 billion in 2030 (7). Globally, 12% of the health expenditures and US$ 1330 per person were anticipated to be spent on diabetes in 2010 (7). In Thailand, 11% of the health

expenditures and US$ 114 per person were estimated to be spent on diabetes in 2010 (7).

In Thailand, there have been few studies estimating the cost of diabetes. Based on the study determining the costs of patients with diabetes in seven Thai government hospitals located in four regions of Thailand and Bangkok, the annual average direct medical cost per diabetic patient was 6017 baht (US$ 200), which was significantly higher than those without diabetes (8). In addition, the annual average total health-care cost per diabetic patient was 13,751 baht (US$ 458) (i.e., direct medical and nonmedical cost [82.26%] and indirect cost [17.74%]) (9). The average direct medical cost per outpatient visit was about 1206 baht (US$ 40) per diabetic patient (10). Furthermore, the recent study estimated the cost of illness of diabetes from societal perspective, reported the average cost of illness per diabetic patient was US$ 881 in 2008 (e.g., direct medical 23%, direct non-medical cost 40% and indirect cost 37%) which was 21% of per capita gross domestic product (GDP) of Thailand (11).

Several studies performed in Thailand have investigated the impact of factors such as demographic characteristics, complications, co-morbidities, healthcare utilization, and payment methods on healthcare costs or hospitalizations (9, 12, 13). Knowledge of these factors may help healthcare providers in managing costs and reducing morbidity, which requires targeting appropriate services and training to “at-risk” patients to maximize use of limited resources. In order to better design interventions and allocate health care resources, it is important for healthcare providers to fully understand the needs and illness burden of their target populations. Methods to quantify the burden of morbidity in populations and the resulting need for healthcare services have important applications in the management and financing of health systems. One key to the successful implementation of this approach is the categorization of morbidity burden in a standardized manner using case-mix adjustment system (14).

The development of diagnosis-based casemix adjustment systems has been published that use administrative data to examine morbidity and utilization of health care. One of the most widely validated diagnosis-based casemix adjustment systems is

the Adjusted Clinical Groups (ACGs). In the 1990s, the Johns Hopkins adjusted clinical groups (ACGs) casemix system was developed using medical diagnosis codes from administrative data to directly quantify the overall requirement for resources based on diagnoses for individuals (15, 16). The ACG system takes into account a person's mix of diseases that stretches across visits, facilities and providers over a defined time period, typically 1 year. Each ACG category is used as an estimate for a group of patients with the same constellation of morbidities, thereby indicating the need for care of each category of patient. The validity and reliability of the ACG system has been widely evaluated in the United States (15-17), Canada (18, 19), Sweden (20-22), Spain (23, 24) and Taiwan (25-27). This system has been applied to capitation rate adjustment, performance profiling, prediction of resource utilization, and health services research. Recently, the explanatory ability of the ACG system has been further enhanced by adding sophisticated statistical components such as ACG-predictive modeling (ACG-PM) and incorporating Rx-Defined Morbidity Groups (Rx-MG) which include medication therapeutic classes into predictive models (24, 28). In addition, Research studies in Thailand have tested whether ACG systems that rely on administrative data are feasible and useful for identifying case-mix patient subgroups (29), and measuring morbidity illness in the population (30, 31).

Several previous studies in Thailand have already demonstrated that ACG can be used to measure morbidity in the population and its application for resources allocation to providers of health services in Thai context. However, these studies included only diagnosis information, age and gender for incorporating into ACG system. With drug information available, it will be interesting to evaluate how a pharmacy-based risk adjustment model or ACG system's Rx-MG, works in evaluating drug utilization pattern of patients with chronic diseases. In addition, the ACG system is a standardized casemix method to categorize co-morbidity in a study of resource utilization of patients with chronic conditions and could be used to determine the morbidity profile of patient populations to more fairly assess provider performance. Therefore, the ACG system should be used to explain the morbidity profile and other related variables among patient with chronic disease such as diabetes.

Research Question

How can 'ACG' be used for evaluating the morbidity burden and Profiling quality of care in patients with diabetes over four consecutive years?

Objective

To examine morbidity burden, healthcare utilization, drug utilization pattern and quality of care among patients with diabetes over four consecutive years (2008 to 2011) by using ACG ® software.

Specific objectives

1. To evaluate the change of morbidity burden, healthcare resourceuse and drug utilization pattern of diabetic patients from fiscal year 2008 to 2011 (over a 4-year period).

2. To assess the quality of diabetic care based on process and outcome measures**.**

Expected outcomes

ACG can be used to assess quality of diabetic care, identify patients with high morbidity burden and medical costs, and enable care providers to select patients for case management and triage into specific care programs. The expected results of this study will demonstrate the data that essential for hospital administrators and healthcare provider to improve patient management and could be applied to predict future healthcare utilization as well as allocate resources for healthcare.

Definition of Terms

Co-morbidity (32)

Presence of additional diseases in relation to an index disease in one individual.

Morbidity burden (32)

Overall impact of the different diseases in an individual taking into account their severity.

The Johns Hopkins ACG Case-Mix System (the ACG System)

A statistically valid, diagnosis-based, case-mix methodology that allows healthcare providers, health plans, and public-sector agencies to describe or predict a population’s past or future healthcare utilization and costs.

ATC (Anatomical Therapeutic Chemical classification) System

The digit code system of drugs according to the organ or system on which they act with therapeutic, pharmaceutical and chemical properties.

Conceptual framework

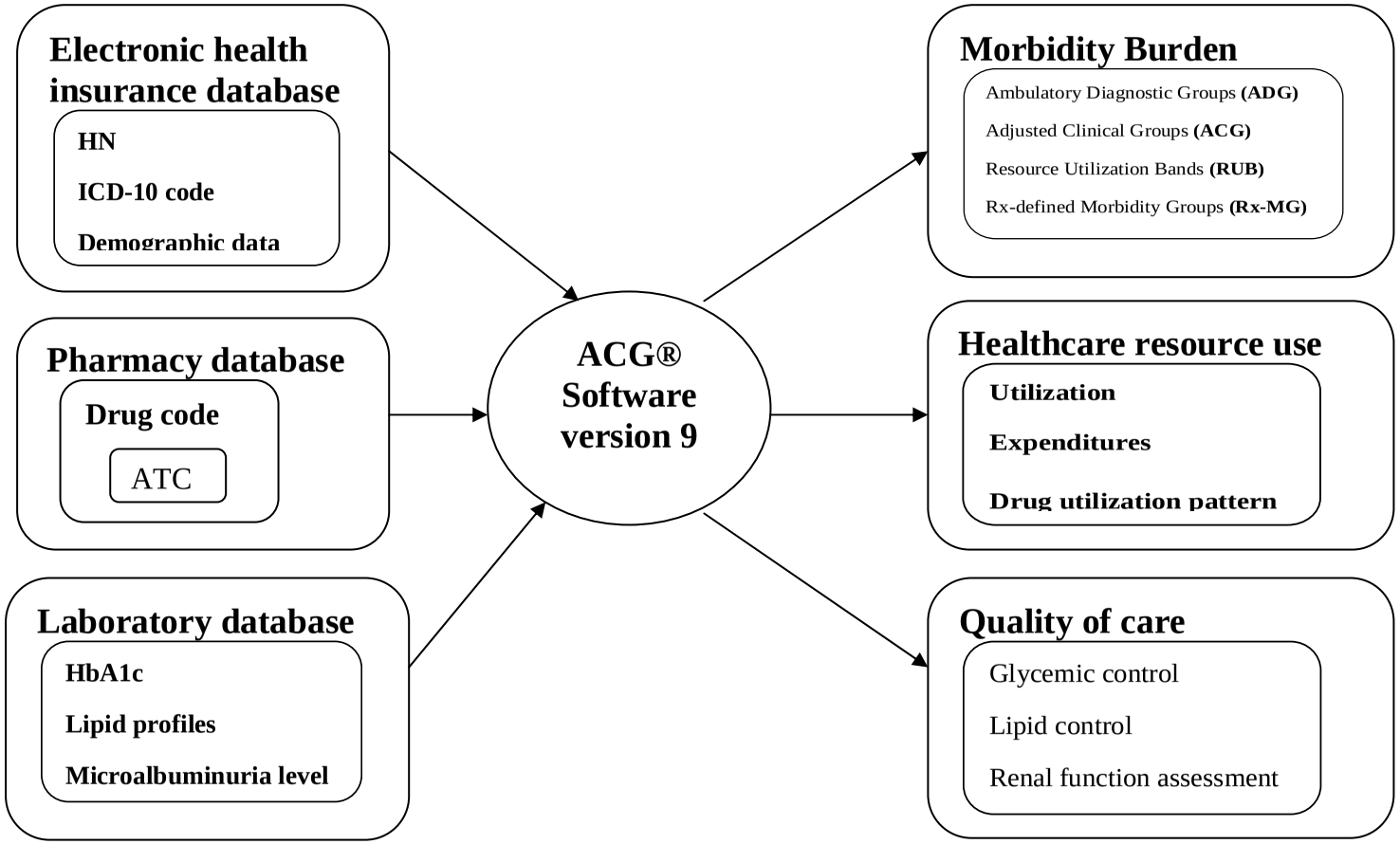


Figure 1.1 Conceptual framework

CHAPTER II
LITERATURE REVIEW

Three parts for literature review are presented. Part I is about Diabetes Mellitus. Part II is the overview of Adjusted Clinical Group or ACG system. The last part is the applications of ACG system.

Part I: Diabetes Mellitus

1. Clinical aspects of Diabetes Mellitus (33)

Definition and classification of diabetes

Diabetes is a syndrome that is caused by a relative or an absolute lack of insulin. Clinically, it is characterized by symptomatic glucose intolerance as well as alterations in lipid and protein metabolism. These metabolic abnormalities, particularly hyperglycemia, contribute to the development of complications over the long time such as retinopathy, nephropathy, and neuropathy.

The classification of diabetes includes four clinical classes, they are:

Type 1 diabetes (results from beta cell destruction, usually leading to absolute insulin deficiency),

Type 2 diabetes (results from a progressive insulin secretory defect on the background of insulin resistance),

Gestational diabetes mellitus (GDM) (diabetes diagnosed during pregnancy that is not clearly overt diabetes)**,**

Other specific types of diabetes due to other causes, e.g. genetic defects in beta cell function, genetic defects in insulin action, diseases of the exocrine pancreas (such as cystic fibrosis), and drug or chemical-induced (such as in the treatment of HIV/AIDS or after organ transplantation)

Diabetic care

1) Initial evaluation

According to American Diabetes Association (ADA) recommendation, a complete medical evaluation should be performed to classify the diabetes, detect the presence of diabetes complications, review previous treatment and glycemic control in patients with established diabetes, assist in formulating a management plan, and provide a basis for continuing care. Laboratory tests appropriate to the evaluation of each patient's medical condition should be performed. A focus on the components of comprehensive care will assist the health care team to ensure optimal management of the patient with diabetes.

2) Management

People with diabetes should receive medical care from a physician-coordinated team. Such teams may include, but are not limited to, physicians, nurse practitioners, physician's assistants, nurses, dietitians, pharmacists, and mental health professionals with expertise and a special interest in diabetes. It is essential in this collaborative and integrated team approach that individuals with diabetes assume an active role in their care. The management plan should be formulated as a collaborative therapeutic alliance among the patient and family, the physician, and other members of the health care team. A variety of strategies and techniques should be used to provide adequate education and development of problem-solving skills in the various aspects of diabetes management.

Implementation of the management plan requires that each aspect is understood and agreed to by the patient and the care providers and that the goals and treatment plan are reasonable. Any plan should recognize diabetes self management education (DSME) and ongoing diabetes support as an integral component of care. In developing the plan, consideration should be given to the patient's age, school or work schedule and conditions, physical activity, eating patterns, social situation and cultural factors, and presence of complications of diabetes or other medical conditions**.**

3) Glycemic control

Assessment of glycemic control

Two primary techniques are available for health providers and patients to assess the effectiveness of the management plan on glycemic control: patient self-monitoring of blood glucose (SMBG) or interstitial glucose, and A1C.

a. Glucose monitoring

Major clinical trials of insulin-treated patients that demonstrated the benefits of intensive glycemic control on diabetes complications have included SMBG as part of multifactorial interventions, suggesting that SMBG is a component of effective therapy. SMBG allows patients to evaluate their individual response to therapy and assess whether glycemic targets are being achieved. Results of SMBG can be useful in preventing hypoglycemia and adjusting medications (particularly prandial insulin doses), medical nutrition therapy (MNT), and physical activity.

b. Hemoglobin A1c

Because A1C is thought to reflect average glycemia over several months, and has strong predictive value for diabetes complications, A1C testing should be performed routinely in all patients with diabetes, at initial assessment and then as part of continuing care. Measurement approximately every 3 months determines whether a patient’s glycemic targets have been reached and maintained. For any individual patient, the frequency of A1C testing should be dependent on the clinical situation, the treatment regimen used, and the judgment of the clinician. Some patients with stable glycemia well within target may do well with testing only twice per year, while unstable or highly intensively managed patients (e.g., pregnant type 1 women) may be tested more frequently than every 3 months. The availability of the A1C result at the time that the patient is seen (point-of-care testing) has been reported to result in increased intensification of therapy and improvement in glycemic control.

Table 2.1 presents glycemic recommendations for nonpregnant adults with diabetes according to American Diabetes Association (ADA) recommendation.

Table 2.1 Glycemic recommendations for nonpregnant adults with diabetes (33)

Glycemic control	**Target**
A1C	< 7.0%
Preprandial capillary plasma glucose	70–130 mg/dl
Peak postprandial capillary plasma glucose*	180 mg/dl
Goals should be individualized based on:	
• duration of diabetes	
• age/life expectancy	
• comorbid conditions	
• known CVD or advanced microvascular complications	
• hypoglycemia unawareness	
• individual patient considerations	
• more or less stringent glycemic goals may be appropriate for individual patients.	
• postprandial glucose may be targeted if A1C goals are not met despite reaching preprandial goals.	

*Postprandial glucose measurements should be made 1–2 h after the beginning of the meal, generally peak levels in patients with diabetes.

4) Pharmacologic and overall approaches to treatment

Therapy for type 1 diabetes

Recommended therapy for type 1 diabetes consists of:

a. use of multiple dose insulin injections (three to four injections per day of basal and prandial insulin)

b. matching of prandial insulin to carbohydrate intake, premeal blood glucose, and anticipated activity

c. for many patients (especially if hypoglycemia is a problem), use of insulin analogs.

Therapy for type 2 diabetes

The American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) published an expert consensus statement on the approach to management of hyperglycemia in individuals with type 2 diabetes (34). Highlights of this approach are: intervention at the time of diagnosis with metformin in combination with lifestyle changes (MNT and exercise) and continuing timely augmentation of therapy with additional agents (including early initiation of insulin therapy) as a means of achieving and maintaining recommended levels of glycemic control (i.e., A1c <7% for most patients). As A1c targets are not achieved, treatment intensification is based on the addition of another agent from a different class.

2. Epidemiology of Diabetes

Diabetes is a common chronic disease in nearly all countries. There are an estimated 285 million in 2010. This number will continue to increase globally due to an aging population, growth of population size, urbanization and high prevalence of obesity and sedentary lifestyle (1). The estimated number of individuals with diabetes in Asia was 113 million in 2010 and will increase to 180 million in 2030 (2). Diabetes leads to both premature death and complications such as blindness, amputations, renal disease, and cardiovascular disease.

In Thailand, diabetes has been a major cause of morbidity and mortality in the past decade (3). Diabetes alone is responsible for 3.3 and 8.3% of total deaths in Thai men and women, respectively (3). A high prevalence rate of diabetes in Thailand makes it among the top ten in Asia (2). In 2004, the National Health Examination Survey (NHES) III reported a prevalence of 6.7% in adults aged $\geq$15 years, of whom 53.3% went undiagnosed. The prevalence of impaired fasting glucose (IFG) is 12.5% (35). Undiagnosed diabetes increases the risk of complications as a result of being untreated, and about 40% of those treated have their fasting plasma glucose (FPG) under control (<7.8 mmol/L) (35).

In 2009, The Thai National Health Examination Survey (NHES) IV reported the prevalence of IFG and diabetes was 10.6 and 7.5%, respectively. Of all diabetes diagnoses, 35.4% were not previously diagnosed, and the proportion was

higher in men than in women (47.3 vs. 23.4%, P < 0.05). Compared with those in year 2004, the proportions of individuals with diabetes and concomitant hypertension did not significantly decrease in 2009 in both sexes, but the proportions of women with diabetes who were abdominally obese or had high total cholesterol (≥5.2 mmol/L) significantly increased in 2009 by 18.0 and 23.5%, respectively (all P <0.01). The rates of treatment and control of blood glucose, high blood pressure, and high total cholesterol were favorably improved in 2009. However, in substantial proportions of individuals with diabetes these concomitants were still controlled suboptimally (4).

3. Economic Burdens of Diabetes Mellitus

Diabetes is also costly to health care systems. People with diabetes have more outpatient visits, use more medications, have a higher probability of being hospitalized, and are more likely to require emergency and long-term care than people without the disease. The global health care expenditure attributable to diabetes has been estimated in 2010 by the International Diabetes Federation (IDF) and reported the global health expenditure on diabetes is expected to total at least US$ 376 billion in 2010 and US$ 490 billion in 2030. Globally, 12% of the health expenditures and US$ 1330 per person are anticipated to be spent on diabetes in 2010. The expenditure varies by region, age group, gender, and country's income level. For Thailand, 11% of the health expenditures and US$ 114 per person were estimated to be spent on diabetes in 2010 (7).

For Thailand, there have been few studies estimating the cost of diabetes. In 2007, Riewpaiboon A., et al. (36) formulated a cost model from a provider perspective regarding the direct medical costs for diabetic patients who received care in a 30-bed public hospital in Thailand during the fiscal year of 2001. The study covered 186 diabetic patients, and found that the average cost of caring for a diabetic patient per year was 6331 Thai baht (THB) at 2001 prices (approximately 40 THB = US$1). A major portion of this cost was spent for pharmacy services, which accounted for 45% of the whole cost, followed by outpatient services (24%), inpatient services (16%), and laboratory investigation (11%).

In 2011, Chatterjee S., et al. (37) estimated the cost of diabetes and its complications from societal perspective, the broadest viewpoint covering all costs

irrespective of who incur them. Data were collected from 475 randomly selected diabetic patients who received treatment from Waritchaphum Hospital in Sakhon Nakhon province of Thailand during 2007–2008 with a response rate of 98%. A micro-costing approach was used to calculate the cost. The direct medical cost was calculated by multiplying the quantity of medical services consumed by their unit costs while indirect cost was calculated by using human capital approach. The total cost of illness of diabetes for 475 study participants was estimated as US$ 418,696 for the year 2008 (1 US$ = 32 THB). Of this, 23% was direct medical cost, 40% was direct non-medical cost and 37% was indirect cost. The average cost of illness per diabetic patient was US$ 881.47 in 2008 which was 21% of per capita gross domestic product (GDP) of Thailand. Existence of complications increased the cost substantially. Cost of informal care contributed 28% of total cost of illness of diabetes.

Neither recent study by Riewpaiboon A., et al. (38), using the same data from Waritchaphum Hospital, estimated cost of illness from the provider's perspective for diabetic patients who received treatment during the fiscal year 2008. Data were collected from the hospital finantial records and medical record of each participant and were analysed with a stepwise multiple regression. This study found that the average public treatment cost per patient per year was US$ 94.71 at 2008 prices. Drug cost was the highest cost component (25% of total cost), followed by inpatient cost (24%) and out patient visit cost (17%). A cost forecasting model showed that the length of stay, hospitalization, visits to the provincial hospital, duration of disease and presence of diabetic complications (e.g. diabetic foot complications and nephropathy) were the significant predictor variables (adjusted R^2 =0.689).

Chaikledkaew U., et al. (12) investigated the factors affecting health-care costs and hospitalizations among diabetic patients in Thai public hospitals, by using administrative claims data obtained from diabetic patients during October 1, 2002 and September 30, 2003. The results of this study suggested that demographic factors of patients (i.e., age and male sex), payment methods (i.e., capitation, fee-for-service, and out-of-pocket) were significantly associated with higher health-care costs and probability of hospitalization. Patients receiving treatment from teaching hospitals significantly consumed higher health-care costs. In addition, the more health-care utilizations (i.e., occurrence of hospitalization, number of outpatient visit, and insulin

utilization), the higher health-care costs the patients had. Diabetic patients taking insulin had significantly higher health-care costs and risk of hospitalization. Furthermore, comorbidities (e.g., hypertension and cancer) and diabetes-related complications (e.g., nephropathy, neuropathy, retinopathy, coronary artery disease, cardiovascular disease, and peripheral vascular disease) were significantly associated with an increase in health-care costs and hospitalization.

Based on the results of these studies, the costs for patients with complications were substantially higher than those without complications and the costs were found to increase progressively with the increase in number of complications, and also showed that total healthcare costs were significantly associated with age, gender, type of diabetes, payment methods, comorbidities and complications.

It is suggested that health-care providers and health policymakers may need to focus on the factors associated with an increase in health-care costs and hospitalizations, such as patients with older age, male sex, co-morbidities and complications. Health-care providers may set up the interventions such as diabetic patient counseling, pharmaceutical care, or disease management to delay the progression of co-morbidities or complications that diabetic patients may possibly have in the future.

4. Measuring quality of Diabetes Management (39)

Quality improvement in diabetes and other diseases is a set of activities undertaken to assure that patients receive the services known to minimize complications and maximize life expectancy. The essence of quality improvement is the performance measure. Performance measures indicate how close to perfection (100%) a provider comes in making a service available to patients. Measures usually contain a time component that specifies the frequency of the service, e.g., HbA1c determination every quarter. The results of performance measures are binary and expresse

Quality improvement has three possible components: structure, process, and outcome. Two of these (process and outcome) are dynamic and one (structure) is relatively static. Structure has to do with the environment in which patient care takes place. Process and outcome measures are disease specific, and, besides obvious

structural problems like inadequate heating or very low nurse to patient ratios, it is seldom clear exactly what role the structural elements play as determinants of hand-on disease management.

Outcome measures are intuitively appealing. They deal with endpoints such as changes in heart disease mortality among diabetes patients or lowered blood pressure among hypertensives. Unfortunately, using outcomes to measure quality especially in comparing one provider to another, is fraught with difficulty. Different facilities have different patient. Even when providers serve the same population, the patients may and often do differ significantly from one provider to another. The provider with sicker patients will usually have the worse outcome. Disparities in health, income, and education differ between population groups, and it is therefore difficult to compare outcomes between providers who serve a largely poor, uneducated, ethnic minority to one whose patients are preponderantly white, educated, and relatively affluent. The use of outcomes requires risk adjustment-a way of taking into account differences in the patients served by a given provider.

The other problem with outcomes is that the combination of patients changes over time even within the same provider. As a consequence, outcomes also will vary even though the quality of care provided remains unchanged. The ultimate outcome, death, is not usually attributable to the specific act of a given provider and may not, therefore, bear any relation whatever to the quality of care provided. Finally, in many diseases and specially in diabetes, the patient plays a major role in determining his own outcome.

Process measures inherently incorporate the limitations of medicine. The process of care, when it includes every service known to be beneficial, is all the health care system has to offer. Process consists of both diagnostic and therapeutic actions. The latter are sometimes referred to as follow-up indicators or intermediate outcomes. Intermediate outcomes specify that should be done for the patient once his problem is known. Thus, as shown in table 2.2, blood pressure determination is the diagnostic measure, the angiotensin converting enzyme (ACE) inhibitor the patient receives if hypertensive is the intermediate measure, and the change in the incidence of the sequelae of hypertension, such as heart failure or stroke, is the outcome. Table 2.2 lists services that are commonly used as performance measures in diabetes.

It is usual for some subset of these measures, often as few as three or four, to be used as the basis of diabetes quality improvement. HbA1c is always included, and retinal examination, feet examination, and blood pressure usually appear along with HbA1c.

Table 2.2 Commonly Used Performance Measures in Diabetes Management (39)

Performance Measures
Process measures
Blood pressure quarterly
HbA1c quarterly
Foot examination twice a year
Retinal examination yearly
Lipid profile yearly
Urine testing for protein yearly
Serum creatinine
Daily aspirin
Immunization against influenza
Immunization against commonly acquired pneumonia
Blood pressure at the ankle to test for peripheral vascular disease
Diabetic education
Nutrition instruction
Exercise
Medication
Use of home glucose meter
Follow-up (intermediate outcomes)
ACE-I if hypertensive
ACE-I if protein in urine
Treatment if hyperlipemic
Ophthamologic referral if abnormal retinal exam

Part II: Adjusted Clinical Group system (ACGs) (40)

The Johns Hopkins ACG Case-Mix System ("the ACG System") is a statistically valid, diagnosis-based, case-mix methodology that allows healthcare providers, health plans, and public-sector agencies to describe or predict a population's past or future healthcare utilization and costs. The ACG System is also widely used by researchers and analysts to compare various patient populations' prior health resource use, while taking into account morbidity or illness burden.

Adjusted **C**linical **G**roup actuarial cells, or **ACGs**, are the building blocks of the Johns Hopkins ACG Case-Mix System ("the ACG System") methodology. ACGs are a series of mutually exclusive, health status categories defined by morbidity, age, and sex. They are based on the premise that the level of resources necessary for delivering appropriate healthcare to a population is correlated with the illness burden of that population.

ACGs are used to determine the morbidity profile of patient populations to more fairly assess provider performance, to reimburse providers based on the health needs of their patients, and to allow for more equitable comparisons of utilization or outcomes across two or more patient or enrollee aggregations.

How ACGs Work (40)

This system used the patient encounter data as the term for grouping which is developed by the School of Hygiene and Public Health at Johns Hopkins University. It combines diagnoses data on types of morbidity, co-morbidity or disorders during the period of time (usually one year). This system assigns each ICD-10 code to 1 of 32 ADGs based on five clinical dimensions:

- **Duration of the condition** (acute, recurrent, or chronic): How long will healthcare resources be required for the management of this condition?

- **Severity of the condition** (e.g., minor and stable versus major and unstable): How intensely must healthcare resources be applied to manage the condition?

- **Diagnostic certainty** (symptoms versus documented disease): Will a diagnostic evaluation be needed or will services for treatment be the primary focus?

- **Etiology of the condition** (infectious, injury, or other): What types of healthcare services will likely be used?

- **Specialty care involvement** (e.g., medical, surgical, obstetric, hematology): To what degree will specialty care services be required?

All diseases can be classified along these dimensions and categorized into one of these 32 ADG clusters. Because most management applications for population-based case-mix adjustment systems require that patients be grouped into single, mutually exclusive categories, the ACG methodology uses a branching algorithm to place people into one of 93 discrete categories based on their assigned ADGs, their age and their sex. The result is that individuals within a given ACG have experienced a similar pattern of morbidity and resource consumption over the course of a given year. (Figure 2.1)

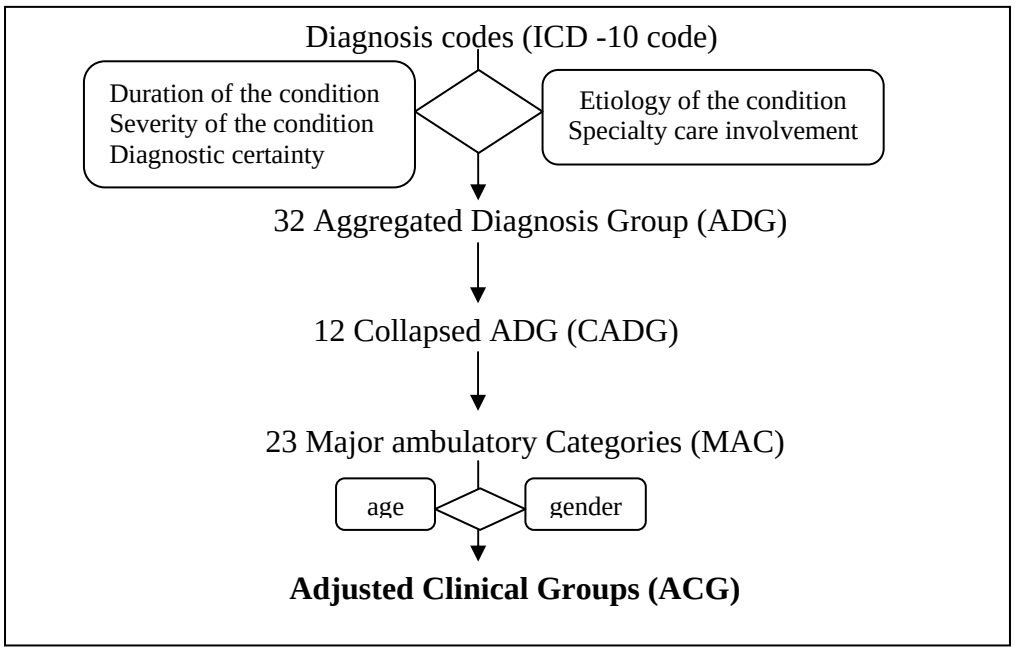


Figure 2.1 ACG Assignment (40)

Overview of the ACG Assignment Process (40)

The ACG System relies on automated claims or encounter data derived from healthcare settings to characterize the degree of overall morbidity in patients and populations. They are 4 steps as follow:

- **Step 1**: Mapping ICD Codes to a Parsimonious Set of Aggregated Diagnosis Groups (ADGs)
- **Step 2**: Creating a Manageable Number of ADG Subgroups(CADGs)
- **Step 3**: Frequently Occurring Combinations of CADGs (MACs)
- **Step 4**: Forming the Terminal Groups (ACGs)

Step 1: Mapping ICD Codes to a Parsimonious Set of Aggregated Diagnosis Groups (ADGs)

There are roughly 25,000 ICD (-9 or -10) diagnosis codes that clinicians can use to describe patients' health conditions. The first step of the ACG grouping logic is to assign each of these codes to one of 32 diagnosis groups referred to as **A**ggregated **D**iagnosis **G**roups, or **ADGs.**

Each ADG is a grouping of diagnosis codes that are similar in terms of severity and likelihood of persistence of the health condition treated over a relevant period of time (such as a year of enrollment). ICD codes within the same ADG are similar in terms of both clinical criteria and expected need for healthcare resources. Just as individuals may have multiple ICD diagnosis codes, they may have multiple ADGs (up to 32).

Table 2.3 The 32 ADGs and exemplary diagnosis codes (40)

ADG	**ICD-10 Diagnosis Code**	
1. Time Limited: Minor	K529	Noninfectious Gastroententris
	L22	Diaper or Napkin Rash
2. Time Limited: Minor-Primary Infections	A084	Viral intestinal infection, unspecified
	J050	Croup
3. Time Limited: Major	I803	Phlebitis of Lower Extremities
	K564	Impaction of Intestine
4. Time Limited: Major-Primary Infections	K752	Nonspecific reactive hepatitis
	M002	Other streptococcal arthritis & polyarthritis
5. Allergies	J304	Allergic Rhinitis, Cause Unspecified
	L509	Unspecified Urticaria
6. Asthma	J450	Predominantly allergic asthma
	J459	Asthma, unspecified
7. Likely to Recur: Discrete	M109	Gout, Unspecified
	M545	Low back pain
8. Likely to Recur: Discrete-Infections	J350	Chronic Tonsillitus
	N390	Urinary Tract Infection
9. Likely to Recur: Progressive	E111	Adult Onset Type II Diabetes w/ Ketoacidosis
	J81	Pulmonary oedema
10. Chronic Medical: Stable	E109	Insulin dependent DM, w/o complications
	I10	Essential Hypertension
11. Chronic Medical: Unstable	D570	Sickle-Cell Anemia w crisis
	E849	Cystic fibrosis, unspecified
12. Chronic Specialty: Stable-Orthopedic	M479	Spondylosis, unspecified
	M200	Deformity of finger(s)
13. Chronic Specialty: Stable-Ear, Nose, Throat	H903	Sensorineural hearing loss, bilateral
	H71	Cholesteatoma of middle ear
14. Chronic Specialty: Stable-Eye	H521	Myopia
	H119	Unspecified Disorder of Conjunctiva
15. No Longer in Use*		
16. Chronic Specialty: Unstable-Orthopedic	M480	Spinal Stenosis of Lumbar Region
	M932	Osteochondritis Dissecans
17. Chronic Specialty: Unstable-Ear, Nose, Throat	H810	Meniere's Disease
	H701	Chronic Mastoiditis
18. Chronic Specialty: Unstable-Eye	H409	Unspecified Glaucoma
	H360	Diabetic retinopathy

Table 2.3 The 32 ADGs and exemplary diagnosis codes (cont.)

ADG	**ICD-10 Diagnosis Code**	
19. No Longer in Use*		
20. Dermatologic	B07	Viral Warts
	I781	Nevus, Non-Neoplastic
21. Injuries/Adverse Effects: Minor	S107	Multiple superficial injuries of neck
	T099	Unspecified injury of trunk, level unspecified
22. Injuries/Adverse Effects: Major	S067	Intracranial injury with prolonged coma
	T789	Adverse effect, unspecified
23. Psychosocial: Time Limited, Minor	F430	Acute stress reaction
	F515	Nightmares
24. Psychosocial: Recurrent or Persistent, Stable	F410	Panic Disorder
	F502	Bulimia
25. Psychosocial: Recurrent or Persistent,Unstable	F232	Acute schizophrenia-like psychotic disorder
	F102	Mental & behav dis d/t use of alcohol
26. Signs/Symptoms: Minor	R51	Headache
	M796	Pain in Limb
27. Signs/Symptoms: Uncertain	M255	Pain in joint
	I951	Orthostatic hypotension
28. Signs/Symptoms: Major	I517	Cardiomegaly
	R55	Syncope and Collaspe
29. Discretionary	K402	Bilateral inguinal hernia, w/o obstruct of gangrene
	L720	Epidermal cyst
30. See and Reassure	N62	Hypertrophy of Breast
	E65	Localized Adiposity
31. Prevention/Administrative	Z001	Routine Infant or Child Health Check
	Z014	Gynecological Examination
32. Malignancy	C509	Malignant Neoplasm of Breast (NOS)
	C819	Hodgkin's Disease, Unspecified Type
33. Pregnancy	Z321	Pregnant State
	O808	Other single spontaneous delivery
34. Dental	K021	Dental caries of dentine
	K051	Chronic Gingivitis

***Note**: Only 32 of the 34 markers are currently in use.

ADGs are distinguished by several clinical characteristics (time limited or not, medical/ specialty/ pregnancy, physical health/psycho-social), and degree of refinement of the problem (diagnosis or symptom/sign). They are not categorized by organ system or disease. Instead, they are based on clinical dimensions that help explain or predict the need for healthcare resources over time. The need for healthcare resources is primarily determined by the likelihood of persistence of problems and their level of severity rather than organ system involvement.

Some ADGs have very high expected resource use and are labeled “Major ADGs.”

Table 2.4 Major ADGs for adult and pediatric populations (40)

Pediatric Major ADGs (ages 0-17 years)	**Adult Major ADGs (ages 18 and up)**
3 Time Limited: Major	3 Time Limited: Major
9 Likely to Recur: Progressive	4 Time Limited: Major-Primary Infections
11 Chronic Medical: Unstable	9 Likely to Recur: Progressive
12 Chronic Specialty: Stable-Orthopedic	11 Chronic Medical: Unstable
13 Chronic Specialty: Stable-Ear, Nose, Throat	16 Chronic Specialty: Unstable- Orthopedic
18 Chronic Specialty: Unstable-Eye	22 Injuries/Adverse Effects: Major
25 Psychosocial: Recurrent or Persistent, Unstable	25 Psychosocial: Recurrent or Persistent, Unstable
32 Malignancy	32 Malignancy

Step 2: Creating a Manageable Number of ADG Subgroups(CADGs)

The ultimate goal of the ACG algorithm is to assign each person to a single morbidity group (i.e., an ACG). There are 4.3 billion possible combinations of ADGs, so to create a more manageable number of unique combinations of morbidity groupings, the 32 ADGs are collapsed into 12 CADGs or Collapsed ADGs (Table 2.5). Like ADGs, CADGs are not mutually exclusive in that an individual can be assigned to as few as none or as many as 12.

Although numerous analytic techniques could be used to form CADGs from ADGs, the ACG Case-Mix System has placed the emphasis on clinical cogency. Three clinical criteria are used:

• the similarity of **likelihood of persistence or recurrence** of diagnoses within the ADG, i.e., time-limited, likely to recur, or chronic groupings.

• the **severity** of the condition, i.e., minor versus major and stable versus unstable.

• the **types of healthcare services required** for patient management--medical versus specialty, eye/dental, psychosocial, prevention/administrative, and pregnancy.

Table 2.5 The Collapsed ADG Clusters and the ADGs That They Comprise (40)

Collapsed ADG (CADG) ADGs in Each	**Collapsed ADG (CADG) ADGs in Each**
1. Acute Minor	1 Time Limited: Minor 2 Time Limited: Minor-Primary Infections 21 Injuries/Adverse Events: Minor 26 Signs/Symptoms: Minor
2. Acute Major	3 Time Limited: Major 4 Time Limited: Major-Primary Infections 22 Injuries/Adverse Events: Major 27 Signs/Symptoms: Uncertain 28 Signs/Symptoms: Major
3. Likely to Recur	5 Allergies 7 Likely to Recur: Discrete 8 Likely to Recur: Discrete-Infections 20 Dermatologic 29 Discretionary
4. Asthma	6 Asthma
5. Chronic Medical: Unstable	9 Likely to Recur: Progressive 11 Chronic Medical: Unstable 32 Malignancy
6. Chronic Medical: Stable	10 Chronic Medical: Stable 30 See and Reassure
7. Chronic Specialty: Stable	12 Chronic Specialty: Stable-Orthopedic 13 Chronic Specialty: Stable-Ear, Nose, Throat
8. Eye/Dental	14 Chronic Specialty: Stable-Eye 34 Dental

Table 2.5 The Collapsed ADG Clusters and the ADGs That They Comprise (40) (cont.)

Collapsed ADG (CADG) ADGs in Each	Collapsed ADG (CADG) ADGs in Each
9. Chronic Specialty: Unstable	16 Chronic Specialty: Unstable-Orthopedic 17 Chronic Specialty: Unstable-Ear, Nose, Throat 18 Chronic Specialty: Unstable-Eye
10. Psychosocial	23 Psycho-social: Time Limited, Minor 24 Psycho-social: Recurrent or Persistent, Stable 25 Psycho-social: Recurrent or Persistent, Unstable
11. Preventive/Administrative	31 Prevention/Administrative
12. Pregnancy	33 Pregnancy

Step 3: Frequently Occurring Combinations of CADGs (MACs)

The third step in the ACG categorization methodology assigns individuals into a single, mutually exclusive category, called a MAC. This grouping algorithm is based primarily on the pattern of CADGs. Table 2.6 shows the MACs and the Collapsed ADGs which comprise them.

There are twenty-three commonly occurring combinations of CADGs which form MACs 1 through 23:

• The first 11 MACs correspond to presence of a single CADG.

• MAC-12 includes all pregnant women, regardless of their pattern of CADGs.

• MACs 13 through 23 are commonly occurring combinations of CADGs.

• MAC-24 includes all other combinations of CADGs.

• MAC-25 is used for enrollees with no service use or invalid diagnosis input data.

• MAC-26 includes all infants (age<12 months), regardless of the pattern of CADGs

Table 2.6 The MACs and The Collapsed ADGs (40)

MACs	**CADGs**
1. Acute: Minor	1
2. Acute: Major	2
3. Likely to Recur	3
4. Asthma 4	4
5. Chronic Medical: Unstable	5
6. Chronic Medical: Stable	6
7. Chronic Specialty: Stable	7
8. Eye/Dental	8
12. Pregnancy	All CADG combinations that include CADG 12
13. Acute: Minor and Acute: Major	1 and 2
14. Acute: Minor and Likely to Recur	1 and 3
15. Acute: Minor and Chronic Medical: Stable	1 and 6
16. Acute: Minor and Eye/Dental	1 and 8
17. Acute: Minor and Psychosocial	1 and 10
18. Acute: Major and Likely to Recur	2 and 3
19. Acute: Minor and Acute: Major and Likely to Recur	1, 2 and 3
20. Acute: Minor and Likely to Recur and Eye and Dental	1, 3 and 8
21. Acute: Minor and Likely to Recur and Psychosocial	1, 3, and 10
22. Acute: Minor and Major and Likely to Recur and Chronic Medical: Stable	1, 2, 3, and 6
23. Acute: Minor and Major and Likely to Recur and Psychosocial	1, 2, 3, and 10
24. All Other Combinations Not Listed Above	All Other Combinations
25. No Diagnosis or Only Unclassified Diagnosis	No CADGs
26. Infants (age less than 1 year)	Any CADGs combinations and less than 1 year old

.

Step 4: Forming the Terminal Groups (ACGs)

MACs form the major branches of the ACG decision tree. The final step in the groupingalgorithm divides the MAC branches into terminal groups, the actuarial cells known as ACGs. The logic used to split MACs into ACGs includes a combination of statistical considerations and clinical insight. During the ACG development process, the overarching goal for ACG assignment was to identify groups of individuals with similar needs for healthcare resources who also share similar clinical characteristics. The variables taken into consideration included: age, sex, presence of specific ADGs, number of major ADGs, and total number of ADGs.

Resource Utilization Bands (RUBs) (40)

ACGs were designed to represent clinically logical categories for persons expected to require similar levels of healthcare resources. However, enrollees with similar predicted (or expected) overall utilization may be assigned different ACGs because they have different epidemiological patterns of morbidity. For example, a pregnant woman with significant morbidity, an individual with a serious psychological condition, or someone with two chronic medical conditions may all be expected to use approximately the same level of resources even though they each fall into different ACG categories.

Often a fewer number of combined categories will be easier to handle from an administrative perspective. ACGs can be combined into what we term Resources Utilization Bands (RUBs). The software automatically assigns 0- 6 RUB classes:

- 0 - No or Only Invalid Dx
- 1 - Healthy Users
- 2 – Low
- 3 - Moderate
- 4 – High
- 5 - Very High

The relationship between ACG categories and RUBs is defined in Table 2.7

Table 2.7 The Final ACG Categories and RUBs (40)

ACG Description	**RUB**
0100 Acute Minor, Age 1	2
0200 Acute Minor, Age 2 to 5	1
0300 Acute Minor, Age 6+	1
0400 Acute Major	2
0500 Likely to Recur, w/o Allergies	2
0600 Likely to Recur, w/ Allergies	2
0700 Asthma	2
0800 Chronic Medical: Unstable	3
0900 Chronic Medical: Stable	2
1000 Chronic Specialty: Stable	2
1100 Eye & Dental	1
1200 Chronic Specialty: Unstable	2
1300 Psychosocial, w/o Psychosocial Unstable	2
1400 Psychosocial, w/ Psychosocial Unstable, w/o Psychosocial Stable	3
1500 Psychosocial, w/ Psychosocial Unstable, w/ Psychosocial Stable	3
1600 Preventive/Administrative	1
1710 Pregnancy, 0-1 ADGs	3
1711 Pregnancy, 0-1 ADGs, Delivered	4
1712 Pregnancy, 0-1 ADGs, Not Delivered	3
1720 Pregnancy, 2-3 ADGs, no Major ADGs	3
1721 Pregnancy, 2-3 ADGs, no Major ADGs, Delivered	4
1722 Pregnancy, 2-3 ADGs, no Major ADGs, Not Delivered	3
1730 Pregnancy, 2-3 ADGs, 1+ Major ADGs	4
1731 Pregnancy, 2-3 ADGs, 1+ Major ADGs, Delivered	4
1732 Pregnancy, 2-3 ADGs, 1+ Major ADGs, Not Delivered	3
1740 Pregnancy, 4-5 ADGs, no Major ADGs	4
1741 Pregnancy, 4-5 ADGs, no Major ADGs, Delivered	4
1742 Pregnancy, 4-5 ADGs, no Major ADGs, Not Delivered	3
1750 Pregnancy, 4-5 ADGs, 1+ Major ADGs	4

Table 2.7 The Final ACG Categories and RUBs (cont.)

ACG Description	**RUB**
1751 Pregnancy, 4-5 ADGs, 1+ Major ADGs, Delivered	4
1752 Pregnancy, 4-5 ADGs, 1+ Major ADGs, Not Delivered	4
1760 Pregnancy, 6+ ADGs, no Major ADGs	4
1761 Pregnancy, 6+ ADGs, no Major ADGs, Delivered	4
1762 Pregnancy, 6+ ADGs, no Major ADGs, Not Delivered	4
1770 Pregnancy, 6+ ADGs, 1+ Major ADGs	4
1771 Pregnancy, 6+ ADGs, 1+ Major ADGs, Delivered	4
1772 Pregnancy, 6+ ADGs, 1+ Major ADGs, Not Delivered	4
1800 Acute Minor/Acute Major	2
1900 Acute Minor/Likely to Recur, Age 1	2
2000 Acute Minor/Likely to Recur, Age 2 to 5	2
2100 Acute Minor/Likely to Recur, Age 6+, w/o Allergy	2
2200 Acute Minor/Likely to Recur, Age 6+, w/ Allergy	2
2300 Acute Minor/Chronic Medical: Stable	2
2400 Acute Minor/Eye & Dental	2
2500 Acute Minor/Psychosocial, w/o Psychosocial Unstable	2
2600 Acute Minor/Psychosocial, w/ Psychosocial Unstable, w/o	3
Psychosocial Stable	3
2700 Acute Minor/Psychosocial, w/ Psychosocial Unstable, w/	3
Psychosocial Stable	3
2800 Acute Major/Likely to Recur	3
2900 Acute Minor/Acute Major/Likely to Recur, Age 1	3
3000 Acute Minor/Acute Major/Likely to Recur, Age 2 to 5	3
3100 Acute Minor/Acute Major/Likely to Recur, Age 6 to 11	3
3200 Acute Minor/Acute Major/Likely to Recur, Age 12+, w/o Allergy	3
3300 Acute Minor/Acute Major/Likely to Recur, Age 12+, w/ Allergy	3
3400 Acute Minor/Likely to Recur/Eye & Dental	2
3500 Acute Minor/Likely to Recur/Psychosocial	3
3600 Acute Minor/Acute Major/Likely to Recur/Chronic Medical: Stable	3

Table 2.7 The Final ACG Categories and RUBs (cont.)

ACG Description	**RUB**
3700 Acute Minor/Acute Major/Likely to Recur/Psychosocial	3
3800 2-3 Other ADG Combinations, Age 1 to 17	2
3900 2-3 Other ADG Combinations, Males Age 18 to 34	3
4000 2-3 Other ADG Combinations, Females Age 18 to 34	3
4100 2-3 Other ADG Combinations, Age 35+ 4210 4-5 Other ADG	3
4210 4-5 Other ADG Combinations, Age 1 to 17, no Major ADGs	3
4220 4-5 Other ADG Combinations, Age 1 to 17, 1+ Major ADGs	3
4310 4-5 Other ADG Combinations, Age 18 to 44, no Major ADGs	3
4320 4-5 Other ADG Combinations, Age 18 to 44, 1 Major ADGs	3
4330 4-5 Other ADG Combinations, Age 18 to 44, 2+ Major ADGs	4
4410 4-5 Other ADG Combinations, Age 45+, no Major ADGs	3
4420 4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	3
4430 4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	4
4510 6-9 Other ADG Combinations, Age 1 to 5, no Major ADGs	3
4520 6-9 Other ADG Combinations, Age 1 to 5, 1+ Major ADGs	4
4610 6-9 Other ADG Combinations, Age 6 to 17, no Major ADGs	3
4620 6-9 Other ADG Combinations, Age 6 to 17, 1+ Major ADGs	4
4710 6-9 Other ADG Combinations, Males, Age 18 to 34, no Major ADGs	3
4720 6-9 Other ADG Combinations, Males, Age 18 to 34, 1 Major ADGs	3
4730 6-9 Other ADG Combinations, Males, Age 18 to 34, 2+ Major ADGs	4
4810 6-9 Other ADG Combinations, Females, Age 18 to 34, no Major ADGs	3
4820 6-9 Other ADG Combinations, Females, Age 18 to 34, 1 Major ADGs	3
4830 6-9 Other ADG Combinations, Females, Age 18 to 34, 2+ Major ADGs	4
4910 6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	3
4920 6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	4
4930 6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	5
4940 6-9 Other ADG Combinations, Age 35+, 4+ Major ADGs	5

Table 2.7 The Final ACG Categories and RUBs (cont.)

ACG Description	**RUB**
5010 10+ Other ADG Combinations, Age 1 to 17, no Major ADGs	3
5020 10+ Other ADG Combinations, Age 1 to 17, 1 Major ADGs	4
5030 10+ Other ADG Combinations, Age 1 to 17, 2+ Major ADGs	5
5040 10+ Other ADG Combinations, Age 18+, 0-1 Major ADGs	4
5050 10+ Other ADG Combinations, Age 18+, 2 Major ADGs	4
5060 10+ Other ADG Combinations, Age 18+, 3 Major ADGs	5
5070 10+ Other ADG Combinations, Age 18+, 4+ Major ADGs	5
5110 No Diagnosis or Only Unclassified Diagnosis (2 input files)	1
5200 Non-Users (2 input files)	0
5310 Infants: 0-5 ADGs, no Major ADGs	3
5311 Infants: 0-5 ADGs, no Major ADGs, Low Birth Weight	4
5312 Infants: 0-5 ADGs, no Major ADGs, Normal Birth Weight	3
5320 Infants: 0-5 ADGs, 1+ Major ADGs	4
5321 Infants: 0-5 ADGs, 1+ Major ADGs, Low Birth Weight	5
5322 Infants: 0-5 ADGs, 1+ Major ADGs, Normal Birth Weight	4
5330 Infants: 6+ ADGs, no Major ADGs	3
5331 Infants: 6+ ADGs, no Major ADGs, Low Birth Weight	4
5332 Infants: 6+ ADGs, no Major ADGs, Normal Birth Weight	3
5340 Infants: 6+ ADGs, 1+ Major ADGs	5
5341 Infants: 6+ ADGs, 1+ Major ADGs, Low Birth Weight	5
5342 Infants: 6+ ADGs, 1+ Major ADGs, Normal Birth Weight	4
9900 Invalid Age or Date of Birth	0

Relationship between ADGs and Diagnoses (40)

The following section shows examples of how ICD codes within related diagnostic classes are assigned to ADGs.

Diabetes

Diabetes is a chronic disease with stable and unstable forms and associated complications (Table 2.8). Codes for uncomplicated diabetes--generally Type II diabetes, a long-term stable condition that can generally be managed in primary care settings with occasional need for specialty consultation--are assigned to ADG-10 (Chronic Medical: Stable). Type I Diabetes is an Unstable, Chronic Disease, and treatment almost certainly demands more resources than most Type II Diabetes; thus, Type I is assigned to ADG-11 (Chronic Medical: Unstable). Diabetes ketoacidosis requires intensive medical management and holds the risk for hospitalization. Because of its high severity and likelihood of recurrence (individuals with an episode of ketoacidosis are at higher risk for recurrence than those who have never had this complication), the ICD-10 code for diabetes with ketoacidosis is assigned to ADG-9 (Likely to Recur: Progressive), which is a major ADG associated with very high expected resource consumption. Diabetic retinopathy is a complication of diabetes that demands intense treatment from ophthalmologists; moreover, it is an unstable condition in that once individuals experience the condition, they tend to get progressively worse. Thus, the ICD-10 code for diabetic retinopathy is assigned to ADG-18 (Chronic Specialty: Unstable--Eye).

Table 2.8 Diabetes ICD-10 Codes and Their Respective ADGs (40)

ICD-10		**ADG**	
Code	Label	Code	Label
E11	Diabetes Mellitus Uncomplicated	10	Chronic Medical: Stable
E119	Diabetes Mellitus II Without Complications	10	Chronic Medical: Stable
E111	Diabetes With Ketoacidosis	09*****	Likely to Recur: Progressive
H360	Diabetic Retinopathy	18******	Chronic Specialty: Unstable-Eye

*Major ADG, all ages

**Major ADG, children only

Clinically Oriented Examples of ACGs (40)

Diabetes Mellitus

For diabetes, during the assessment period, patient 1 had diagnosis codes given only for uncomplicated diabetes mellitus and a routine medical exam and is therefore classified into the ACG for patients with stable, chronic medical conditions (ACG-0900). In contrast, patients 2 and 3 with diabetes are in ACGs that branch from MAC-24 (combinations of ADGs not otherwise classified). This occurs because their combinations of ADGs occur too infrequently to merit a separate ACG. Patients in MAC-24 have both high levels of morbidity and high levels of health need. There is a strong link between the total number of ADGs/major ADGs and resource consumption. The following patient types demonstrate the levels of diabetes mellitus, ADGs, and associated costs.

Table 2.9 Patient 1: Low Cost Patient with Diabetes (40)

Input Data/Patient	**Characteristics ACG Output**	**Resource**
Age/Sex: 56/Male	ACG-4100: 2-3 Other ADG Combinations, age > 35	Total Cost: $318 Ambulatory visits: 2 >1 Hospitalization: N
Conditions: Hypertension, Disorder of lipid metabolism, Glaucoma, and Bursitis/synovitis	ADGs: 07, 10, and 18. Likely to Recur: Discrete, Chronic Medical: Stable, and Chronic Specialty: Unstable Eye	

Table 2.10 Patient 2: High Cost Patient with Diabetes (40)

Input Data/Patient	**Characteristics ACG Output**	**Resource**
Age/Sex: 53/Male	ACG-4430: 4-5 Other ADG Combinations, Age >45, 2+Major	Total Cost: $1,968 Ambulatory visits: 7 >1 Hospitalization: N
Conditions: Hypertension, General medical exam, Cardiovascular symptoms; Ischemic heart disease, Disorders of lipoid metabolism, Debility/fatigue, Cerobrovascular disease, Arthralgia, and Bursitis/synovitis	Time Limited: Minor, Likely to Recur: Progressive, Chronic Medical: Stable, Chronic Medical: Unstable, Signs/Symptoms: Uncertain and Prevention/Administrative	

*****Major ADG, all ages

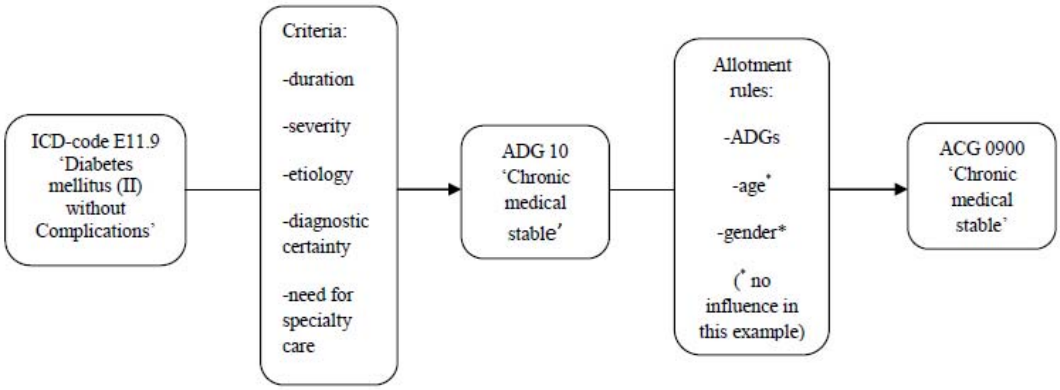
Table 2.11 Patient 3: Very High Cost Patient with Diabetes (40)

Input Data/Patient	**Characteristics ACG Output**	**Resource**
Age/Sex: 47/Male	ACG- 4920: 6-9 Other ADGs Combination, Age >35, 2 Majors	Total Cost: $16,960 Ambulatory visits: 22 >1 Hospitalization: Y
Conditions: Hypertension, General medical exam, Ischemic heart disease, Congenital heart disease, Cardiac valve disorders, Gastrointestinal signs/ symptoms, Diverticular disease of colon, Chest pain, and Lower back pain	ADGs: 07, 09*, 11*, 27, 28, and 31. Likely to Recur: Discrete, Likely to Recur: Progressive, Chronic Medical: Stable, Chronic Medical: Unstable, Signs/Symptoms: Uncertain, Signs/Symptoms: Major, and Prevention/Administrative	

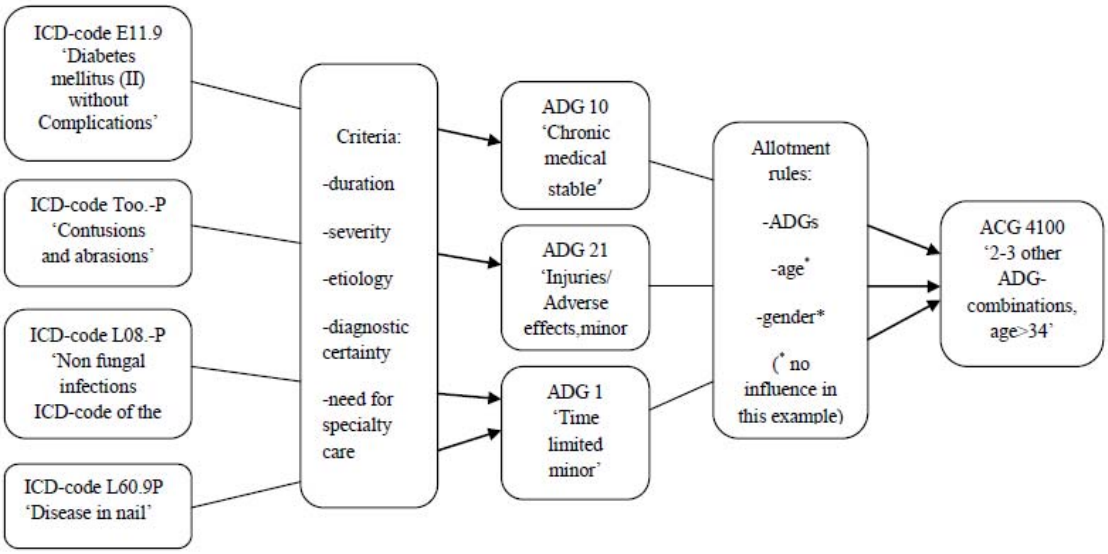
*****Major ADG, all ages

In summary, the principal information concerning the ACG system and the grouping algorithms has been demonstrated. The end result of the grouping is that each patient is allotted to one, and no more than one, ACG, depending on his/her registered type or types of morbidity. Each one of the ICD-10 codes in this system is assigned to one of 32 different types of morbidity, the Aggregated Diagnostic Groups (ADGs), using a set of criteria as follows: likely persistence of the condition, grade of severity, aetiology, diagnostic certainty, and need for speciality care. Thus each group of the ADGs is a cluster of diagnoses that are homogenous with respect to these criteria. These ADGs are the building blocks of the ACG.

Each ADG, either alone or in combinations with others, is assigned to one or more of the 93 ACGs, describing the health status category of each patient. In some cases the assignment of one or several ADGs to one ACG takes into account the age and/or gender of the patient. This is shown by our two examples in Figure 2.2. Thus each ACG is used as an average for a group of patients with the same constellation of morbidity, and the ACGs describe the patterns of morbidity, thereby indicating the need for care of each category of patients (22).



(a) A male patient who has 1 ICD code that belongs to 1 ADG that is allotted to 1 ACG.



(b) A female patient, 60 years of age, who has 4 ICD codes that belong to 3 ADGs that are allotted to 1 ACG.

Figure 2.2 Two examples, where both patients have diabetes, of allotting a patient to an Adjusted Clinical Group (ACG) (22)

Rx-PM: Medication-Defined Predictive Model (40)

The ACG System's Rx-PM is a predictive model that is constructed from outpatient pharmacy information, age, and sex. It is based on a newly developed clinical model that organizes medications into Rx-defined morbidity groups (Rx-MGs). These morbidity groups are used as risk factors in the Rx-PM, or in applications involving prescribing pattern assessments.

Rx-PM is a predictive model for forecasting medication costs and it performs well in applications that forecast total healthcare costs. Unlike diagnosis based models which require several months of data before valid PM risk scores can be assigned, Rx- PM risk scores can be assigned as soon as a patient's full medication regimen is known. This may be as soon as a clinical history is obtained, or a few months later if claims records are the source. World Health Organization (WHO) Anatomical Therapeutic Chemical (ATC) System codes can be data inputs for Rx-PM.

Anatomical Therapeutic Chemical (ATC) System (40)

The Anatomical Therapeutic Chemical (ATC) System serves as the World Health Organization (WHO) standard for drug consumption studies. It is maintained by the WHO Collaborating Centre for Drug Statistics Methodology.

In the Anatomical Therapeutic Chemical (ATC) classification system, the drugs are divided into different groups according to the organ or system on which they act in addition to their chemical, pharmacological, and therapeutic properties. Drugs are classified into five different group levels. The drugs are divided into fourteen main groups (1st level), with one pharmacological/therapeutic subgroup (2nd level). The 3rd and 4th levels are chemical/ pharmacological/therapeutic subgroups and the 5th level is the chemical substance. The 2nd, 3rd and 4th levels are often used to identify pharmacological subgroups when that is considered more appropriate than therapeutic or chemical subgroups. Example of the complete classification of metformin is shown in Table 2.12.

Table 2.12 The complete classification of metformin illustrates the structure of the code (40)

Level	**Description**	**Group Level**
A	Alimentary tract and metabolism	1st level, anatomical main group
A10	Drugs used in diabetes	2nd level, therapeutic subgroup
A10B	Blood glucose lowering drugs, excluding insulins	3rd level, pharmacological subgroup
A10BA	Biguanides	4th level, chemical subgroup
A10BA02	A10BA02 Metformin	5th level, chemical substance

Therefore, in the ATC system, all plain metformin preparations are given the code A10BA02.

ATCs are classified based upon the therapeutic use of the main active ingredient. In fact, the same generic substance can be given more than one ATC code if it is available in two or more strengths or formulations with clearly different therapeutic uses. However, an international classification system has the challenges of capturing country specific, main therapeutic use of a drug that often results in several different classification alternatives. As a general guideline, the ATC system has attempted to assign such drugs to one code, the main indication being decided on the basis of the available literature.

Rx-Defined Morbidity Groups (40)

The building blocks of Rx-PM are Rx-defined morbidity groups (Rx-MGs). Each generic drug /route of administration combination is assigned to a single Rx-MG. The specific clinical criteria that we used to assign medications to an Rx-MG category were the primary anatomico-physiological system, morbidity differentiation, expected duration, and severity of the morbidity type being targeted by the medication. These four clinical dimensions not only characterize medications by morbidity type, they also have major consequences for predictive modeling. Higher levels of

differentiation, chronicity, and greater severity would all be expected to increase resource use. Each of these criteria is discussed below.

1. Primary Anatomico-Physiological System

The Rx-MG classification system is organized into 19 Major Rx-MG categories: 16 anatomico-physiological groupings; 1 general signs and symptoms category; 1 toxic effects/adverse events group; and 1 other and non-specific medications category.

2. Morbidity Differentiation

Very few medications are used for a single disease. Even insulin treatment, which is employed in the management of diabetes, does not separate patients into Type 1 and Type 2 diabetes, because it can be used to manage either form. A single medication is often administered for multiple clinical indications; thus, a medication classification system that is solely disease-based will not validly reflect patient morbidity. Rx-MGs assign medications to a specific disease when there is a logical 1-to-1 assignment (e.g., digoxin -congestive heart failure). However, most medications are assigned to broader morbidity groups, which are reflective of the patient's underlying patho-physiology. Furthermore, a large amount of medication treatment is for physically (e.g., pain medications) and emotionally (e.g., anxiolytics) experienced body sensations. These symptoms are undifferentiated morbidities that generally require palliative therapy. In contrast, specific medical diseases are more differentiated morbidity types. Because we sought to create a comprehensive classification system of medications, the Rx-MGs include categories for symptoms (assigned to an acute minor category within an organ system grouping or to the general signs and symptoms category), fully developed diseases that have a 1-to-1 correspondence with medication, and more general morbidity-types.

3. Expected Duration

This dimension refers to the expected time period that the morbidity will require treatment and is used to characterize conditions as acute, recurrent, or chronic. An acute condition is a time-limited morbidity that is expected to last less than 12 months. The classic example of acute conditions is infections. Recurrent conditions are episodic health problems. They tend to occur repeatedly, and over time. Migraine headaches and gout are two examples of recurrent conditions.

Each episode is time-limited and, in isolation, could be considered an acute health problem. However, the repetitive occurrences may span several years with asymptomatic inter-current periods; this episodic relapsing nature of the morbidity type is the hallmark feature of recurrent morbidities. Chronic conditions are persistent health states that generally last longer than 12 months.

4. Severity

The severity of morbidities refers to somewhat different concepts for acute and recurrent /chronic conditions. For acute problems, morbidity severity is related to the expected impact of the condition on the physiological stability of the patient or the patient's functional status. Low impact conditions have minimal effects on functioning or physiological stability, whereas high impact problems can have significant effects on the ability of an individual to perform daily activities. For recurrent and chronic conditions, morbidity severity is related to the stability of the problem over several years. Without adequate treatment, unstable chronic conditions are expected to worsen over time, whereas stable conditions are expected to change less rapidly.

ATC to Rx-MG Assignment Methodology (40)

1. **Larger number of codes assigned**. The ATC assignment involved assigning close to 5,100 ATC codes (900 4th Level and nearly 4,200 5th Level ATC codes) to an Rx-MG.

2. **International variability**. Incorporating international variability and off label use was also considered. Literature was extensively reviewed for evidence of alternate and prevalent international use of medications. Whenever evidence showed that the predominant use of the medication was different from the FDA approved use, the Rx- MG assignment was modified to reflect this.

3. **Route of administration was not available for some ATC codes**. Route is not provided in the ATC dictionary for nearly 41% of the ATC codes. However, this was not an impediment in establishing Rx-MG assignments due to the fact that the ATC hierarchy is therapeutic centric; and, in almost every case, it provides much more information than the drug/route combinations.

4. **Use of original Drug/Route-to-Rx-MG Assignments**. In order to preserve assignment consistency from the NDC based Rx-MGs, Drug/Route-to-Rx-MG assignments were systematically reviewed and were considered as a guide when making ATC-to-Rx-MG assignments.

Examples of Rx-MG categories, along with their distinguishing clinical characteristics, is shown in Table 2.13.

To illustrate the content of each Rx-MG, Table 2.14 shows examples of a set of exemplary medications for each category.

Table 2.13 Examples of Rx-MG Morbidity Taxonomy and Clinical Characteristics of Medications Assigned to Each Rx-MG (40)

Rx-Defined Morbidity Group	**Differentiation**	**Duration**	**Severity**	
			Acute Conditions: Impact	**Chronic and Recurrent Conditions: Stability**
Cardiovascular				
Chronic Medical	General	Chronic	-	Stable
Congestive Heart Failure	Disease	Chronic	-	Unstable
High Blood Pressure	Disease	Chronic	-	Stable
Disorders of Lipid Metabolism	Disease	Chronic	-	Stable
Vascular Disorders	General	Chronic	-	Stable
Endocrine				
Bone Disorders	General	Chronic	-	Stable
Chronic Medical	General	Chronic	-	Stable
Diabetes With Insulin	Disease	Chronic	-	Unstable
Diabetes Without Insulin	Disease	Chronic	-	Stable
Thyroid Disorders	General	Chronic	-	Stable

Table 2.14 Exemplary Modifications and Therapeutic Classes for Each Rx-MG (40)

Rx-Defined Morbidity Group	**Medication Examples**
Cardiovascular	
Chronic Medical	Oral Nitroglycerine, Antiarrhythmic Agents
Congestive Heart Failure	Digoxin
High Blood Pressure	Atenolol, Thiazide Diuretics, Lisinopril
Disorders of Lipid Metabolism	HMG-Coa Reductase Inhibitors, Niacin
Vascular Disorders	Subcutaneous Tinzaparin, Warfarin
Endocrine	
Bone Disorders	Bisphosphonates
Chronic Medical	Growth Hormones, Oral Mineralocorticoids
Diabetes With Insulin	Insulin, Injectable Glucagon
Diabetes Without Insulin	Oral Metformin, Sulfonylureas
Thyroid Disorders	Levothyroxine, Propylthiouracil

Part III: International applications of ACG system

Past research indicates that morbidity burden assessment could add considerably to the ability of health systems to make better use of data for planning and evaluation. Current uses of the ACG System in health care systems worldwide reflect the numerous applications for which the system was designed; namely, profiling of populations, assessment of provider practices, more equitable resource allocation, high-risk patient identification, and monitoring of interventions and policy reforms as well as evaluating existing systems.

Table 2.15 summaries research using ACGs and its applications. Example of its applications are as follow.

Profiling of populations or describe a population health

Population profiling is a technique for comparing the morbidity patterns of one or more groups or regions. By taking into account the differences in illness burden among different patient population, this system allow one to determine variations in disease prevalence as well as resource use (40). Typically, population profiling is the

first step to better understanding the health care needs of a population. For example, for subpopulations that differ in age, gender, geographical region, ethnicity or other characteristics, population profiling can assess the differences in health status and identify the health care needs of special groups. Population profiling can also help explain variability in referral rates and differences in primary care services costs by linking these changes to changes in morbidity of the populations compared. Having a solid knowledge of the morbidity pattern of different populations also allows for the accurate evaluation of the efficiency of different healthcare practices, as well as the equitable setting of capitation payments.

Monitoring the health status of a population may be desirable for purposes of setting health policy or demonstrating value to health purchasers. As a population ages, health may be expected to decline, but interventions to improve population health may improve or reverse that trend. The monitoring of morbidity burden across populations has facilitated comparisons of population segments in other countries, across both regional boundaries and socio-economic groups as well as by ethnicity, with insights into the presence of variance in disease prevalence that enable more targeted interventions (41).

The approach using the ACG system yields a pattern of the burden of morbidity in a defined population from the clinical logic because patients in the same ACG have a similar need for health care resources. The ACG system expected to perform reasonably well in accounting for severity associated co-morbidities among patients with chronic illness. These results suggest that the ACG system performs reasonable well in accounting for needs and co-morbidity at either individual diseases or group level (42). It seeks to accomplish the needs indicators and link services to individuals at the level of individual by clustering morbidities into clinical meaningful categories of health care need (18, 19, 22, 26, 43).

Profiling of providers or Performance Assessment

Performance profiling is often viewed skeptically by targeted providers. To be successful, performance profiling must address important differences in case-mix and the often-stated concern that “my patients are sicker” (14). The key to provider acceptance of performance reporting is the transparency and underlying

clinical integrity of the adjustment process. For examples, recognizing that physicians' practice behavior varies, the Ministry of Health in British Columbia, Canada, has used the ACG System to evaluate physicians and detect true cases of fraud and abuse. Prior to the introduction of the ACG System, audit results showed that, in 3 out of 4 cases, high healthcare expenses were justified by a sicker patient pool. After the ACG system was extensively evaluated, subsequent audit results showed that unjustified healthcare expenses were actually confirmed in 3 out of 4 cases identified (44). Several applications such as in the United States managed care providers, ACGs used for adjusting prospective payment rates and profiling of providers performance (45-47).

Care Management (including case management, disease management and high risk case identification)

The ACGs describe the health service needs across the full range of health problems that physicians see in health care institutions. The overall intent of ACGs is to estimate an individual's health status in relation to health service need based on age, sex, and the grouping of diagnoses assigned to individuals over a defined time. Diagnoses are logically grouped into morbidity categories based on several clinical attributes or co-morbidity (48). The ACG system can provides the basis for further analysis of health in patient groups such as measuring of health risk (49, 50), quality of care improvement (51-53).

ACG predictive modeling provides information at the individual patient level to help identify persons who potentially would be well served by special attention from the organization's care management infrastructure (54). This high-risk case identification process could be used to target a person for interventions such as a referral to a case-manager, special communication with the patient's physician, structured disease management programs, or educational outreach. This application has been gaining in importance as demonstrated by experiences in Germany and the US as well as the UK. Given the limited resources present in every health care system, targeting individuals who could most benefit by early detection and intervention is a prudent way to utilize those limited resources (55).

Resource allocation and profiling resource use

With the increasing number of chronically ill individuals, the need for morbidity adjusted resource allocation that considers a wider range of characteristics than simply age, gender and geography is critical. The ACG system has used to describe differences in the pattern of illness in population and used to stratify population into clinically meaningful groups for profiling the practices of practitioners. Furthermore, it used as a method for studying resource use and planning for resource needs of population. The morbidity categories reflect the mix conditions that patients face and thus are use for case-mix adjusting patient-based capitation payments (56). Perhaps the most common administrative use of the ACG System is in the distribution of budgets – both regionally (as in Sweden) as well as to individual clinics (as in Spain) (14). In Sweden, where people were given the choice of a public or a private primary care provider, those choosing to stay with a public primary care provider had higher morbidity burdens as determined by the ACG method (57). By applying case-mix to payment formulas, a health care authority is able to ensure that payment is provided according to the needs of patients (58).

Evaluation of quality, efficiency, and equity of care

ACG is currently used for measuring differential morbidity burden of populations and describing for cost, quality and efficiency of health care service worldwide such as in the United Kingdom (59), Canada (56), Sweden (21, 43), and Spain (23, 60). ACG is an important tool for evaluating both quality and costs of care. All comparisons of quality of care require standardization of initial morbidity before evaluating differences in the results. Differences in the expenditure of resources between health systems may result from variations in the extent of morbidity in the populations. Since some populations may be sicker than others and require a different type of care even for the same condition under investigation. The use of outcome measures is an essential element for understanding the quality of care. When comparing outcomes, risk adjustment is necessary to ensure that differences in the outcome are not the result of differences in the baseline characteristics of the population being served. Without adequate risk adjustment, poor performers will always be able to argue “our patients are sicker.” For examples, ACG adjustment

assist in controlling for the health status or illness burden across patients when monitoring the use of specialist or sub-specialist and generalist of children with chronic conditions across insurance plan (61). In addition, ACG model could be used to examine the impact of co-morbidities on predicting stroke rehabilitation outcomes in assessing quality of care (62).

Furthermore, two recent studies from Ontario, Canada, demonstrated the ability of the ACG system in; (1) assessing outcome in health service by using ADGs to predict mortality in a general ambulatory population cohort (63); and (2) evaluating the equity of age-sex adjusted primary care capitation payment (64).

Other applications of ACG system such as; explaining and predicting prescription drug expenditure and use in Canada (65), and Spain (66, 67); explaining the variation in healthcare cost and predicting future health care utilization by incorporating pharmacy data (Rx-MGs) into predictive model (24, 28). Therefore, countries or regions that routinely collect prescription claim data, the Rx-MGs within ACG case-mix system could be applied to predict healthcare utilization as well as allocate resources for healthcare.

In summary, ACGs represent a significant advance in measuring health care need in populations. For policy makers and health administrators, the ACG system is particularly attractive because it uses existing data such as medical care claims or hospital administrative database. ACGs are available as proprietary software products that can be applied to the data systems of most health care organizations and are used currently used by the Center for Medicare and Medicaid Studies and many private and commercial health care companies. This feature is particularly important for populations that may be unstable in the nature of illness and performance of health care services.

Experiences of ACG applications in Thailand

In Thailand, Ambulatory case-mix development work was done in 2004 by researchers at Centre for Health Equity Monitoring (CHEM), Naresuan University. Feasibility testing of the ACG was done from the national health insurance database of 2002. This case-mix systems was technically feasible but needed more complete data especially on delivery of pregnant woman (29). After that, ACGs was used to examine

a burden of illness for outpatient care in the social security scheme (SSS) population. The burden of illness in a social security population can be described in terms of ACG case-mix using the individual data for outpatient care. The results showed that differences between health service utilization and annual charge between health care sectors were the result of differences of inputs and outputs in the defined populations according to their morbidity patterns. ACG can be used to measure morbidity in the population and its application for resources allocation to providers of health services (31). Furthermore, ACG was used to determine the cost of chronic illness for outpatient services at general hospitals and develop a predictive model for outpatient cost by comparing with the Charlson Comorbidity Index (CCI)**.** This retrospective study included patients attending 22 large general hospitals in Thailand during the year 2008. Hospital and pharmacy cost data for outpatients were obtained from a hospital-based computer system, and the results demonstrated that the co-morbidity index adapted from ACGs had a higher influence on the predictive model for outpatient cost of chronic diseases than the CCI (30). Therefore, the ACG System appears to be the suitable co-morbidity measure for explaining and predicting healthcare cost in an outpatient setting.

In conclusion, several previous studies in Thailand have demonstrated that ACG can be used to measure morbidity in the population and its application for resources allocation to providers of health services in Thai context. However, these studies included only diagnosis information, age and gender for incorporating into ACG system. With drug information available, it will be interesting to evaluate how a pharmacy-based risk adjustment model, ACG system's Rx-MG, works in evaluating drug utilization pattern of patients with chronic diseases.

Table 2.15 Summary of literatures relevant on the applications of ACGs

Authors (Year)	Subject	Data source	Findings	Ref
Profiling of populations or describe a population health/ Profiling of providers				
Reid RJ, et al. (2001)	Profiling population of two provinces, same-year and next year expenditures	Claims in two Canadian provinces	ACG system explained 25-50% for physician costs in same-/next-year, and 14-40% for total costs	(18)
Reid RJ, et al (2002)	Assessment ability of ACG measure health needs	Health service utilization, mortality, and census data	ACG morbidity index, socioeconomic risk, physician utilization explain standardized mortality rate (98%)	(19)
Carlsson L, et al.(2004)	Type of morbidity and categories of patient, in Sweden	Electronic patient record databases in primary care	ACG system explained type of morbidity in primary care are dominated by nearly proportion of “time limited”, “likely to recur”, “chronic”, and “signs/symptoms”	(22)
Lee WC (2008)	Morbidities for Taiwanese population, relationship to utilizations and costs	Claims data for ambulatory services	ACG system assigned 98% of the subjects, mostly “ acute and minor” and “moderate to high morbid chronic”	(26)
Baldwin LM, et al. (2006)	Co-morbidity for predict receipt chemotherapy	Medicare claims and cancer registries	ACGs improved models for prediction of chemotherapy receipt and non-cancer death	(42)
Carlsson L, et al(2006)	Morbidity and primary care visits in population	13 primary care centers, Sweden	About one third of patients each year had two or more types of morbidity	(43)
Verhulst L,et al.(2001)	Physicians’ practice behavior	British Columbia, Canada,	After the ACG System was extensively evaluated, unjustified healthcare expenses were actually confirmed in 3 out of 4 cases identified	(44)
Thomas JW, et al. (2004)	Practice efficiency of primary care physician	Claims records for health maintenance organization	Six risk-adjusted measure agreement was greater among pediatrician than adult primary care physician	(46)
Adams EK, et al. (2002)	Predictive ratio for Medicaid enrolles	Claims data for Medicaid	ACGs improve Medicaid payment accuracy relative to based on age and sex only	(47)

Table 2.15 Summary of literatures relevant on the applications of ACGs (cont.)

Authors (Year)	Subject	Data source	Findings	Ref
Care Management (including case management, disease management and high risk case identification)				
Perkins AJ, et al. (2004)	Predictive ability for costs and mortality	Electronic medical record system	ACGs (16.4%) and number of medications (15.0%) had highest predictive validity for ambulatory visits	(48)
Chang HY, et al. (2010)	High risk patient case finding	Taiwan's national health insurance claims	Diagnosis-based models were better in identifying top users with manageable diseases; prior expenditures models were better in identifying people with higher average expenditures	(49)
Wong ST, et al. (2006)	Health care cost can utilisation	Cliams for Medicaid in California	American Indians/Alaska had lower use of ambulatory visits, prescriptions, hospitalizations, and costs than Whites	(50)
Murphy SM, et al. (2011)	Cut point selection method for care management program	Administrative health plan data	ACG-PM software demonstrated how best to utilize predictive modeling scores to improve the identification process for care management programs and other population health initiatives	(51)
Sylvia ML, et al. (2008)	Patient at high risk of future health care utilization	Insurance information from claims data	ACG-PM software identified patients who will generate insurance expenditures that will rank within the highest 5% of the poppulation during the following year	(52)
Sylvia ML, et al. (2006)	Cinical features of high risk older persons	Administrative claims data	A claims-based predictive modeling algorithm identifies older persons whose health, functional ability, and use of health services, candidates for clinical interventions	(53)
Forrest CB, et al. (2009)	Predictors of high-risk patients in need of care management	PharMetrics Patient-Centric Database	Clinically based PMs are a better choice tan prior cost alone for program that seek to identify high-risk groups of patients	(54)
Starfieid B, et al. (2003)	Variation in extent of comorbidity and resource utilization	Administrative claims data	Comorbidity varied within each diagnosis; resource use depended on the degree of comorbidity rather than the diagnosis.	(55)

Table 2.15 Summary of literatures relevant on the applications of ACGs (cont.)

Authors (Year)	Subject	Data source	Findings	Ref
Resource allocation/ Evaluation of quality, efficiency, and equity of care				
Zielinski A, et al. (2009)	Equitable resource allocation in Swedish primary health care	Electronic primary health care record	The ACGs explains patient costs in primary care to a high degree. Age and gender are important explanatory factors, but most of the variance in concurrent patient costs was explained by ACGs.	(20)
Halling A, et al. (2006)	Validate ACG for predictive value of poly pharmacy	Data from four primary care centers in Sweden	Resource utilization band (RUB) from ACG output had a good fit for who multiple prescriptions	(21)
Orueta JF, et al. (2006)	Explain the utilization of primary care, Spain	Computerized medical record from primary care	The ACGs is a useful tool to explain the use of primary care services and feasible to implement from physician's annotations in the computerized medical records	(23)
Bolanos-Carmona V, et al. (2002)	Health services use by primary care patients	21 health centres in seven regions in Spain	ACG explain 49% of ambulatory visits, 14% in the number of referrals, and 16% in the number of diagnostic tests	(60)
Kuhlthau K, et al. (2001)	Generalist, subspecialist, and specialist use	Medicaid claims data from 4 states	Children younger than 13 years, lived in urban, white, and higher ACGs score were more likely to use subspecialists	(61)
Berlowitz DR, et al. (2008)	Impact of co-morbidities on stroke rehabitation outcomes	Clinical and administrative database	The ACG model were significantly better than the age and sex model for both 6-month mortality and re-hospitalization.	(62)

Table 2.15 Summary of literatures relevant on the applications of ACGs (cont.)

Authors (Year)	Subject	Data source	Findings	Ref
Other applications				
Calderon-Larranaga A, et al. (2010)	Predicting pharmacy use in Aragon, Spain	Electronic medical records from six primary care centers	Pharmacy spending is more predictable using pharmacy-based risk markers compared with diagnosis-based risk markers.	(24)
Kuo RN, et al. (2010)	Predicting healthcare costs in Taiwan	Longitudinal Health Insurance Database	The medication-based Rx-Defined Morbidity Groups was useful in predicting pharmacy cost as well as total cost in Taiwan. Combining the information on medication and diagnosis as adjusters could arguably be the best method for explaining variations in healthcare cost.	(28)
Austin PC, et al. (2011)	Predicting mortality in ageneral ambulatory population cohort, Canada	Population- based administrative database,Ontario	Logistic regression models using age, sex, and the John Hopkins ADGs were able to accurately predict 1-year mortality in a general ambulatory population of subjects.	(63)
Sibley LM, et al. (2011)	The equity of age–sex adjusted primary care capitation payments	Administrative database,Ontario, Canada	Adjusting capitation rates for morbidity burden in addition to age and sex may reduce incentives to preferentially enrolled patients with higher socioeconomic status.	(64)
Hanley GE, et al. (2010)	Explaining Prescription Drug Use and Expenditures	Population- wide administrative database	ACGs are a valuable predictor of pharmaceutical use and expenditures with much higher predictive power than age, sex, and the Charlson index of comorbidity.	(65)
Calderon-Larranaga A, et al. (2010)	The behavior of pharmacy expenditure	Computerised clinical records from six primary care centers in Spain	This interpretation of pharmacy expenditure gives new clues for the efficiency in utilization of healthcare resources, and could be complementary to management interventions focused on individuals with a high morbidity burden.	(66)
Aguado A, et al. (2008)	Variability in prescription drug expenditures	Electronic records in five primary care centers, Spain	ACG is useful to profile physicians and centers using electronic records in real practical conditions. Physicians with lower pharmaceutical expenditure have higher scores for a prescription quality index.	(67)

Table 2.15 Summary of literatures relevant on the applications of ACGs (cont.)

Authors (Year)	Subject	Data source	Findings	Ref
ACG applications in Thailand				
Upakdee N. (2006)	The feasibility for outpatient casemix systems	National health insurance database, 2002	Development for outpatient classification system from national health insurance database was technically feasible in Thailand. ACG needed even more complete data for the study period usually one year.	(29)
Upakdee N. (2007)	Resource allocation of social security population in Thailand	Computerized health insurance data, 2005	The ACGs system was useful to explain the variation in utilization of health care services of the SS population, and also have potential usefulness as a management tool which payment to differences in levels of morbidity.	(31)
Upakdee N. (2009)	Predicting Outpatient Cost of Chronic Diseases in Thailand	Hospital-based computer system.	The co-morbidity index adapted from ACGs had a higher influence on the predictive model for outpatient cost of chronic diseases than the Charlson Co-morbidity Index.	(30)

CHAPTER III
METHODOLOGY

This chapter provides a description of research methodology including research design, study location, study period, study population, data source, data collection and data analysis.

Research design

This research is retrospective cohort study of longitudinal data using a regional hospital's electronic databases for 4 consecutive years (2008-2011).

Study location

Buddhachinaraj Hospital, a 1,000-bed regional hospital in Phitsanulok, where electronic database is available and ethics committee has approved the study (October 19th, 2011).

Study period

Data recorded during fiscal year 2008-2011 (October 1st, 2007 to September 30th, 2011) were studied.

Study population

Included patients were required to have at least one diabetes-related visit per year, for 4 consecutive years (2008-2011) at outpatient service, Buddhachinaraj Hospital, Phitsanulok.

Data source

Inpatient and outpatient utilization data were obtained from electronic health insurance database (68), medication use and laboratory data information were obtained from pharmacy and laboratory databases from Buddhachinaraj Hospital, Phitsanulok (see in appendix A-C).

Study procedure and data collection

The Johns Hopkins ACG software version 9 was used as a tool for incorporating information from three data sources.

1. Patient Identification and classification

ACG software identified numbers of diabetic condition according to diagnosis (ICD-10 code) and/or pharmacy information such as medication in groups of oral hypoglycemic drug and insulin.

2. Characteristic of patient population

Demographics of diabetic patient such as age, gender, health insurance scheme, and patient co-morbidity are obtained by ACG software from electronic health insurance database (standard dataset 12 file).

Age was categorized into age band, possible values include: 00-04, 05-11, 12-17, 18-34, 35-44, 45-54, 55-69, 70-74, 75-79, 80-84, and 85+

Type of health insurance were classified as universal coverage (UC), social security scheme (SSS), civil servant medical benefit scheme (CSMBS), and out of pocket payment.

For co-morbidity, from ICD-10 code and patient medication, the software automatically demonstrated 19 chronic conditions. Five chronic conditions were chosen in this study: hypertension, hyperlipidemia, chronic renal failure, chronic heart failure, and ischemic heart disease.

3. Morbidity burden in diabetic patient by ACG grouping

The construction of an ACG requires the age, gender and diagnoses according to the ICD-10 code. The process of converting ICD-10 code to ACG consists of 4 stages: the first two group a series of conditions according to similarity of resource consumption and the second two combine the most-common groupings: a) ICD-10 code diagnoses are grouped into 32 Ambulatory Diagnostic Groups (ADG), of which a patient may have one or more; b) ADG are transformed into 12 Collapsed Ambulatory Diagnostic Groups (CADG); c) CADG are transformed into 25 Major Ambulatory Categories (MAC); and d) MAC are transformed into ACG.

Then, the ACG software will assign each patient to a resource iso-consumption group, by providing the resource utilization bands (RUB), which group each patient into one of five mutually-exclusive categories,1) healthy users, 2) low morbidity, 3) moderate morbidity, 4) high morbidity, and 5) very-high morbidity) according to morbidity.

For medication data collected outside the U.S., an international mapping algorithm within the ACG system also performs the Rx-MGs assignment based on the WHO Anatomical Therapeutic Chemical (ATC) classification (69). Therefore, in this study, the prescription codes within the claim data were first mapped to the WHO ATC codes, then entered into the Johns Hopkins ACG system for Rx-MGs assignment, which categorized patient medication into 60 Rx-MGs groups.

4. Performance measures in diabetes management

Data from hospital laboratory information system (hemoglobin A1c, lipid profiles, and microalbuminuria) were linked with output from ACG software to monitor outcomes of care such as:

- HbA1c quarterly,
- Lipid profile yearly, and
- Urine testing for protein yearly

Data analysis

All data output from ACG software (see table 3.1) were analyzed by SPSS version 13.0 and Microsoft Excel 2007.

1. Patient characteristic

Age, gender, health insurance scheme and patient's co-morbidities were analyzed by descriptive statistics (frequency, mean and percentage) for each fiscal year.

2. Morbidity burden in diabetic patient by ACG grouping

Diabetic patient's morbidities were described and compared according to their assigned ADGs and ACGs between 2008 and 2011. Number of unique ADGs and major ADGs were counted. Distributions of the cohort population according to their assigned ADGs and ACGs in each year were plotted and compared from 2008 to 2011. Friedman's test was used to compare distribution of ACGs between the four years ($p<0.05$). The mean number of outpatient, inpatient visits and expenditures per diabetic patient per year for each top ten ACG categories were compared between 2008 and 2011. Frequency and percent of patients in each RUBs were presented.

Distributions of Rx-MGs categories in diabetic patients were described and compared from 2008 to 2011, to demonstrate drug utilization pattern. Mean number of Rx-MGs and drug expenditure in most frequent ACGs between the four years, were assessed.

3. Healthcare resource use

Utilization of service

Outpatient visit, emergency room visit and inpatient hospitalization were identified from electronic health insurance database (standard dataset 12 file). The output from software showed the number of visit per individual patient each year.

Utilization rate is the total number of times that a patient comes for treatment in hospital during a period of time. This rate was determined

separately for outpatient and inpatient. Comparison of utilization rate each year between 2008 and 2011 were determined.

Healthcare expenditure

Healthcare expenditures are charge of treatment per diabetic patient each year, which classified into 2 groups, drug and other service, for outpatient and inpatient services**.** In order to compare between years, all expenditures were adjusted at 2008 price by using consumer price index (70).

Total expenditures were sum of all service expenditures (charges) during treatment in hospital, separated for outpatient and inpatient. Drug and total expenditures per patient each year between the four years, were determined.

In addition, utilization of service and healthcare expenditure of diabetic patient were determined for each subgroup among three different health insurance schemes

4. Performance measures in diabetes management

Result of each laboratory test at the last date each year from 2008 to 2011 was used to calculate at target control according to ADA recommendation (HbA1c < 7%, LDL cholesterol < 100 mg/dl, and urine albumin excretion < 30 μg/mg creatinine). Number of laboratory tests (HbA1c, LDL cholesterol, microalbuminuria screening) in diabetic patient were described in frequency and percent. The proportion of diabetic patients with good control, were presented.

With drug code in prescription data from pharmacy database, could be identified intermediate outcomes such as:

- ACEI (or ARB) if hypertensive
- Statin if hyperlipidemia

Table 3.1 presents the patient list analysis generated as the output of the ACG system as a single row per patient.

Table 3.1 Patient List Analysis Report Layout

Column Name	**Definition**
Patient ID	The patient's unique identifier
Age	The patient's age in years
Health insurance scheme	Type of health insurance were classified as universal coverage (UC), social security scheme (SSS), civil servant medical benefit scheme (CSMBS), and out of pocket payment.
Age Band	A banded indicator of patient age. Possible values include: • 00-04 • 05-11 • 12-17 • 18-34 • 35-44 • 45-54 • 55-69 • 70-74 • 75-79 • 80-84 • 85+
Outpatient visit	Number of outpatient visit for this patient during the observation period.
Emergency room visit	Number of emergency room visit for this patient during the observation period.
Inpatient hospitalization	Number of hospitalization for this patient during the observation period.
Total expenditure	The total medical and drug expenditures for this patient during the observation period.
Drug expenditure	The total drug expenditures for this patient during the observation period.

Table 3.1 Patient List Analysis Report Layout (cont.)

Column Name	**Definition**
Outpatient expenditure	The total medical and drug expenditures for outpatient service of this patient during the observation period.
Inpatient expenditure	The total medical and drug expenditures for inpatient service of this patient during the observation period.
ADG Codes	Aggregated Diagnosis Groups -- the building blocks of the ACG System, each ADG is a grouping of diagnosis codes that are similar in terms of severity and likelihood of persistence of the health condition over time.
Major ADG Count	The number of major ADGs assigned to this patient. A "major ADG" is an ADG found to have a significant impact on concurrent or future resource consumption. There are separate "major ADGs" for pediatric and adult populations.
ACG Code	Adjusted Clinical Groups -- the ACG code assigned to this patient. ACGs assign persons to unique, mutually exclusive morbidity categories based on patterns of disease and expected resource requirements.
Resource Utilization Band	Aggregations of ACGs based upon estimates of concurrent resource use providing a way of separating the population into broad co-morbidity groupings as follows: • 1 - Healthy Users • 2 - Low • 3 - Moderate • 4 - High • 5 - Very High
Rx-MG Codes	Pharmacy Morbidity Group Codes -- all of the Rx-MG codes assigned to this patient.

Table 3.1 Patient List Analysis Report Layout (cont.)

Column Name	**Definition**
Major Rx-MG Codes	Major Pharmacy Morbidity Group Codes -- All of the Major Rx-MG codes assigned to this patient.
Chronic Condition Count	A count chronic condition with significant expected duration and resource requirements.
Diabetes	A flag indicating if this patient has this medical condition and how it was indicated
Hyperlipidemia	A flag indicating if this patient has this medical condition and how it was indicated
Hypertension	A flag indicating if this patient has this medical condition and how it was indicated
Ischemic heart disease	A flag indicating if this patient has this medical condition and how it was indicated
Congestive Heart Failure	A flag indicating if this patient has this medical condition and how it was indicated
Chronic Renal Failure	A flag indicating if this patient has this medical condition and how it was indicated

CHAPTER IV
RESULTS

The results are divided into four parts as:

Part I Patient characteristics,

Part II Morbidity pattern of diabetic patients by ACG® software,

Part III Determination of resource utilization and healthcare expenditure

Part IV Performance measures in diabetes management

Part I Patient characteristics

This study recruited 5,535 diabetic patients who attended at least one diabetes-related visit per year for 4 consecutive years (from 2008 to 2011). Approximately 66% were female and 37% aged 65 and over. Slightly more than half of diabetic patients were under the Universal Coverage Scheme (UC), 44% of diabetic patients were under the Civil Servant Medical Benefit Scheme (CSMBS) and approximately 4% of diabetic patients were under the Social Security Scheme (SSS) (see Table 4.1).

Approximately, a half of patients had 6-10 outpatient visits per year. One-fifth of patients had at least 1 emergency visit, and one-sixth of patients had at least 1 inpatient hospitalization each year from 2008 to 2011.

Except diabetic, hypertension and hyperlipidemia are the two most assign chronic conditions. Table 4.1 shows that the percentage of diabetic patients with co-morbidities such as hypertention, hyperlipidemia, chronic heart failure, chronic renal failure, and ischemic heart disease was increased consistently from 2008 to 2011.

Comparing 2011 to that in 2008, %maximum change was in chronic renal failure, which increased nearly 4-fold, follow by chronic heart failure, hypertention, hyperlipidemia, and ischemic heart disease.

Table 4.1 Characteristics of 5,535 diabetic patients at Buddhachinaraj Hospital

Characteristics	2008		2009		2010		2011	
	n	%	n	%	n	%	n	%
Age band								
0-17	19	0.34	18	0.33	17	0.31	15	0.27
18-44	417	7.53	350	6.32	292	5.28	257	4.64
45-64	3,052	55.14	2,947	53.24	2,845	51.40	2,707	48.91
≥ 65	2,047	36.98	2,220	40.11	2,381	43.02	2,556	46.18
Mean age (S. D.)	60.34(11.57)		61.34(11.56)		62.34(11.56)		63.32(11.54)	
Health insurance scheme								
Self-pay	7	0.13	4	0.07	4	0.07	8	0.14
CSMBS	2,458	44.41	2,456	44.37	2,450	44.26	2,445	44.17
SSS	272	4.91	265	4.79	247	4.46	243	4.39
UC	2,798	50.55	2,810	50.77	2,833	51.18	2,839	51.29
Outpatient visit								
1_5	1,448	26.16	1,580	28.55	1,880	33.97	2,054	37.11
6_10	2,859	51.65	2,746	49.61	2,536	45.82	2,508	45.31
11_15	818	14.78	795	14.36	697	12.59	585	10.57
≥16	410	7.41	414	7.48	422	7.62	388	7.01
Emergency visit								
0	4,277	77.27	4,371	78.97	4,332	78.27	4,356	78.70
1	784	14.16	723	13.06	701	12.66	697	12.59
2	257	4.64	230	4.16	246	4.44	240	4.34
3	92	1.66	96	1.73	98	1.77	104	1.88
4	54	0.98	43	0.78	53	0.96	49	0.89
≥5	71	1.28	72	1.30	105	1.90	89	1.61
Hospitalization								
0	4,668	84.34	4,770	86.18	4,739	85.62	4,546	82.13
1	605	10.93	519	9.38	531	9.59	641	11.58
2	159	2.87	160	2.89	143	2.58	180	3.25
3	68	1.23	47	0.85	51	0.92	72	1.30
4	18	0.33	15	0.27	29	0.52	36	0.65
≥5	17	0.31	24	0.43	42	0.76	60	1.08
Co-morbidities								
Hypertention	4,659	84.17	4,894	88.42	4,962	89.65	5,088	91.92
Hyperlipidemia	4,342	78.45	4,516	81.59	4,647	83.96	4,741	85.65
Chronic heart failure	626	11.31	722	13.04	746	13.48	779	14.07
Chronic renal failure	125	2.26	243	4.39	325	5.87	489	8.83
Ischemic heart disease	369	6.67	369	6.67	344	6.21	377	6.81

Part II Morbidity patterns of diabetic patients by ACG® software

2.1 ADG assignment

ACG® software used the patients' data from health insurance database each year, and assigned all ICD-10 codes to one of 32 Adjusted Diagnosis Groups, or ADGs. The distribution of each of the 32 ADGs in the study population is described in Table 4.2.

The occurrences of the diabetic patients' ADGs ranged from a low of 0.07% (ADG 17: Chronic Specialty: Unstable-Ear, Nose, Throat) to a high of 98.50% (ADG 10: Chronic Medical: Stable) in 2008, and from a low of 0.04% (ADG17: Chronic Specialty: Unstable-Ear, Nose, Throat) to a high of 98.74% (ADG 10: Chronic Medical: Stable) in 2011.

The study population had parallel ADG distributions from 2008 to 2011as shown in Figure 4.1. The most frequently assigned ADG was ADG 10: Chronic Medical: Stable (98.14-98.74%), followed by ADG 11: Chronic Medical: Unstable (31.58-36.17%), ADG 31: Prevention/Administrative (21.63-26.12%), ADG 7: Likely to Recur: Discrete (14.91-16.04%), and ADG 2: Time Limited: Minor-Primary Infections (14.51-15.14%).

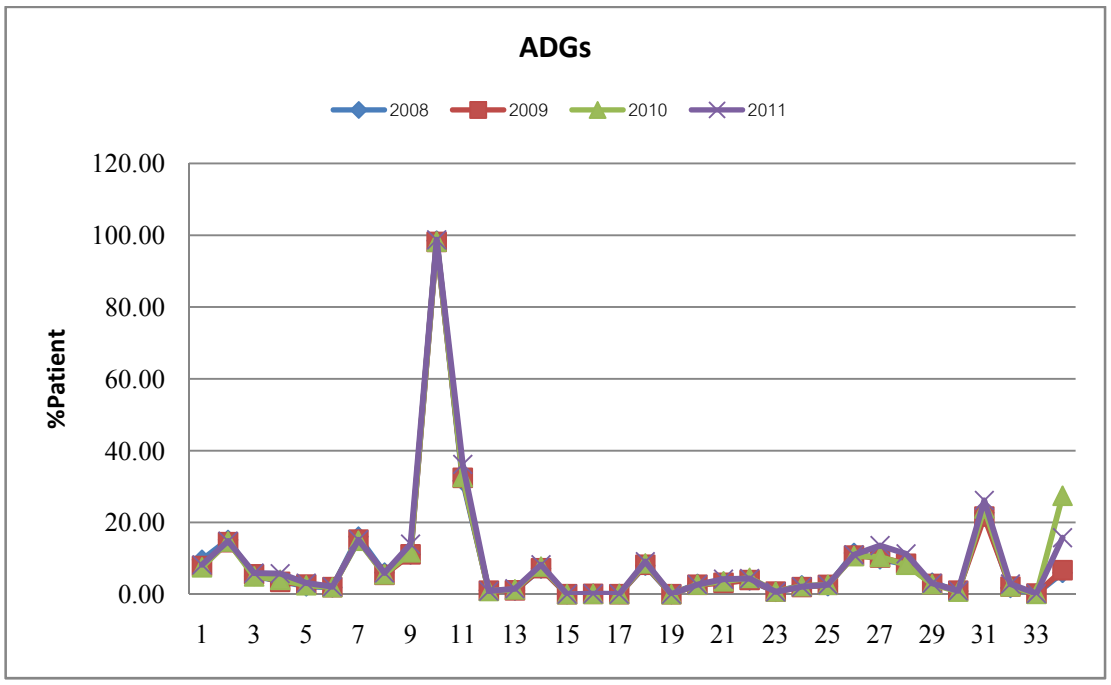


Figure 4.1 The Adjusted Diagnosis Groups (ADGs) distribution across 4 years.

Table 4.2 Morbidity patterns by ADG of diabetic patients at Buddhachinaraj Hospital

ADG & Description (Total N=5,535)	**Year 2008**		**Year 2009**		**Year 2010**		**Year 2011**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
1 Time Limited: Minor	531	9.59	435	7.86	415	7.50	453	8.18
2 Time Limited: Minor-Primary Infections	838	15.14	803	14.51	813	14.69	819	14.80
3 Time Limited: Major	281	5.08	308	5.56	275	4.97	326	5.89
4 Time Limited: Major-Primary Infections	202	3.65	190	3.43	222	4.01	318	5.75
5 Allergies	122	2.20	150	2.71	137	2.48	172	3.11
6 Asthma	104	1.88	109	1.97	108	1.95	115	2.08
7 Likely to Recur: Discrete	888	16.04	842	15.21	825	14.91	839	15.16
8 Likely to Recur: Discrete-Infections	334	6.03	298	5.38	307	5.55	328	5.93
9 Likely to Recur: Progressive	613	11.07	615	11.11	646	11.67	773	13.97
10 Chronic Medical: Stable	5,452	98.50	5,432	98.14	5,437	98.23	5,465	98.74
11 Chronic Medical: Unstable	1,748	31.58	1,795	32.43	1,806	32.63	2,002	36.17
12 Chronic Specialty: Stable-Orthopedic	60	1.08	55	0.99	49	0.89	49	0.89
13 Chronic Specialty: Stable-Ear, Nose, Throat	57	1.03	59	1.07	75	1.36	84	1.52
14 Chronic Specialty: Stable-Eye	396	7.15	401	7.24	426	7.70	454	8.20
16 Chronic Specialty: Unstable-Orthopedic	8	0.14	6	0.11	4	0.07	7	0.13
17 Chronic Specialty: Unstable-Ear, Nose, Throat	4	0.07	1	0.02	3	0.05	2	0.04
18 Chronic Specialty: Unstable-Eye	441	7.97	455	8.22	475	8.58	503	9.09
20 Dermatologic	160	2.89	146	2.64	149	2.69	149	2.69

Table 4.2 Morbidity patterns by ADG of diabetic patients at Buddhachinaraj Hospital (cont.)

ADG & Description (Total N=5,535)	**Year 2008**		**Year 2009**		**Year 2010**		**Year 2011**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
21 Injuries/Adverse Effects: Minor	191	3.45	176	3.18	199	3.60	232	4.19
22 Injuries/Adverse Effects: Major	212	3.83	219	3.96	252	4.55	243	4.39
23 Psychosocial: Time Limited, Minor	38	0.69	41	0.74	41	0.74	36	0.65
24 Psychosocial: Recurrent or Persistent, Stable	137	2.48	110	1.99	123	2.22	115	2.08
25 Psychosocial: Recurrent or Persistent, Unstable	125	2.26	145	2.62	145	2.62	145	2.62
26 Signs/Symptoms: Minor	636	11.49	595	10.75	588	10.62	607	10.97
27 Signs/Symptoms: Uncertain	539	9.74	565	10.21	575	10.39	751	13.57
28 Signs/Symptoms: Major	461	8.33	470	8.49	453	8.18	622	11.24
29 Discretionary	178	3.22	159	2.87	155	2.80	168	3.04
30 See and Reassure	49	0.89	54	0.98	39	0.70	52	0.94
31 Prevention/Administrative	1,257	22.71	1,197	21.63	1,322	23.88	1,446	26.12
32 Malignancy	97	1.75	118	2.13	120	2.17	158	2.85
33 Pregnancy	11	0.20	10	0.18	5	0.09	10	0.18
34 Dental	330	5.96	370	6.68	1,518	27.43	871	15.74

Noting that, as the ADGs are not mutually exclusive, subjects with a diagnosis in a given ADG can also have diagnoses within other ADGs. The number of distinct ADGs in which subjects had diagnoses ranged from 0 to 17 each year.

Table 4.3 shows the number of unique ADGs per person per year, 66% of this population had one to three unique ADGs, 27% had four to six ADGs, and 7% had seven or more ADGs. These diabetic patients were assigned to an average of 2.98 unique ADGs per person in 2008 and increased slightly to 3.31 in 2011.

Table 4.3 Number of ADGs per patient per year (N=5,535)

Number of ADGs	**Year 2008**		**Year 2009**		**Year 2010**		**Year 2011**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
0	17	0.31	28	0.51	24	0.43	2	0.04
1	1,312	23.70	1,437	25.96	1,268	22.91	1,254	22.66
2	1,383	24.99	1,371	24.77	1,206	21.79	1,237	22.35
3	1,089	19.67	999	18.05	1,052	19.01	968	17.49
4	708	12.79	688	12.43	753	13.60	678	12.25
5	474	8.56	441	7.97	483	8.73	526	9.50
6	244	4.41	224	4.05	323	5.84	343	6.20
7	140	2.53	140	2.53	183	3.31	231	4.17
8+	168	3.04	207	3.74	243	4.39	296	5.35
Mean (SD)	2.98(1.91)		2.95(1.99)		3.20(2.11)		3.31(2.19)	

Major ADGs are the ADG with very high-expected resource consumption. An example of a major ADG is the uncontrolled type 1 DM, which falls into ADG 11 (Chronic Medical: Unstable). On the other hand, stable, controlled DM falls into ADG 10 (Chronic Medical: Stable), which is not a major ADG. The occurrence of major ADGs in this population is described in table 4.4. Approximately 40% of patients had at least 1 major ADG count.

Table 4.4 Number of major ADGs per patient per year

Number of major ADGs	Year 2008		Year 2009		Year 2010		Year 2011	
	N	%	N	%	N	%	N	%
0	3,204	57.89	3,195	57.72	3,162	57.13	2,938	53.08
1	1,553	28.06	1,522	27.50	1,523	27.52	1,560	28.18
2	625	11.29	622	11.24	651	11.76	765	13.82
3+	153	2.76	196	3.54	199	3.59	272	4.91

2.2 ACG assignment

The diabetic patient's total number of unique ADGs, major ADGs, together with his/her age and gender, were used to group each case into mutually exclusive morbidity clusters, namely Adjusted Clinical Groups or ACGs. Each individual was assigned 1 or more ADGs but only 1 of the total 93 ACGs in a given year. The ACG distributions of study population are shown in table 4.5. For ACG assignment, the distribution patterns among ACGs were substantially consistent but unequally distributed across the 4 years (figure 4.2). No statistical significant difference ($p<0.05$) in distribution of the ACGs between the four years was found. Most of diabetic patients could be classified into 40, 45, 37, and 35 ACGs in fiscal year 2008, 2009, 2010, and 2011, respectively. Approximately 80% of patients were assigned to only 5 ACGs, included ACG 4100 (2-3 Other ADG Combinations, Age 35+), ACG 0900 (Chronic medical, stable), ACG 4430 (4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs), ACG 4420 (4-5 Other ADG Combinations, Age 45+, 1 Major ADGs) and ACG 2300 (Chronic medical: stable and acute minor). In order to better understand the ACGs, the variation among top ten ACGs category was presented in figure 4.3.

The overview gave the distributions for the four years, of the most common ACGs found among 5,535 cases of diabetes in this study. More than a third of cases were ACG 4410 2-3 Other ADG Combinations, Age 35+, which changed a little each year (2.31%). The maximum shifts of assigned ACGs in each year was 4.79%, and this was in ACG 0900 Chronic medical, stable, which was the second frequently assigned ACGs. The ten most frequent ACGs comprised about 96% of all diabetic patients. The most severe cases in figure 4.3 were ACG4930 6-9 Other ADG Combinations, Age 35+, 3 Major ADGs, which had slightly increased from 1.32% in

2008 to 2.31% in 2011. To understand discrimination effects of the ACG casemix, the average number of outpatient visit and average outpatient expenditure were shown in table 4.6. Cases in the more severe ACGs had higher outpatient expenditures and more frequent outpatient visits than the less severe cases. In addition, Table 4.7 show the average number of hospitalization and inpatient expenditure of top ten ACGs**.**

Table 4.5 Morbidity patterns by ACG among diabetic patients at Buddhachinaraj Hospital

ACG	Description	2008		2009		2010		2011	
		N	%	N	%	N	%	N	%
0300	Acute minor, age 6+	2	0.04	3	0.05	0	0.00	0	0.00
0400	Acute major	4	0.07	2	0.04	2	0.04	5	0.09
0500	Likely to recur, without allergy	1	0.02	2	0.04	1	0.02	0	0.00
0800	Chronic medical, unstable	15	0.27	18	0.33	21	0.38	19	0.34
0900	Chronic medical, stable	1,527	27.59	1,639	29.61	1,374	24.82	1,380	24.93
1100	Eye/Dental	2	0.04	3	0.05	2	0.04	0	0.00
1600	Preventive/Administrative	4	0.07	3	0.05	3	0.05	0	0.00
1722	Pregnancy: 2-3 ADGs, no major ADGs, not delivered	3	0.05	1	0.02	0	0.00	1	0.02
1731	Pregnancy: 2-3 ADGs, 1+ major ADGs, delivered	0	0.00	1	0.02	0	0.00	0	0.00
1732	Pregnancy: 2-3 ADGs, 1+ major ADGs, not delivered	1	0.02	2	0.04	0	0.00	0	0.00
1751	Pregnancy: 4-5 ADGs, 1+ major ADGs, delivered	1	0.02	2	0.04	1	0.02	0	0.00
1752	Pregnancy: 4-5 ADGs, 1+ major ADGs, not delivered	4	0.07	2	0.04	2	0.04	0	0.00
1771	Pregnancy: 6+ ADGs, 1+ major ADGs, delivered	4	0.07	0	0.00	0	0.00	1	0.02
1772	Pregnancy: 6+ ADGs, 1+ major ADGs, not delivered	0	0.00	2	0.04	1	0.02	4	0.07
1800	Acute major and Acute minor	1	0.02	1	0.02	0	0.00	0	0.00
2300	Chronic medical: stable and Acute minor	402	7.26	367	6.63	272	4.91	283	5.11

Table 4.5 Morbidity patterns by ACG among diabetic patients at Buddhachinaraj Hospital (cont.)

ACG	Description	2008		2009		2010		2011	
		N	%	N	%	N	%	N	%
2400	Eye/Dental and Acute minor	0	0.00	1	0.02	1	0.02	1	0.02
2500	Psychosocial w/o Psychosocial: unstable and Acute minor	0	0.00	1	0.02	0	0.00	0	0.00
2800	Acute major and Likely to recur	1	0.02	1	0.02	1	0.02	1	0.02
3400	Acute Minor/Likely to Recur/Eye & Dental	0	0.00	1	0.02	0	0.00	0	0.00
3600	Acute Minor/Acute Major/Likely to Recur/Chronic Medical: Stable	83	1.50	63	1.14	59	1.07	64	1.16
3800	2-3 Other ADG Combinations, Age 1 to 17	7	0.13	4	0.07	8	0.14	7	0.13
3900	2-3 Other ADG Combinations, Males Age 18 to 34	13	0.23	10	0.18	13	0.23	8	0.14
4000	2-3 Other ADG Combinations, Females Age 18 to 34	11	0.20	12	0.22	11	0.20	9	0.16
4100	2-3 Other ADG Combinations, Age 35+	2,041	36.87	1,962	35.45	2,090	37.76	2,016	36.42
4210	4-5 Other ADG Combinations, Age 1 to 17, no Major ADGs	0	0.00	1	0.02	0	0.00	1	0.02
4220	4-5 Other ADG Combinations, Age 1 to 17, 1+ Major ADGs	4	0.07	3	0.05	2	0.04	1	0.02
4310	4-5 Other ADG Combinations, Age 18 to 44, no Major ADGs	19	0.34	12	0.22	19	0.34	9	0.16
4320	4-5 Other ADG Combinations, Age 18 to 44, 1 Major ADGs	24	0.43	24	0.43	14	0.25	14	0.25
4330	4-5 Other ADG Combinations, Age 18 to 44, 2+ Major ADGs	17	0.31	11	0.20	20	0.36	9	0.16
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	236	4.26	196	3.54	257	4.64	208	3.76
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	370	6.68	392	7.08	454	8.20	424	7.66

Table 4.5 Morbidity patterns by ACG among diabetic patients at Buddhachinaraj Hospital(cont.)

ACG	Description	2008		2009		2010		2011	
		N	%	N	%	N	%	N	%
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	309	5.58	324	5.85	322	5.82	411	7.43
4620	6-9 Other ADG Combinations, Age 6 to 17, 1+ Major ADGs	2	0.04	1	0.02	0	0.00	0	0.00
4720	6-9 Other ADG Combinations, Males, Age 18 to 34, 1 Major ADGs	2	0.04	0	0.00	0	0.00	1	0.02
4730	6-9 Other ADG Combinations, Males, Age 18 to 34, 2+ Major ADGs	2	0.04	2	0.04	1	0.02	1	0.02
4810	6-9 Other ADG Combinations, Females, Age 18 to 34, no Major ADGs	0	0.00	0	0.00	1	0.02	0	0.00
4820	6-9 Other ADG Combinations, Females, Age 18 to 34, 1 Major ADGs	0	0.00	2	0.04	2	0.04	1	0.02
4830	6-9 Other ADG Combinations, Females, Age 18 to 34, 2+ Major ADGs	1	0.02	1	0.02	2	0.04	2	0.04
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	159	2.87	133	2.40	177	3.20	210	3.79
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	140	2.53	155	2.80	204	3.69	231	4.17
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	73	1.32	88	1.59	109	1.97	128	2.31
4940	6-9 Other ADG Combinations, Age 35+, 4+ Major ADGs	10	0.18	20	0.36	24	0.43	39	0.70
5040	10+ Other ADG Combinations, Age 18+, 0-1 Major ADGs	4	0.07	5	0.09	2	0.04	3	0.05
5050	10+ Other ADG Combinations, Age 18+, 2 Major ADGs	5	0.09	15	0.27	15	0.27	4	0.07
5060	10+ Other ADG Combinations, Age 18+, 3 Major ADGs	6	0.11	5	0.09	11	0.20	19	0.34
5070	10+ Other ADG Combinations, Age 18+, 4+ Major ADGs	8	0.14	14	0.25	13	0.23	18	0.33
5110	No Diagnosis or Only Unclassified Diagnosis (2 input files)	17	0.31	28	0.51	24	0.43	2	0.04

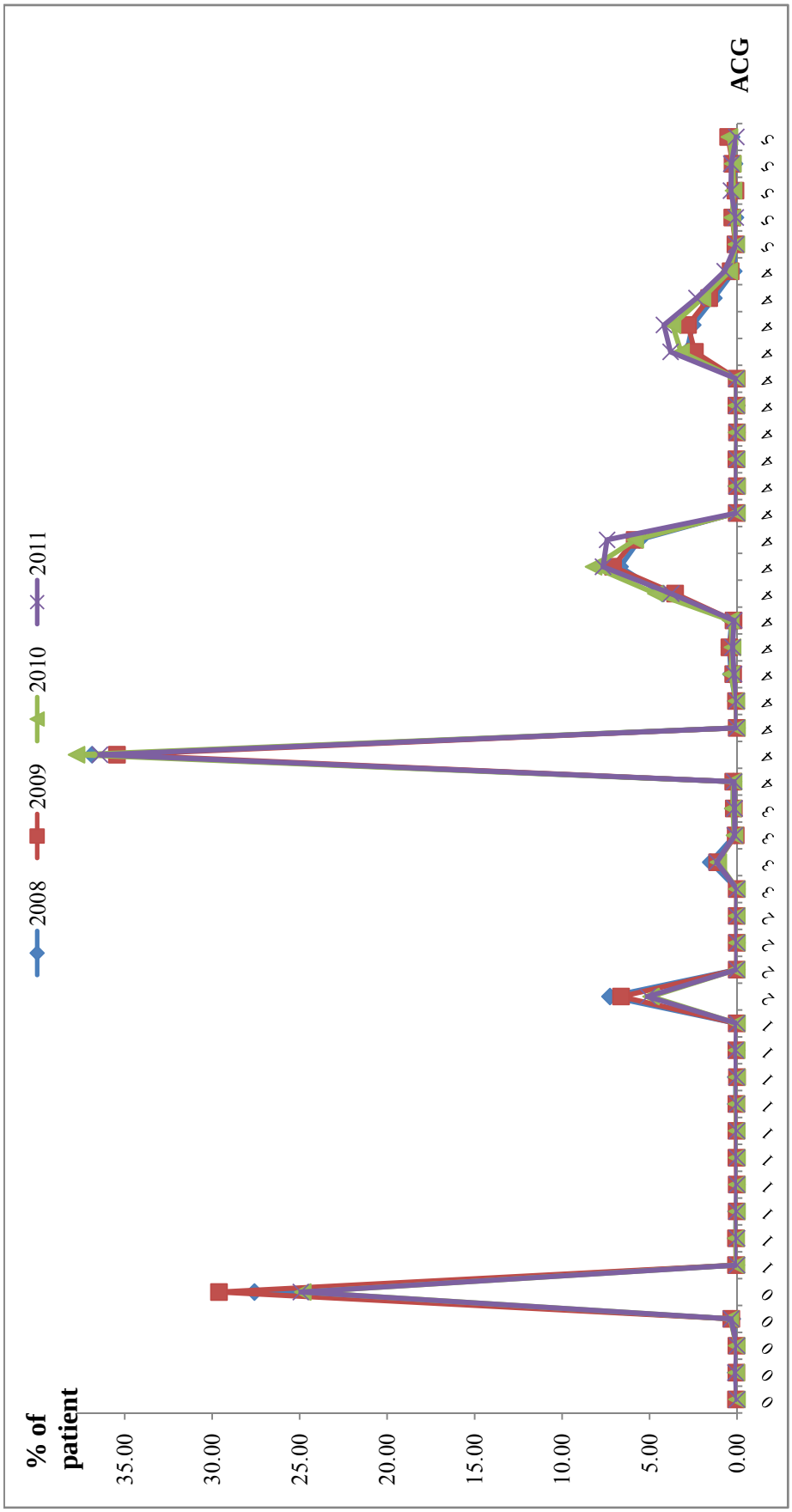
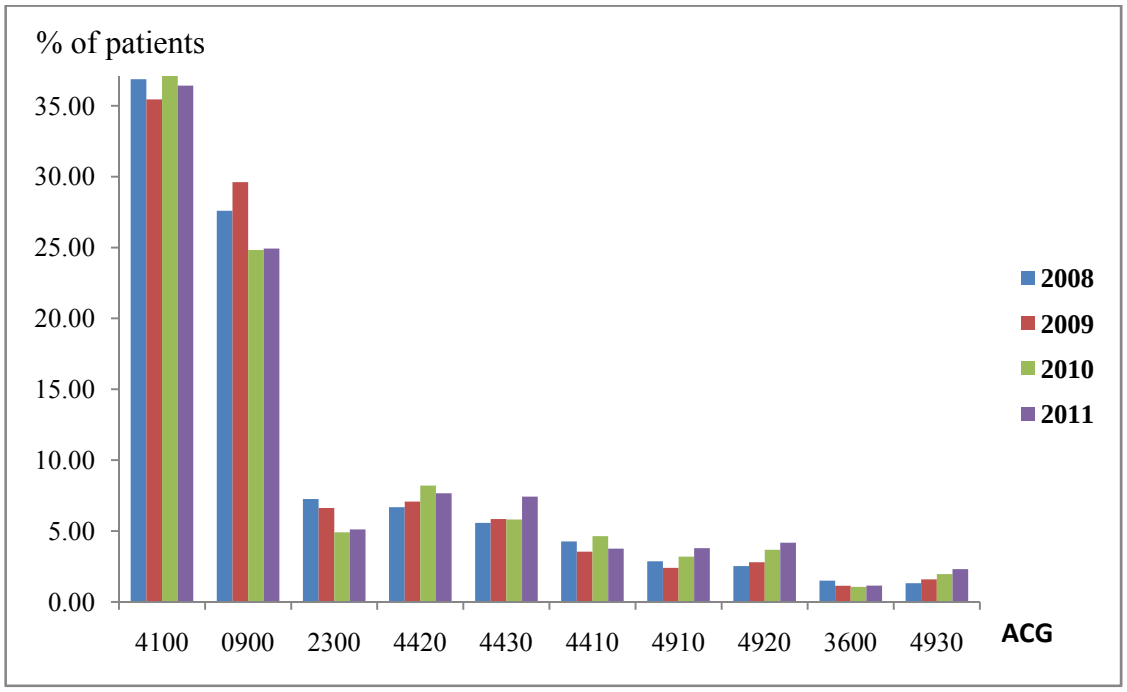


Figure 4.2 ACGs distribution from 2008 to 2011



Range (%)	ACG code	Description
2.31	4100	2-3 Other ADG Combinations, Age 35+
4.79	0900	Chronic medical, stable
2.35	2300	Chronic medical: stable and Acute minor
1.52	4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs
1.84	4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs
1.10	4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs
1.39	4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs
1.64	4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs
0.43	3600	Acute Minor/Acute Major/Likely to Recur/Chronic Medical: Stable
0.99	4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs

Figure 4.3 The distributions of ACGs in diabetic patients during the period 2008-2011, excluding ACGs comprising < 1% of the total patients

Table 4.6 Most frequent ACGs with outpatient visit and expenditure from 2008 to 2011

ACG	**2008**			**2009**			**2010**			**2011**		
	%N	Outpatient visit (MEAN±SD)	Outpatient expenditure (MEAN±SD)	% N	Outpatient visit (MEAN±SD)	Outpatient expenditure* (MEAN±SD)	% N	Outpatient visit (MEAN±SD)	Outpatient expenditure* (MEAN±SD)	%N	Outpatient visit (MEAN±SD)	Outpatient expenditure* (MEAN±SD)
0900	27.59	6.17±2.73	14,256±20,895	29.61	6.05±2.97	11,679±15,323	24.82	5.48±3.28	9,370±11,430	24.93	5.35±5.01	9,406±10,445
2300	7.26	8.16±3.59	12,554±18,257	6.63	7.94±3.50	11,471±16,400	4.91	7.09±5.03	10,321±18,687	5.11	6.88±8.50	8,166±8,241
3600	1.50	13.13±6.27	22,092±31,943	1.14	11.60±5.27	16,177±16,250	1.07	11.78±6.73	14,593±16,610	1.16	10.84±8.93	13,883±13,989
4100	36.87	7.71±3.75	22,168±32,995	35.46	7.54±3.89	22,465±32,880	37.76	7.41±5.46	19,544±28,400	36.42	7.12±6.03	16,734±24,613
4410	4.26	11.44±4.92	17,167±21,457	3.54	11.64±6.10	18,489±22,499	4.64	11.75±10.28	20,093±28,726	3.76	12.11±11.75	16,288±15,081
4420	6.68	10.46±5.10	24,809±30,929	7.08	10.68±6.45	23,909±23,916	8.20	10.52±7.40	26,344±71,449	7.66	10.45±11.15	25,848±75,746
4430	5.58	9.49±4.58	34,592±40,869	5.85	9.87±4.37	34,858±45,742	5.82	9.49±5.19	35,109±49,190	7.43	9.77±13.53	25,958±35,815
4910	2.87	15.08±6.18	24,560±23,934	2.40	17.77±9.03	27,665±29,839	3.20	15.14±11.20	27,823±22,298	3.79	18.18±20.73	21,430±16,252
4920	2.53	15.75±8.10	33,378±34,858	2.80	13.75±5.47	34,025±45,015	3.69	13.99±8.56	32,283±37,967	4.17	13.93±11.42	28,621±35,497
4930	1.32	14.64±8.73	39,057±57,494	1.59	15.44±6.74	34,054±30,690	1.97	14.10±9.56	31,368±29,706	2.31	13.09±6.47	29,589±32,802

*Adjusted at 2008 price

ACG 0900= Chronic medical, stable, ACG 2300= Chronic medical: stable and Acute minor, ACG 3600= Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable, ACG 4100=2-3 Other ADG Combinations, Age 35+, ACG 4410=4-5 Other ADG Combinations, Age 45+, no Major ADGs, ACG 4420=4-5 Other ADG Combinations, Age 45+, 1 Major ADGs, ACG 4430=4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs, ACG 4910=6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs, ACG 4920=6-9 Other ADG Combinations, Age 35+, 2 Major ADGs, ACG4930=6-9 Other ADG Combinations, Age 35+, 3 Major ADGs

Table 4.7 Most frequent ACGs with hospitalization and hospitalization expenditure from 2008 to 2011.

ACG	**2008**			**2009**			**2010**			**2011**		
	%N	Hospitaliza-tion (MEAN±SD)	Hospitalization expenditure (MEAN±SD)	% N	Hospitaliza-tion (MEAN±SD)	Hospitalization expenditure* (MEAN±SD)	% N	Hospitaliza-tion (MEAN±SD)	Hospitalization expenditure* (MEAN±SD)	%N	Hospitaliza-tion (MEAN±SD)	Hospitalization expenditure* (MEAN±SD)
0900	27.5	0.01±0.10	189±3,396	29.6	0.01±0.08	204±6,022	24.8	0.01±0.13	179±3,612	24.9	0.01±0.09	19±306
2300	7.3	0.03±0.20	979±11,586	6.6	0.02±0.15	169±1,736	4.9	0.01±0.12	537±7,252	5.1	0.03±0.17	372±4,538
3600	1.5	0.52±0.75	5,058±9,505	1.1	0.35±0.57	3,837±9,657	1.1	0.63±1.16	14,748±56,869	1.2	0.56±0.66	16,963±86,721
4100	36.8	0.14±0.42	2,790±18,545	35.4	0.11±0.39	2,855±17,395	37.8	0.09±0.35	1,774±15,845	36.4	0.10±0.32	1,866±14,434
4410	4.3	0.22±0.57	2,617±10,503	3.5	0.17±0.45	1,950±5,678	4.6	0.11±0.35	1,256±4,711	3.8	0.19±0.45	1,808±5,869
4420	6.7	0.45±0.75	7,882±21,695	7.1	0.37±0.80	5,939±29,213	8.2	0.36±0.66	5,818±18,247	7.7	0.43±0.83	7,246±28,047
4430	5.6	0.63±1.00	14,649±40,804	5.85	0.55±0.85	13,374±41,028	5.8	0.46±0.89	8,405±29,276	7.4	0.55±0.94	13,417±37,767
4910	2.9	0.58±0.89	6,769±15,301	2.4	0.62±0.92	10,427±32,257	3.2	0.50±0.78	6,348±15,043	3.8	0.63±1.01	9,437±29,660
4920	2.5	1.27±1.48	20,825±40,789	2.8	1.07±1.16	15,028±27,304	3.7	1.15±1.56	18,420±43,504	4.2	1.35±1.54	26,994±54,197
4930	1.3	1.70±1.47	32,674±48,634	1.6	1.73±1.71	38,082±59,135	2.0	1.73±1.78	30,548±39,898	2.3	2.61±2.70	45,507±73,225

*Adjusted at 2008 price

ACG 0900= Chronic medical, stable, ACG 2300= Chronic medical: stable and Acute minor, ACG 3600= Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable, ACG 4100=2-3 Other ADG Combinations, Age 35+, ACG 4410=4-5 Other ADG Combinations, Age 45+, no Major ADGs, ACG 4420=4-5 Other ADG Combinations, Age 45+, 1 Major ADGs, ACG 4430=4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs, ACG 4910=6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs, ACG 4920=6-9 Other ADG Combinations, Age 35+, 2 Major ADGs, ACG4930=6-9 Other ADG Combinations, Age 35+, 3 Major ADGs

When comparing an outpatient visit per patient each year in top ten ACGs which approximately composed of 96% of these diabetic patients, the highest was 18.18 (SD=20.73), and this was in ACG4910 in 2011, followed by ACG4920 and ACG4930. While, the lowest was 5.35 (SD=5.01), and this was in ACG0900 in 2011, followed by ACG2300 and ACG4100 (tables 4.6).

To consider an average of outpatient expenditure per patient, the highest was 39,057 Baht (SD=57,494), and this was in ACG4930 (RUB 5 very high morbidity) in 2008, followed by ACG4430 and ACG 4920. While, the lowest was 8,166 Baht (SD=8,241), and this was in ACG2300 in 2011, followed by ACG0900 and ACG4100.

Furthermore, from tables 4.7, the maximum average number of hospitalization was 2.61 (SD=2.70), and was in ACG4930 in 2011, followed by ACG4920 and ACG4930. While, the minimum was in the low morbidity groups, ACG0900 and ACG2300. When considering an hospitalization expenditure, the highest also was in ACG 4930 in 2011, which represents adults with 6-9 ADG combinations, age 35+, 0-1 major ADGs, had mean hospitalization expenditure of 45,507 Baht (SD=73,225), and the lowest was in ACG0900, which represents chronic medical, stable conditions, with mean hospitalization expenditure of 19 Baht (SD=306) in 2011.

The details of outpatient and hospitalization expenditures in most frequent ACGs are also shown in appendix D and E.

2.3 Resource Utilization Bands (RUBs) assignment

The ACG system automatically collapses the full set of ACG categories to five simplified morbidity categories termed resource utilization bands (RUBs), including healthy users (RUB 1), low (RUB 2), moderate (RUB 3), high (RUB 4), and very high (RUB 5) morbidity groups.

Table 4.8 illustrates the distributions in resource utilization bands (RUBs) of diabetic patients across 4 years. More than 80% of these patients were classified as low to moderate users. The proportion of RUBs 4 and 5 or high and very high users was increased quite rapidly across 4 years.

Table 4.8 The distributions in RUBs of diabetic patients across 4 years

	2008		**2009**		**2010**		**2011**	
RUB	N	%	N	%	N	%	N	%
1 healthy users	25	0.45	37	0.67	29	0.52	2	0.04
2 low	1942	35.09	2018	36.46	1658	29.95	1676	30.28
3 moderate	2982	53.88	2832	51.17	3121	56.39	2987	53.97
4 high	489	8.83	521	9.41	570	10.30	666	12.03
5 very high	97	1.75	127	2.29	157	2.84	204	3.69

In this study, 10 most assigned ACGs were collapsed to four morbidity categories, such as, ACG0900 and ACG2300 were in RUB 2 low morbidity; ACG3600, ACG4100, ACG4410, ACG4420 and ACG4910 were in RUB 3 moderate morbidity; ACG4430 and ACG4920 were in RUB 4 high morbidity; and ACG4930 was in RUB 5 very high morbidity.

2.4 Rx-MGs assignment

Pharmacy-based morbidity groups or Rx-MGs are created to account for the anatomical and physiological systems that drugs act on, as well as the morbidity differentiation, the expected duration and the severity of the diseases to be treated using the medication. The Rx-MGs used pharmacy data as a means of assessing the validity of diagnoses recorded in physicians' medical records. Comparisons were made between patients identified as having specific chronic conditions using diagnosis

codes (ICD-10 through ADG), pharmacy code (ATC Classification System through Rx-MG), and both diagnoses and pharmacy code.

As shown in table 4.9 the distribution of each Rx-MG was similar across four years. The most frequently assigned Rx-MG was ENDx040 (Endocrine: Diabetes without insulin 85.49-88.53%) followed by CARx040 (Cardiovascular: Hyperlipidemia 80.96-86.43%), CARx030 (Cardiovascular: High blood pressure 75.27-83.83%), and CARx050 (**Cardiovascular**: Vascular disorders 69.29-73.17%), which were correlated with patient's medical conditions from diagnostic data. Top ten assigned Rx-MGs are shown in figure 4.4.

Figure 4.4 demonstrates that the use of medication leading to major Rx-MG Cardiovascular (CARx040, CARx030, and CARx050) was increased, while the use of medication in other Rx-MGs was decreased slightly across 4 years. In addition 17% of diabetic patients took insulin, which were assigned to ENDx030 (Endocrine: Diabetes with insulin) in 2008, and this number increased to 20.72% in 2011. Approximately one third of diabetic patients took medication in 2 major Rx-MGs: 1) General signs and symptoms, including GSIx020 Pain (e.g. narcotic analgesics) and GSIx030 Pain and inflammation (e.g. NSAIDs), and 2) Gastrointestinal/hepatic GASx060 Peptic disease (e.g. ranitidine, omeprazole).

Table 4.9 Frequency of Rx-MGs by study sample

Rx-MG label	**Description**	**2008**		**2009**		**2010**		**2011**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
	Allergy/immunology								
ALLx010	Acute minor	844	15.25	815	14.72	819	14.80	871	15.74
ALLx030	Chronic inflammatory	31	0.56	23	0.42	30	0.54	33	0.60
ALLx040	Immune disorders	0	0.00	0	0.00	0	0.00	0	0.00
ALLx050	Transplant	9	0.16	21	0.38	9	0.16	7	0.13
	Cardiovascular								
CARx010	Chronic medical	429	7.75	419	7.57	423	7.64	417	7.53
CARx020	Congestive heart failure	597	10.79	684	12.36	718	12.97	737	13.32
CARx030	High blood pressure	4166	75.27	4510	81.48	4588	82.89	4640	83.83
CARx040	Hyperlipidemia	4481	80.96	4735	85.55	4789	86.52	4784	86.43
CARx050	Vascular disorders	3835	69.29	3991	72.10	4050	73.17	4025	72.72
	Ear-nose-throat								

Table 4.9 Frequency of Rx-MGs by study sample (cont.)

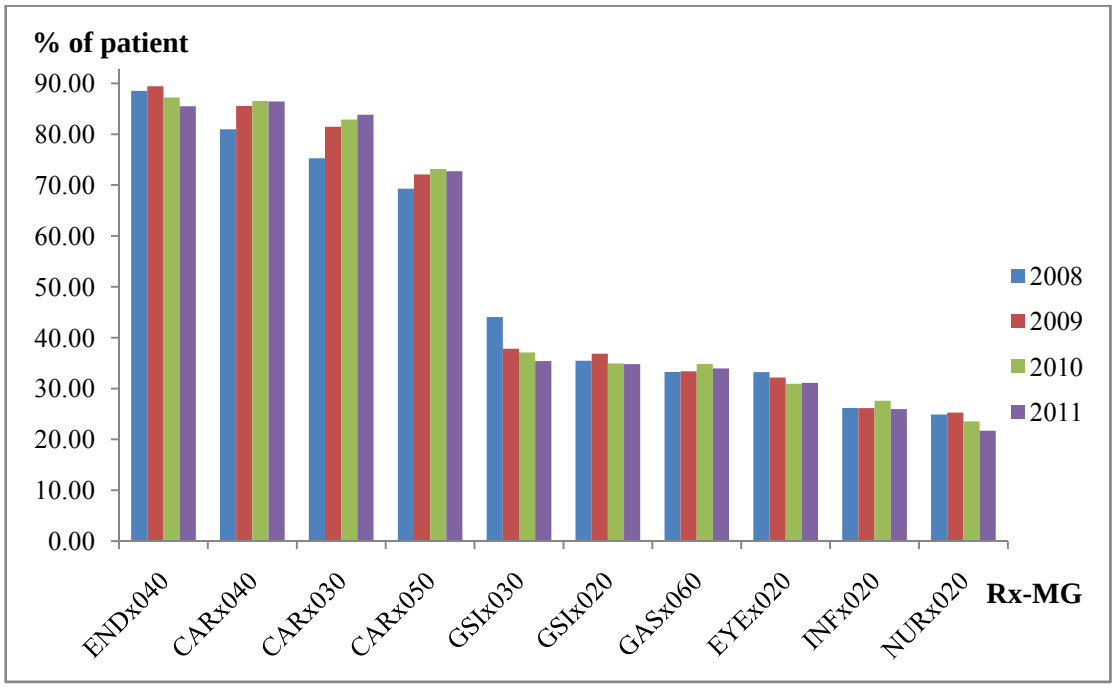
Rx-MG label	Description	2008		2009		2010		2011	
		n	%	n	%	n	%	n	%
EARx010	Acute minor	2	0.04	1	0.02	3	0.05	3	0.05
	Endocrine								
ENDx010	Bone disorders	53	0.96	80	1.45	97	1.75	83	1.50
ENDx020	Chronic medical	32	0.58	29	0.52	25	0.45	20	0.36
ENDx030	Diabetes with insulin	941	17.00	1080	19.51	1113	20.11	1147	20.72
ENDx040	Diabetes without insulin	4900	88.53	4950	89.43	4828	87.23	4732	85.49
ENDx050	Thyroid disorders	127	2.29	67	1.21	67	1.21	68	1.23
	Eye								
EYEx010	Acute minor: curative	101	1.82	73	1.32	91	1.64	82	1.48
EYEx020	Acute minor: palliative	1840	33.24	1780	32.16	1712	30.93	1723	31.13
EYEx030	Glaucoma	97	1.75	117	2.11	131	2.37	142	2.57
	Female reproductive								
FREx010	Hormone regulation	9	0.16	7	0.13	8	0.14	3	0.05
FREx020	Infertility	0	0.00	0	0.00	0	0.00	0	0.00
FREx030	Pregnancy and delivery	0	0.00	0	0.00	0	0.00	0	0.00
	Gastrointestinal/hepatic								
GASx010	Acute minor	349	6.31	504	9.11	520	9.39	493	8.91
GASx020	Chronic liver disease	7	0.13	10	0.18	9	0.16	6	0.11
GASx030	Chronic stable	462	8.35	482	8.71	532	9.61	488	8.82
GASx040	Inflammatory bowel disease	10	0.18	9	0.16	8	0.14	9	0.16
GASx050	Pancreatic disorder	0	0.00	0	0.00	0	0.00	0	0.00
GASx060	Peptic disease	1841	33.26	1848	33.39	1928	34.83	1960	35.41
	General signs and symptoms								
GSIx010	Nausea and vomiting	7	0.13	7	0.13	6	0.11	8	0.14
GSIx020	Pain	1962	35.45	2039	36.84	1934	34.94	1879	33.95
GSIx030	Pain and inflammation	2438	44.05	2094	37.83	2054	37.11	1927	34.81

Table 4.9 Frequency of Rx-MGs by study sample (cont.)

Rx-MG label	Description	2008		2009		2010		2011	
		n	%	n	%	n	%	n	%
GSIx040	Severe Pain	11	0.20	21	0.38	16	0.29	26	0.47
	Genitourinary								
GURx010	Acute minor	52	0.94	65	1.17	53	0.96	65	1.17
GURx020	Chronic renal failure	13	0.23	9	0.16	1	0.02	2	0.04
	Hematologic								
HEMx010	Coagulation disorders	10	0.18	6	0.11	11	0.20	8	0.14
	Infections								
INFx010	Acute major	125	2.26	131	2.37	136	2.46	156	2.82
INFx020	Acute minor	1449	26.18	1447	26.14	1528	27.61	1436	25.94
INFx030	HIV/AIDS	27	0.49	29	0.52	31	0.56	40	0.72
INFx040	Tuberculosis	7	0.13	6	0.11	3	0.05	1	0.02
INFx050	Severe Acute Major Infections	179	3.23	155	2.80	170	3.07	171	3.09
	Malignancies								
MALx010	Malignancies	42	0.76	47	0.85	50	0.90	58	1.05
	Musculoskeletal								
MUSx010	Gout	238	4.30	260	4.70	278	5.02	308	5.56
MUSx020	Inflammatory	12	0.22	9	0.16	13	0.23	9	0.16
	Neurologic								
NURx010	Alzheimer's disease	57	1.03	56	1.01	57	1.03	63	1.14
NURx020	Chronic medical	1377	24.88	1398	25.26	1250	22.58	1202	21.72
NURx030	Migraine headache	101	1.82	116	2.10	112	2.02	81	1.46
NURx040	Parkinson's disease	64	1.16	68	1.23	71	1.28	74	1.34
NURx050	Seizure disorder	89	1.61	176	3.18	196	3.54	233	4.21
	Psychosocial								
PSYx030	Anxiety	1151	20.79	1226	22.15	1183	21.37	1159	20.94
PSYx040	Depression	332	6.00	336	6.07	296	5.35	298	5.38
PSYx050	Acute minor	1	0.02	3	0.05	4	0.07	5	0.09

Table 4.9 Frequency of Rx-MGs by study sample (cont.)

Rx-MG label	Description	2008		2009		2010		2011	
		n	%	n	%	n	%	n	%
PSYx060	Chronic unstable	245	4.43	262	4.73	242	4.37	250	4.52
	Respiratory								
RESx010	Acute minor	981	17.72	990	17.89	927	16.75	914	16.51
RESx020	Chronic medical	27	0.49	17	0.31	27	0.49	29	0.52
RESx030	Cystic fibrosis	0	0.00	0	0.00	0	0.00	0	0.00
RESx040	Airway hyper-reactivity	207	3.74	204	3.69	243	4.39	250	4.52
	Skin								
SKNx010	Acne	1	0.02	1	0.02	2	0.04	2	0.04
SKNx020	Acute and recurrent	159	2.87	152	2.75	150	2.71	153	2.76
SKNx030	Chronic medical	83	1.50	94	1.70	105	1.90	115	2.08
	Toxic effects/adverse effects								
TOXx010	Acute major	195	3.52	200	3.61	228	4.12	219	3.96
ZZZx000	Other and nonspecific medications	2449	44.25	2418	43.69	2447	44.21	2493	45.04



Range(%)	Rx-MG label	Description
3.94	ENDx040	**Endocrine**: Diabetes without insulin
5.56	CARx040	**Cardiovascular**: Hyperlipidemia
8.56	CARx030	**Cardiovascular**: High blood pressure
3.88	CARx050	**Cardiovascular**: Vascular disorders
8.64	GSIx030	**General signs and symptoms**: Pain and inflammation
2.02	GSIx020	**General signs and symptoms**: Pain
1.57	GASx060	**Gastrointestinal/hepatic**: Peptic disease
2.31	EYEx020	**Eye**: Acute minor: palliative
1.66	INFx020	**Infections**: Acute minor
3.54	NURx020	**Neurologic**: Chronic medical

Figure 4.4 The most frequent Rx-MGs, and four-year distributions in diabetic patients from 2008 to 2011.

Table 4.10 shows the number of assigned Rx-MGs per diabetic patient per year for four consecutive years or the number of drug groups for treating these patients. There was 0.38-0.76% of cases with zero Rx-MGs or less than 1% of patients had no drug treatments. The average numbers of Rx-MGs were rather stable at 6.52, 6.67, 6.65, and 6.59 in 2008, 2009, 2010, and 2011, respectively. Also, approximately 11% of cases were high multi-pharmacy groups, with more than 10 Rx-MGs.

Table 4.10 Number of Rx-MGs per patient per year from 2008 to 2011

Number of Rx-MGs	**Year 2008**		**Year 2009**		**Year 2010**		**Year 2011**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
0	42	0.76	31	0.56	21	0.38	37	0.67
1	85	1.54	52	0.94	61	1.10	51	0.92
2	229	4.14	194	3.50	188	3.40	176	3.18
3	515	9.30	519	9.38	517	9.34	512	9.25
4	667	12.05	673	12.16	672	12.14	752	13.59
5	749	13.53	732	13.22	784	14.16	773	13.97
6	721	13.03	742	13.41	758	13.69	746	13.48
7	644	11.64	671	12.12	628	11.35	602	10.88
8	585	10.57	532	9.61	549	9.92	544	9.83
9	411	7.43	440	7.95	421	7.61	422	7.62
10	311	5.62	289	5.22	291	5.26	298	5.38
11	218	3.94	242	4.37	224	4.05	212	3.83
12	122	2.20	156	2.82	141	2.55	162	2.93
13	101	1.82	96	1.73	103	1.86	111	2.01
14	61	1.10	81	1.46	76	1.37	48	0.87
15	32	0.58	32	0.58	52	0.94	35	0.63
16+	42	0.76	53	0.96	49	0.89	54	0.98
Mean (SD)	**6.52**	**3.08**	**6.67**	**3.12**	**6.65**	**3.12**	**6.59**	**3.08**

The mean number of unique Rx-MGs and drug expenditure per patient in top ten ACGs were shown in tables 4.11. Cases with more severe ACGs had higher number of unique Rx-MGs and drug expenditure than the less severe cases.

Table 4.11 Most frequent ACGs with number of Rx-MGs and drug expenditure from 2008 to 2011

ACG	2008			2009			2010			2011		
	%N	Number of Rx-MGs (MEAN±SD)	Drug expenditure (MEAN±SD)	% N	Number of Rx-MGs (MEAN±SD)	Drug expenditure* (MEAN±SD)	% N	Number of Rx-MGs (MEAN±SD)	Drug expenditure* (MEAN±SD)	%N	Number of Rx-MGs (MEAN±SD)	Drug expenditure* (MEAN±SD)
0900	27.59	4.62±2.02	12,804±20,422	29.61	4.84±2.06	10,251±14,753	24.82	4.76±1.89	7,948±10,996	24.93	4.74±1.92	7,958±10,005
2300	7.26	7.07±2.43	10,905±17,691	6.63	7.20±2.37	9,544±14,898	4.91	7.01±2.30	8,513±17,817	5.11	7.07±2.36	6,416±7,479
3600	1.50	9.59±2.96	19,116±30,719	1.14	9.75±2.44	13,552±15,844	1.07	9.27±3.14	12,757±16,496	1.16	9.09±2.72	14,336±26,474
4100	36.87	6.15±2.49	19,976±31,376	35.46	6.35±2.59	20,119±31,584	37.76	6.16±2.56	17,018±27,317	36.42	6.02±2.53	14,291±23,551
4410	4.26	8.96±2.62	14,214±20,803	3.54	9.32±2.54	15,280±20,385	4.64	8.93±2.86	16,021±27,302	3.76	8.53±2.54	12,342±13,471
4420	6.68	7.98±2.83	22,451±30,511	7.08	8.12±2.94	21,139±24,364	8.20	7.88±3.02	22,674±69,303	7.66	7.88±2.95	22,792±73,936
4430	5.58	7.64±2.88	33,746±45,439	5.85	7.50±2.85	32,272±45,551	5.82	7.31±2.74	32,015±47,371	7.43	7.07±2.82	24,078±35,103
4910	2.87	11.08±2.90	20,597±21,946	2.40	11.41±3.45	22,313±28,422	3.20	11.07±3.17	22,801±21,011	3.79	10.58±3.02	16,481±14,866
4920	2.53	10.68±3.60	31,360±34,117	2.80	10.32±3.03	31,016±44,251	3.69	9.90±3.51	29,927±38,834	4.17	9.78±3.29	27,849±35,768
4930	1.32	9.55±2.83	40,058±59,196	1.59	10.47±3.41	33,007±35,707	1.97	9.48±3.37	29,814±29,163	2.31	9.48±3.31	35,377±47,231

*Adjusted at 2008 price

ACG 0900= Chronic medical, stable, ACG 2300= Chronic medical: stable and Acute minor, ACG 3600= Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable, ACG 4100=2-3 Other ADG Combinations, Age 35+, ACG 4410=4-5 Other ADG Combinations, Age 45+, no Major ADGs, ACG 4420=4-5 Other ADG Combinations, Age 45+, 1 Major ADGs, ACG 4430=4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs, ACG 4910=6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs, ACG 4920=6-9 Other ADG Combinations, Age 35+, 2 Major ADGs, ACG4930=6-9 Other ADG Combinations, Age 35+, 3 Major ADGs

The details of drug expenditures in most frequent ACGs are also shown in appendix F.

When comparing variation of the average number of unique Rx-MGs among top ten ACGs, figure 4.5 shows that cases in ACG4910 (6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs) had maximum average number of unique Rx-MGs, followed by ACG4920 (6-9 Other ADG Combinations, Age 35+, 2 Major ADGs) and ACG4930 (6-9 Other ADG Combinations, Age 35+, 3 Major ADGs); while the minimum was in ACG0900 (Chronic medical, stable). In addition, comparing 2011 to 2008, in the same ACG, the average number of unique Rx-MGs was decreased slightly, except in ACG0900 and ACG2300.

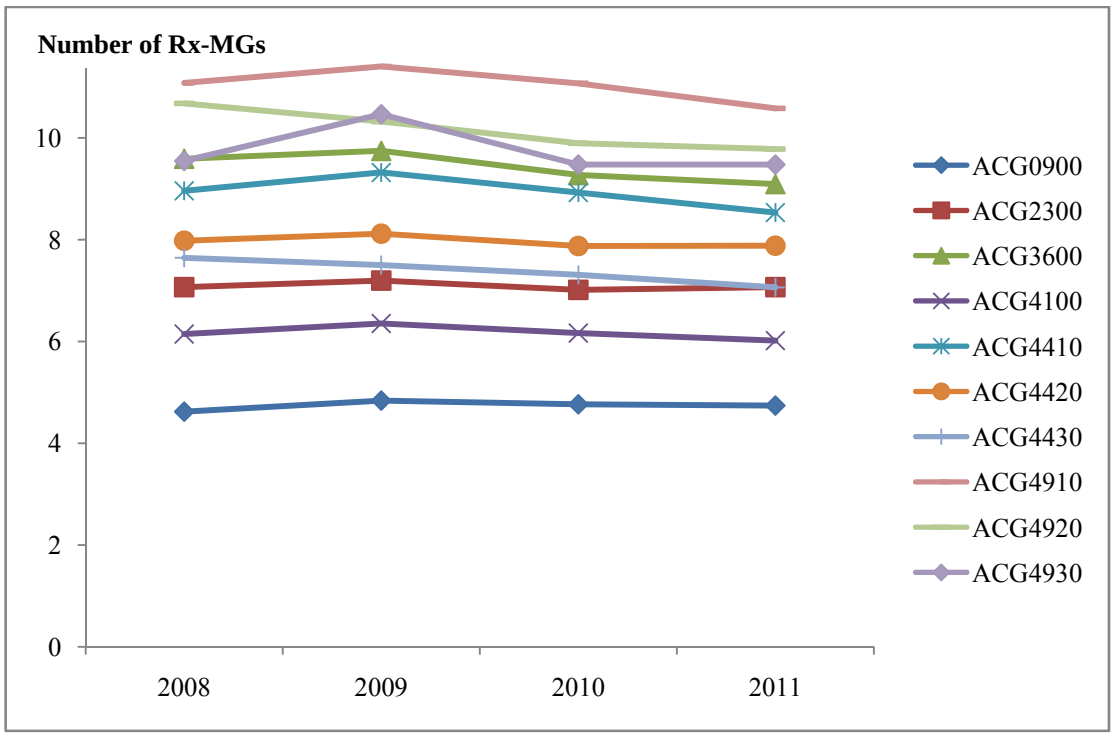


Figure 4.5 The average number of unique Rx-MGs among top ten ACGs from 2008 to 2011

Part III Determination of resource utilization and healthcare expenditure

The average outpatient visits were approximately 8 visits per person per year. 21-23% of patients had at least 1 emergency visit, and 14-18% of patients had at least 1 inpatient hospitalization each year from fiscal year 2008 to 2010 (see table 4.12).

Table 4.12 Utilization and expenditure per patient per year from 2008 to 2011

	Year			
	2008	**2009**	**2010**	**2011**
Utilization (Mean±SD)				
Outpatient visits	8.49±5.03	8.47±5.70	8.41±7.17	8.46±9.88
Emergency visits	0.42±1.12	0.41±1.24	0.45±1.32	0.44±1.35
Hospitalization	0.23±0.66	0.22±0.74	0.24±0.79	0.32±0.98
Expenditure* (Mean±SD)				
Outpatient	20,647±30,704	20,183±30,532	19,405±34,417	17,211±31,544
Inpatient	4,261±20,814	4,266±21,830	4,382±23,815	6,020±28,061
Drug	18,701±30,225	17,954±29,397	16,981±33,205	15,228±31,146
Total	24,908±38,926	24,449±39,397	23,787±43,041	23,232±43,668

*Adjusted at 2008 price

An average outpatient and emergency visit were consistent across 4 years, but the number of hospitalization increased from 2008 to 2011. Comparing 2011 to 2008, the number of hospitalization increased approximately 40%.

Outpatient expenditure decreased slightly from 2008 to 2011. Comparing 2011 expenditure to that of 2008, there was a 17% decrease in outpatient expenditure, but 41% increase in inpatient expenditure. However total expenditure decreased slightly from 2008 to 2011.

In addition, drug expenditure accounted for a large proportion of total expenditure but decreased continuously across 4 years. Drug expenditure was 75, 73, 71, and 65 percent of total expenditure in 2008, 2009, 2010, and 2011, respectively. Comparing 2011 to 2008, drug expenditure decreased approximately 19%.

Comparison of resource utilization and healthcare expenditure of diabetic patients under different health insurance schemes

Table 4.13 shows utilization and expenditure for outpatient service of diabetic patients under three different health insurance schemes. This table illustrates that there was significant variation in mean drug and total expenditure for outpatient service across health insurance schemes. As expected, patients under the CSMBS had the largest mean drug and total expenditure. However, outpatient expenditure of diabetic patients under the CSMBS decreased consistently from 2008 to 2011 while outpatient expenditure of diabetic patients under the UC and the SSS increased.

Table 4.13 Utilization and expenditure for outpatient service stratified by health insurance scheme

Health insurance	**Outpatient visits, (Mean±SD)**			
	2008	**2009**	**2010**	**2011**
UC	8.16±4.65	8.10±5.05	7.93±6.61	7.66±8.15
SSS	9.56± 6.36	9.59±8.71	9.15±8.81	8.69±11.21
CSMBS	8.76±5.25	8.78±5.96	8.90±7.57	9.36±11.40
	Drug expenditure*/ outpatient, (Mean±SD)			
UC	7,164±10,782	7,679±10,664	7,758±10,355	8,007±10,348
SSS	8,167±11,690	10,226±21,122	14,248±87,670	16,211±93,086
CSMBS	31,606±38,163	29,069±37,458	26,382±36,087	20,942±30,336
	Total expenditure*/ outpatient, (Mean±SD)			
UC	9,330±12,576	10,022±11,991	10,492±10,355	10,727±10,348
SSS	10,852±14,622	13,610±26,219	18,141±87,670	19,627±93,086
CSMBS	34,630±39,582	32,525±39,846	29,855±36,087	24,485±30,336

*Adjusted at 2008 price

Comparing 2011 to 2008, in patients under the CSMBS**,** the mean number of outpatient visit was increased approximately 7%, while the mean number of drug and total expenditure were decreased nearly 34% and 29% respectively. But, in patients under the UC**,** the mean number of outpatient visit was decreased approximately 6%, while the mean number of drug and total expenditure were increased nearly 12% and 15% respectively. In addition, the maximum change was in

patients under SSS**,** the mean number of outpatient visit was decreased approximately 9%, while the mean number of drug and total expenditure were increased nearly 98% and 81% respectively.

For inpatient service, drug and total expenditure of patients under CSMBS were also higher than patients under UC and SSS, while the mean number of hospitalization was lower. (Table 4.14)

Table 4.14 Utilization and expenditure for inpatient service stratified by health insurance scheme

Health insurance	**Inpatient hospitalization, (Mean±SD)**			
	2008	**2009**	**2010**	**2011**
UC	0.27±0.70	0.24±0.77	0.28±0.87	0.36±1.05
SSS	0.27±0.79	0.15±0.48	0.19±0.66	0.33±1.32
CSMBS	0.19±0.19	0.20±0.72	0.21±0.87	0.27±0.84
	Drug expenditure* / Inpatient, (Mean±SD)			
UC	530±2,665	570±3,514	612±4,419	1,002±5,293
SSS	435±1,758	412±2,329	810±8,900	852±3,630
CSMBS	759±5,936	787±6,663	764±6,229	1,305±11,135
	Total expenditure* / Inpatient, (Mean±SD)			
UC	4,004±17,411	3,867± 17,236	3,884±19,867	5,594±24,843
SSS	4,065±17,289	2,871± 14,452	3,144±22,669	6,004±25,564
CSMBS	4,541±24,384	4,871± 26,664	5,078±27,795	6,430±31,530

*Adjusted at 2008 price

Comparing 2011 to 2008, in patients under the CSMBS**,** the mean number of hospitalization was increased approximately 42%, while the mean number of drug and total expenditure were increased nearly 72% and 42% respectively. In patients under the UC**,** the mean number of hospitalization was increased approximately 33%, while the mean number of drug and total expenditure were increased nearly 89% and 40% respectively. In addition, the maximum change of expenditure was in patients under the SSS**,** the mean number of drug and total expenditure were increased nearly 96% and 48% respectively, while the mean number of hospitalization was increased approximately 22%, but was lower than the UC.

The details of outpatient and hospitalization expenditures stratified by health insurance scheme are also shown in appendix G.

Table 4.15 and 4.16 shows the distribution of diabetic patients in top ten ACGs and RUBs stratified by health benefit schemes.

Table 4.15 The distribution of diabetic patients in top ten ACGs stratified by health insurance schemes

Health insurance scheme	Top ten ACGs (n(%))										Other ACGs	Total
	0900	**2300**	**3600**	**4100**	**4410**	**4420**	**4430**	**4910**	**4920**	**4930**		
2008												
UC	786(14.20)	218(3.93)	43(0.77)	986(17.81)	133(2.40)	173(3.12)	157(2.83)	87(1.57)	71(1.28)	41(0.73)	103(1.86)	2,798(50.55)
SSS	78(1.40)	25(0.45)	6(0.10)	87(1.57)	1(0.19)	14(0.25)	8(0.14)	8(0.14)	6(0.10)	3(0.05)	26(0.50)	272(4.91)
CSMBS	660(11.92)	159(2.87)	34(0.61)	964(17.41)	92(1.66)	183(3.30)	144(2.60)	64(1.15)	63(1.13)	29(0.52)	66(1.19)	2,458(44.41)
2009												
UC	864(15.60)	194(3.50)	35(0.63)	972(17.56)	99(1.78)	190(3.43)	155(2.80)	62(1.12)	83(1.49)	46(0.83)	110(1.99)	2,810(50.77)
SSS	90(1.62)	29(0.52)	6(0.10)	72(1.30)	5(0.09)	12(0.21)	6(0.10)	8(0.14)	9(0.16)	3(0.05)	25(0.45)	265(4.79)
CSMBS	683(12.33)	144(2.60)	22(0.39)	916(16.54)	92(1.66)	190(3.43)	163(2.94)	63(1.13)	63(1.13)	39(0.70)	81(1.46)	2,456(44.37)
2010												
UC	775(14.00)	150(2.71)	30(0.54)	1032(18.64)	124(2.24)	221(3.99)	141(2.54)	75(1.35)	108(1.95)	61(1.10)	116(2.10)	2,833(51.18)
SSS	82(1.48)	25(0.45)	4(0.07)	63(1.13)	7(0.12)	12(0.21)	11(0.19)	12(0.21)	8(0.14)	3(0.05)	20(0.36)	247(4.46)
CSMBS	517(9.34)	96(1.73)	25(0.45)	993(17.94)	126(2.27)	220(3.97)	170(3.07)	90(1.62)	88(1.58)	45(0.81)	80(1.45)	2,450(44.26)
2011												
UC	774(13.98)	170(3.07)	39(0.70)	977(17.65)	99(1.78)	211(3.81)	186(3.36)	100(1.80)	114(2.05)	62(1.12)	107(1.93)	2,839(51.29)
SSS	75(1.35)	19(0.34)	3(0.05)	76(1.37)	10(0.18)	13(0.23)	12(0.21)	9(0.16)	5(0.09)	7(0.12)	14(0.25)	243(4.39)
CSMBS	530(9.57)	94(1.69)	22(0.39)	963(17.39)	98(1.77)	198(3.57)	212(3.83)	101(1.82)	111(2.00)	59(1.06)	57(1.03)	2,445(44.17)

Table 4.16 The distribution of diabetic patients in RUBs stratified by health insurance schemes

Health insurance scheme	**RUB (N(%))**					Total
	1_Healthy	2_Low	3_Moderate	4_High	5_Very high	
	2008					
UC	7(0.13)	1,012(18.28)	1,474(26.63)	256(4.63)	49(0.89)	2798(50.55)
SSS	-	103(1.86)	146(2.64)	19(0.34)	4(0.07)	272(4.91)
CSMBS	18(0.33)	824(14.89)	1358(24.53)	214(3.87)	44(0.79)	2458(44.41)
	2009					
UC	12(0.22)	1063(19.21)	1408(25.44)	263(4.75)	64(1.16)	2810(50.77)
SSS	2(0.04)	120(2.17)	119(2.15)	19(0.34)	5(0.09)	265(4.79)
CSMBS	23(0.42)	833(15.05)	1303(23.54)	239(4.32)	58(1.05)	2456(44.37)
	2010					
UC	10(0.18)	932(16.84)	1530(27.64)	279(5.04)	82(1.48)	2833(51.18)
SSS	-	107(1.93)	112(2.02)	22(0.40)	6(0.11)	247(4.46)
CSMBS	19(0.34)	618(11.17)	1475(26.65)	269(4.86)	69(1.25)	2450(44.26)
	2011					
UC	1(0.02)	953(17.22)	1467(26.50)	316(5.71)	102(1.84)	2839(51.29)
SSS	-	94(1.70)	119(2.15)	20(0.36)	10(0.18)	243(4.39)
CSMBS	1(0.02)	628(11.35)	1398(25.26)	328(5.93)	90(1.63)	2445(44.17)

When considering on pharmacy data, table 4.17 demonstrates that the mean number of unique Rx-MGs in diabetic patients was not different between three health insurance scheme.

Table 4.18 presents the distribution of number of unique Rx-MGs in diabetic patients in top ten ACGs stratified by health insurance schemes, which shows differently in number of unique Rx-MGs in some ACGs with high morbidity such as: ACG 4910, 4920, and 4930.

Table 4.17 The number of unique Rx-MGs in diabetic patients stratified by health insurance scheme

Health insurance scheme	**2008**		**2009**		**2010**		**2011**	
	N(%) of patient	No. of Rx-MGs Mean±SD	N(%) of patient	No. of Rx-MGs Mean±SD	N(%) of patient	No. of Rx-MGs Mean±SD	N(%) of patient	No. of Rx-MGs Mean±SD
UC	2798(50.55)	6.40±3.04	2810(50.77)	6.56±3.03	2833(51.18)	6.54±3.02	2839(51.29)	6.56±3.08
SSS	272(4.91)	6.38±2.81	265(4.79)	6.46±2.94	247(4.46)	6.52±3.27	243(4.39)	6.15±3.06
CSMBS	2458(44.41)	6.67±3.14	2456(44.37)	6.82±3.23	2450(44.26)	6.81±3.21	2445(44.17)	6.66±3.08
Total*	5535(100)	6.52±3.08	5535(100)	6.67±3.12	5535(100)	6.65±3.12	5535(100)	6.59±3.08

*included Self- pay

Table 4.18 The distribution of number of unique Rx-MGs in diabetic patients in top ten ACGs stratified by health insurance schemes

Health insurance scheme	**Number of unique Rx-MGs (Mean±SD)**									
	0900	**2300**	**3600**	**4100**	**4410**	**4420**	**4430**	**4910**	**4920**	**4930**
2008										
UC	4.47±1.97	7.08± 2.28	9.58±2.96	6.08±2.54	8.71±2.35	7.89±2.72	7.44±2.88	10.91±2.88	10.42±3.20	9.27±2.66
SSS	4.53±2.05	7.12±2.39	9.00±4.38	6.20±2.13	9.00±2.61	6.93±2.64	7.25±1.83	9.88±1.73	9.33±2.58	8.67±3.21
CSMBS	4.82±2.07	7.04±2.66	9.71±2.77	6.22±2.46	9.33±2.95	8.15±2.93	7.89±2.93	11.47±3.02	11.10±4.05	10.03±3.04
2009										
UC	4.79±2.02	7.31±2.26	9.66±2.34	6.31±2.62	9.48±2.51	7.97±2.81	7.35±2.68	11.15±3.37	10.23±2.81	10.13±3.41
SSS	4.63± 2.01	7.14±2.63	10.17±2.64	6.10±2.13	8.40±1.95	6.67±2.90	8.50±2.95	10.88±2.23	8.78±2.17	9.00±0.00
CSMBS	4.93± 2.12	7.06±2.47	9.77±2.64	6.42±2.59	9.20±2.60	8.36±3.05	7.61±3.00	11.73±3.66	10.67±3.36	10.97±3.51
2010										
UC	4.77± 1.87	7.11±2.32	9.60±3.24	6.12±2.51	9.16±2.79	7.79±2.99	7.22±2.58	10.64±2.59	10.00±3.35	9.20±3.56
SSS	4.44± 1.80	7.28±1.95	10.25±3.10	6.16±2.73	10.43±4.54	5.83±2.33	7.45±2.46	11.92±3.18	10.25±3.28	9.67±4.73
CSMBS	4.80±1.92	6.83±2.32	8.72±3.05	6.21±2.60	8.61(2.80	8.09±3.06	7.38±2.90	11.32±3.58	9.74±3.75	9.84±3.06
2011										
UC	4.78±1.89	7.07±2.31	9.03±2.75	6.08±2.51	9.06±2.60	7.92±3.10	7.01±2.89	10.55±3.01	9.70±3.33	8.98±3.28
SSS	4.11±1.81	6.89±2.21	9.33±1.53	5.75±2.26	8.40±1.26	7.23±3.49	7.75±2.77	11.00±2.50	12.80±2.17	8.71±1.80
CSMBS	4.78±1.96	7.10±2.48	9.18±2.89	5.98±2.57	8.06±2.47	7.89±2.76	7.09±2.77	10.57±3.10	9.70±3.26	10.08±3.42

Part IV Performance measures in diabetes management

For process measure of diabetes management, more cases were monitored with HbA1c (from 74% of cases in 2008 to 80% in 2011) but with less favourable results (only 42% of patients tested reached the target of HbA1c <7% in 2008 to only 38% in 2011). More cases were monitored with lipid profile with higher favourable results (from 76% to 82% of patients tested with 61% to 72% reached the target of <100 mg/dl). For renal function assessment, only 19-35% of diabetic patients had annual microalbumin urine test. (table 4.19)

Table 4.19 Performance measures (Indicator) in diabetes management

Characteristic	**2008**	**2009**	**2010**	**2011**
Process measures: % of patients tested, (no. of tests/no. of patients)				
HbA1c tests	**74.26%** (8,486/ 4,110)	**77.47%** (9,442/ 4,288)	**79.42%** (9,158/ 4,396)	**80.47%** (9,587/ 4,454)
Lipid profile	**74.62%** (6,602/ 4,130)	**78.16%** (7,370/ 4,326)	**81.95%** (7,749/ 4,536)	**76.08%** (7,312/ 4,211)
Urine testing for protein	**28.94%** (2,090/ 1,602)	**19.22%** (1,380/ 1,064)	**36.75%** (2,433/ 2,034)	**34.49** (2,371/ 1,909)
Outcome measures: % of patients reached target				
HbA1c < 7 %	42.58%	39.48%	37.17%	38.53%
LDL cholesterol < 100 mg/dl	63.50%	60.56%	70.89%	71.59%
Albumin excretion < 30 (μg/mg creatinine)	68.10%	69.45%	66.47%	67.67%
Follow-up (intermediate outcomes)				
ACE-I (or ARB) if hypertensive	77.40%	78.69%	75.96%	78.48%
Treatment with statin if hyperlipidemia	84.22%	86.74%	86.94%	87.60%

Table 4.19 has also shown that more than 76% of diabetic patients with hypertension have taken angiotensin converting enzyme inhibitor (ACE-I) or angiotensin receptor antagonist (ARB), and more than 84% of diabetic patients with hyperlipidemia have taken statin drugs.

To compare between health insurance schemes, more diabetic patients under the UC and SSS were tested for HbA1c, but more patients under the CSMBS patients reached the treatment target than patients under the UC and the SSS, as shown in table 4.20.

Table 4.20 Performance measures (Indicator) in diabetes management stratified by health insurance scheme

% of patients	**2008**		**2009**		**2010**		**2011**	
	% tested	% at target	% tested	% at target	% tested	% at target	% tested	% at target
HbA1c								
CSMBS	73.96	49.12	74.88	46.22	76.78	42.69	76.11	43.58
SSS	73.53	34.50	81.89	34.10	84.62	28.71	86.42	33.81
UC	74.59	37.66	79.29	34.47	81.26	33.45	83.66	35.03
LDL cholesterol								
CSMBS	71.89	65.87	75.90	64.32	78.65	74.16	72.80	73.09
SSS	82.35	61.61	85.66	55.95	92.31	59.65	79.84	68.56
UC	76.27	61.67	79.40	57.87	83.90	69.29	78.55	70.63
Urine albumin excretion								
CSMBS	35.11	69.64	23.78	69.69	38.20	67.41	34.48	67.02
SSS	24.26	68.18	15.85	73.81	31.58	66.67	28.40	65.22
UC	23.66	65.71	15.23	68.22	34.80	64.40	31.14	64.59

For LDL cholesterol testing, the same as HbA1c, number of tested in patients under the UC and SSS was higher than the CSMBS but more patients under the CSMBS reached the treatment target than patients under the UC and SSS.

When considering on renal function assessment, both proportion of patient under the CSMBS who was tested and reached the target was higher than the UC and SSS, excepted in 2009, more patients under the SSS reached the treatment target than patients under the CSMBS and UC.

Table 4.21 presents that in the CSMBS program, the number of diabetic patients with hypertension who have taken angiotensin converting enzyme inhibitor (ACE-I) or angiotensin receptor antagonist (ARB) was higher than in the UC and SSS. While the number of diabetic patients with hyperlipidemia who have taken statin drugs was not largely different between three health insurance schemes especially in year 2011.

Table 4.21 Medication use in diabetic patient with hypertention/hyperlipidemia stratified by health insurance scheme

% of patients	**2008**	**2009**	**2010**	**2011**
Treatment with ACE-I (or ARB) if hypertensive				
CSMBS	85.17	91.50	83.86	86.38
SSS	74.88	72.20	74.16	73.83
UC	70.20	67.72	69.09	71.94
Treatment with statin if hyperlipidemia				
CSMBS	86.10	87.75	86.87	87.11
SSS	82.87	82.35	82.18	85.31
UC	83.95	86.34	87.37	88.16

CHAPTER V
DISCUSSIONS

This study applied the concept of the Adjusted Clinical Group (ACG) to describe the pattern of morbidity burden in diabetic patients across 4 years. Diabetes was focused in this study for several reasons, including: 1) diabetes is reported as a chronic disease with high prevalence in Thailand and many countries(1, 2, 4), 2) the chronic nature of diabetes and its devastating complications make it a very costly disease, high healthcare cost and high drug use for treatment (7, 33). In Thailand, the ACG has been studied for several years for measuring morbidity in the population in order to allocate outpatient resources more efficiently and equitably (30, 31). Furthermore, the results of this study indicate that ACG also perform well in explaining morbidity burden, resource use, and assessing the quality of diabetic care in diabetic patient of regional hospital, across 4 years, by incorporating information from electronic database into ACG software version 9. Useful information can be extracted for hospital administrator and healthcare provider to improve diabetic patient management and applied to predict future healthcare utilization as well as allocate resources for healthcare.

This study discusses on many related issues as followings.

5.1 Characteristics of diabetic patient

In 2008, from electronic health insurance database, 10358 diabetic patients were identified by the Johns Hopkins ACG software version 9, but only 5535 patients (53.43%) who had at least one diabetes-related outpatient visit per year for 4 consecutive years (2008-2011), were recruited. Thus, approximately a half of all diabetic patients each year were included in this study.

Demographic characteristics of diabetic patients in terms of age, gender and co-morbidities were similar to several studies (12, 71, 72). Most of them were female (~66%) and average age of 60 years. Approximately 80% of diabetics patient had cardiovascular co-morbidities such as, hypertension and hyperlipidemia, which were quite high compared to other studies. For health insurance schemes, there were slightly more diabetic patients under UC than the CSMBS (~51% to 44%). The proportion of patients under the SSS was quite low compared to the UC and the CSMBS as other studies (72, 73).

5.2 Morbidity pattern of diabetic patient

The ACG grouping process assigns diagnosis codes first to Adjusted Diagnostic Groups (32 ADGs), then to Adjusted Clinical Groups (93 ACGs) and finally to Resource Utilization Bands (5 RUBs). The results from ADG and ACG assignment suggest that most of diabetic patients in this study can be appropriate assigned to ACG categories and the distribution of ACGs was highly persistent over 4 years. The stability over time provides reasons for using the ACG system for estimating utilization and expenditure and for elucidating categories of diabetic patients for the purpose of disease management.

The results from ADG assignment also show that approximately 66% of patient had only one to three unique ADGs and 56% of patient had no major ADGs which demonstrate that more than 50% of patient was not in very high expected resource consumption group. As the results from RUB assignment which indicate that ore than 80% of this patient was classified as low to moderate users.

Although, no statistical significant difference in distribution of ACGs between the four years was found, the results from Figure 4.4 illustrate that the number of diabetic patient in more severe ACG such as, ACG 4910, 4920, and 4930 was slightly increased across 4 years while the number of diabetic patient in ACG 0900 and 2300 was decreased.

Table 4.6-4.7 explain the resource use in top ten ACGs. These reflect the fact that most highly morbidity patients had higher both outpatient/inpatient visits and medical expenditure as other studies (27, 65). The mean number of visits and

expenditure of the patient assigned to a given ACG was associated with its morbidity burden, diabetic patients assigned to ACGs with major ADGs or more ADGs combinations required more costly care than those with stable condition or fewer ADGs combinations.

Two studies in Spain and Taiwan had demonstrated the usefulness of incorporating pharmacy data into ACG risk adjustment technique in predicting drug and total expenditure (24, 28). The results from Rx-MGs assignment show the pattern of medication use in diabetic patient which should be apply to evaluate for an appropriate drug use. This diabetic patient had similarity Rx-MGs distribution across 4 year (2008-2011), and the assigned Rx-MGs were also associated with their co-morbidities.

In addition, table 4.11 shows the relationship between Rx-MGs, ACGs and drug expenditure. Patients with more severe ACG had more number of unique Rx-MG and higher drug expenditure. The results of this study reflect that pharmacy data could be used to estimate morbidity burdens and drug expenditures. Studies in the U.S (54, 74) and Spain (24) have outlined the potential of pharmacy data to improve the system of risk adjustment for both care management program, capitation payments and pharmacy budget planning. This is of particular interest in a situation in which the information related to drug prescription is routinely recorded in electronic hospital database. In Thailand, this is the first study to demonstrate that it’s feasible to use information from electronic pharmacy database for analyzing by ACG software. But drug codes have to be mapped to the WHO ATC codes, according to the guidelines of the World Health Organization.

5.3 Determination of resource utilization and healthcare expenditure

5.3.1 Utilization of service

Several studies demonstrated that diabetic patients had more hospital utilization rate than non-diabetic patient in both outpatient and inpatient (71-73). Furthermore, if diabetic patients had complications and co-morbidities, utilization rate would be increased. The average annual outpatient visits in this study were nearly the

same across 4 years, and not largely different from other studies (71-73). Because of the outpatient visits in this study composed of overall illness condition of patients not solely for diabetes, as this average annual outpatient visits were high.

On the other hand, the average annual hospitalizations were increased continuously but lower if compared to other studies (71-73). The main reason might be from inclusion criteria of this study that comprised only diabetic patients who had to continue treatment at outpatient service across 4 years. So, patient with severe or near end of life stage, who did not turn up the following years were not included in this study.

However, this study did not elucidate the disease condition for hospitalization, thus the results could be explain particularly patients with more morbidity burdens (from ACG grouping) had more hospitalization.

5.3.2 Healthcare expenditure

In this study, healthcare expenditure was only classified as drug and others (non-drugs), separated to outpatient and inpatient service. Similarly to other studies (71-73) , drug expenditure accounted for a large proportion of total expenditure. The interesting point from this study was why drug expenditure was decreased and made total expenditure not grown up.

Several studies in Thailand indicated that the factors affecting healthcare expenditure in diabetic patients were such as demographic factors, health insurance schemes, hospital characteristics, healthcare utilization, co-morbidities, and complications (12, 71, 72). Also in this study, besides morbidity burden, overall impact of the different diseases in an individual, with associate to utilization and expenditure, the results from part III shows the highest expenditure was in patients under CSMBS. Although, the healthcare expenditure of these patients decreased continuously, the total expenditure for outpatient was nearly 3-fold compared to patients under UC, excepted in 2011, this proportion was decreased slightly. On the other hand, when considering in patients under SSS, the results demonstrate that the total expenditure in both outpatient and inpatient service was increased tremendously across 4 years. However, the number of patients under SSS was quite low compared to CSMBS and UC in both top ten ACGs and five RUBs. (see table 4.15 and 4.16) This

information should be considered and analyzed, for proposing to hospital administrators.

5.3.3 Comparison of healthcare expenditure in diabetic patient among health insurance schemes

In 2006, the reimbursement system for the CSMBS in Thailand was changed to a direct billing system. Then, in recent year, the outpatient expenditure outpaced the inpatient one and drug expenditure accounted for a large proportion of total expenditure of outpatient. An analysis of prescriptions and expenditures of the outpatient drugs of 26 out of 34 large public hospitals under direct billing system in 2009 revealed that on average 41% of total prescriptions and 67% of expenditure belonged to those not covered by the current National List of Essential Medicines (75).

In general, patients under CSMBS are the group of patients who provides revenues to the hospital and a direct billing system made the patients more convenience, not have to pay fee for service. Then, heath professionals usually offer costlier service, such as non-essential (NE) drug or original drug which is more expensive. For these reason, the result in Table 4.13- 4.14 show that diabetic patient under CSMBS program had the highest medical expenditure in both outpatient and inpatient service, especially on drug expenditure.

However, outpatient expenditure of diabetic patients under CSMBS decreased consistently from 2008 to 2011, demonstrate that the hospital administrator concerned of controlling for medical expenditure and have done several policies for cost containment, including, purchasing and inventory management, restricted use (by indication, prescriber), generic substitution (therapeutic interchange), drug use evaluation, prescribing guideline, limited new drug to hospital formulary and develop prescriber reports on the targeted high-cost drugs and discuss methods for cost reduction in pharmacy and therapeutic (P&T) committee. Nevertheless, it seemed that these policies worked well for only patient under UC. Although, drug expenditure of patients under CSMBS was decreased over 4 years but nearly 3-fold and 2-fold comparing to UC and SSS, respectively, in 2011. In contrast, comparing 2011 to 2008, the mean number of drug and total expenditure of patients under SSS were increased nearly 98% and 81% respectively.

Oversupply of chronic disease medication is a significant financial burden to hospitals. The direct billing system in the CSMBS may affect prescribing patterns, as indicated by the trend of the increased number of months of coverage per prescription and the higher medication possession ratio which reflected the oversupply of medication (76). Moreover, the hospital administrator should be considered this problem, further evidence is still need.

One example of cost containment policies which was present by pharmacy department in this hospital, is to set up the Medication Reconciliation Center (RCC) for outpatient in 2010. First, the objectives were to decrease medication errors, prevent adverse drug reaction and monitor patient adherence for patient with chronic disease. Furthermore, this also proves that the drug expenditure could be decreased by encouraging patients to use their old medication properly before refilling new medication to prevent the oversupply of medication (77).

5.4 Performance measures in diabetes management

Data from hospital laboratory information system including, hemoglobin A1c, LDL cholesterol, and microalbuminuria were linked with the output from ACG software to monitor outcomes of care. The results indicate that, for process measure across 4 years (2008-2011), more cases were monitored with HbA1c, lipid profiles, and microalbuminuria. However, only for HbA1c and lipid profiles, involved nearly 80% of diabetic patient, but, for renal assessment by microalbuminuria examination, less than 40% of them had been tested.

HbA1c was recommended by American Diabetes Association (ADA) to be performed for all diabetic patients at least twice a year in patients who are meeting treatment goals and have stable glycemic control, and in patients whose therapy has changed or who are not meeting glycemic goals should be perform the A1C test quarterly (33). Table 4.19 presents 74 to 80% of diabetic patients had HbA1c tested and the average annual number of HbA1c test per person of these patients was twice a year. Although, this number was lower than the ADA recommendation, but higher if compared to other studies (71, 73) .

Nevertheless, only approximately 40% of diabetic patients had HbA1c at target of < 7%, which recommended by ADA, and this number was decreased across 4 years. This reflects that more than a half of diabetic patients had poor glycemic control.

For dyslipidemia/lipid management, in most adult patients, should be measured fasting lipid profile at least annually. This study results show 76% to 82% of diabetic patients had lipid profile tested with 61% to 72% reached the target of LDL-cholesterol<100 mg/dl, still higher if compared to two studies in Thailand as following (71, 73).

The study of Semangern, in 2005, found percentages for control of individual outcomes according the ADA guideline were: HbA1c (36%), BP (23%), and LDL-cholesterol (41%). And the study of Chunnguleum, in 2006, found percentages for control of individual outcomes according the ADA guideline were: HbA1c (22%), BP (24%), and LDL-cholesterol (26%). Unfortunately, this study did not have the data on blood pressure control because of no information from the electronic database. However, there were many factors which affect the glycemic control of patients such as, life style modification, diet control, weight management, patient adherence and others which were not mentioned in this study.

For assessment of renal function, screening for microalbuminuria can be performed by measurement of the albumin-to-creatinine ratio in a random spot collection. Compare to HbA1c and lipid profile testing, the number of diabetic patients who had microalbuminuria screening, was lower, but this number was continuously increased across 4 years. This might reflect that healthcare provider has intended to improve management of these patients. The DM center has been set up in this hospital since 2009 for registry and collecting information of all diabetic patients and supporting both healthcare providers and patient to achieve treatment goal.

To consider intermediate outcome in diabetic management such as, medication if hypertensive or hyperlipidemia, from ADA recommendation, pharmacologic therapy for patients with diabetes and hypertension should be with a regimen that includes either an ACE inhibitor or an ARB. Statin therapy should be considered in addition to lifestyle therapy if LDL cholesterol was above 100 mg/dl. Proportion of diabetic patients with ACEI (or ARB) or statin if hypertensive or

hyperlipidemia were approximately more than 80%, and increased consistently across 4 year reflecting better access to good quality care.

However, for performance measures in diabetes management, there were many indicators not mentioned in this study such as blood pressure, foot examination, and retinal examination, because of lacking information in electronic database. In the future, DM center in this hospital will provide this important information that necessary for health provider to consider in managing proper service.

CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

This chapter provides the conclusions and recommendations of this study. The study was a retrospective database analysis of morbidity burden and healthcare resource use in diabetic patients at regional hospital over 4 consecutive years (from October 2007 to September 2011) by using diagnosis-based case-mix adjustment system, the Johns Hopkins ACG software version 9, with the objectives to

1. Evaluate the change of morbidity burden, healthcare resource use and drug utilization pattern, and

2. Assess the quality of diabetic care based on process and outcome measures

Conclusions

Characteristics of diabetic patient

Approximately a half of all diabetic patients each year were included in this study, 66% were female and 37% aged 65 years and over. Hypertension and hyperlipidemia are the two most common co-morbidities. The percentage of diabetic patients with co-morbidities such as hypertention, hyperlipidemia, chronic heart failure, chronic renal failure, and ischemic heart disease was increased consistently from 2008 to 2011. The average outpatient visits were 8.5 visits per person per year. One-fifth (21-23%) of patients had at least one emergency visit, and one-sixth (14-18%) had at least one hospitalization each year.

Morbidity pattern of diabetic patient

Most of diabetic patient in this study can be appropriate assigned to ACG categories and the distribution of ACGs was highly consistent for the cohort

population across 4 years. Approximately 66% of patient had only one to three unique ADGs and 56% of patient had no major ADGs which demonstrate that more than 50% of patient was not in group with very high expected resource consumption. Two most assigned ACG, ACG 0900 (RUB 2_low morbidity) and 4100 (RUB 3_moderate mobidity) were comprised of more than 60% of diabetic patients. The mean number of visits and expenditure of the patient assigned to a given ACG was associated with its morbidity burden.

The distribution of Rx-MGs show the pattern of medication use in diabetic patient and were similarity across 4 year (2008-2011). The assigned Rx-MGs were also associated with their co-morbidities, the top 3 most assigned Rx-MGs were ENDx040 (Endocrine: diabetes without insulin), CARx030 (Cardiovascular: high blood pressure), CARx040 (Cardiovascular: hyperlipidemia). The average numbers of unique Rx-MGs were 6.6 and cases in more severe ACGs had higher number of unique Rx-MGs and drug expenditure than the less severe cases.

Determination of resource utilization and healthcare expenditure

The average annual outpatient visits were nearly the same across 4 years, while the average annual hospitalizations were increased continuously from 2008 to 2011. Drug expenditure accounted for a large proportion of total expenditure but decreased continuously across 4 years, as same as outpatient expenditure, while total expenditure was approximately the same. When comparing between different health insurance schemes, the highest expenditure was in patients under CSMBS. Although, the healthcare expenditure of these patients decreased continuously, the total expenditure for outpatient was nearly 3-fold and 2-fold compared to patients under UC and SSS, respectively, excepted in 2011, this proportion was decreased.

Performance measures in diabetes management

For process measure of diabetes management, more cases were monitored with HbA1c (from 74% of cases in 2008 to 80% in 2011) but with less favourable results (only 42% of tests had HbA1c at target (< 7%) in 2008 to 38% in 2011). More cases were monitored with lipid profile with higher favourable results (from 76% to 82% of diabetic patients tested with 61% to 72 % reached the target of < 100 mg/dl).

For renal function assessment, only 19-35% of diabetic patients had annual microalbumin urine test.

In conclusion, this study found substantial feasibility in the ACG system to determine morbidity burdens in patients with diabetes and to monitor their healthcare utilization in comparison with outcome. The appropriate use of ACG system can provide useful information for hospital administrator and healthcare provider in analyzing and managing for planning the health budget and identifying high cost risk patients amenable to care management in the future.

Recommendations

An application of ACGs for a high risk screening tool would be useful for care management. This risk adjustment system could define a risk group of patients with multi-morbidity, more medication use and more healthcare costs. Thus, “ACGs” should be well suited for healthcare organization or specific programs that target care management for individuals with chronic disease. This group of patients should be targeted for intervention before a morbidity event occurs or flares to high severity, thereby forgoing the need for costly interventions and continuing care.

Previous studies in Thailand demonstrated the implementation of the ACG in the Thai context to be used as a risk-adjusted capitation for outpatient services to increase the equity for resource allocation. In this study, besides determining of resource use, monitoring outcome to assess quality of care is one of an important part. When comparing outcomes, risk adjustment is also necessary to ensure that differences in the outcome are not the result of differences in the baseline characteristics, or illness severity, of the patients. “ACGs” also should be used for further analysis in this objective to adjust the health status of patients between health settings or providers for performance assessment.

REFERENCES

1. Shaw J, Sicree R, Zimmet P. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Pract 2010;87:4-14.
2. Chan J, Malik V, Jia W. Diabetes in Asia: epidemiology, risk factors, and pathophysiology. JAMA 2009;301:2129-40.
3. Porapakkham Y, Rao C, Pattaraarchachai J. Estimated causes of death in Thailand, 2005: implications for health policy. Popul Health Metr 2010;8:14.
4. Aekplakorn W, Chariyalertsak S, Kessombooon P. Prevalence and management of diabetes and metabolic risk factors in Thai adults: The Thai National Health Examination Survey IV, 2009. Diabetes Care 2011;34:1980-5.
5. Ministry of Public Health Thailand. Thailand Health Profile 2005-2007. Nonthaburi: Bureau of Policy and Strategy; 2009.
6. American Diabetes Association. Economic costs of diabetes in the U.S. in 2007. Diabetes Care 2008;31:596-615.
7. Zhang P, Zhang X, Brown J. Global healthcare expenditure on diabetes for 2010 and 2030. Diabetes Res Clin Pract 2010;87:293-301.
8. Pudsuk P. Cost of patients with diabetes [M.S. Thesis in Pharmacy Administration]. Bangkok: Mahidol University; 1999.
9. Pornlertwadee P. Societal perspective on the cost of diabetes mellitus at Ampawa Hospital, Samutsongkram Province [M.S. Thesis in Pharmacy Administration]. Bangkok: Mahidol University; 2002.
10. Jansaropos T. Comparison of revenues and costs of services at Chaopra-yayommaraj Hospital, fiscal year 2002–2003 [M.S. Thesis in Pharmacy Administration]. Bangkok: Mahidol University; 2003.
11. Chatterjee S, Riewpaiboon A, Piyauthakit P. Cost of diabetes and its complications in Thailand: a complete picture of economic burden. Health and Social Care in the Community 2011;19(3):289-98.

12. Chaikledkaew U, Pongchareonsuk P, Chaiyakunapruk N. Factors affecting health-care costs and hospitalizations among diabetic patients in Thai public hospitals. Value in Health 2008;11(Suppl. 1):S69-S74.
13. Upakdee N, Pannarunothai S. Medical charges for outpatients: a case study in three provinces using health insurance data. Journal of Health Science 2003;12:775-87.
14. Starfield B, Kinder K. Multimorbidity and its measurement. Health policy 2011; 103:3-8.
15. Weiner J, Starfield B, Steinwachs D, et al. Development and application of a population-oriented measure of ambulatory care case-mix. Med Care 1991;29:452-72.
16. Starfield B, Weiner J, Mumford L, et al. Ambulatory care groups: a categorization of diagnoses for research and management. Health Serv Res 1991;26:53-74.
17. Rosen A, Loveland S, Anderson J, et al. Evaluating diagnosisbased case-mix measures: how well do they apply to the VA population? Med Care 2001;39:692-704.
18. Reid R, MacWilliam L, Verhulst L, et al. Performance of the ACG case-mix system in two Canadian provinces. Med Care 2001;39:86-99.
19. Reid R, Roos N, MacWilliam L, et al. Assessing population health care need using a claims-based ACG morbidity measure: a validation analysis in the Province of Manitoba. Health Serv Res 2002;37:1345-64.
20. Zielinski A, Kronogard M, Lenhof H, et al. Validation of ACG Case-mix for equitable resource allocation in Swedish primary health care. BMC Public Health 2009;9:347.
21. Halling A, Fridh G, Ovhed I. Validating the Johns Hopkins ACG Case-Mix System of the elderly in Swedish primary health care. BMC Public Health 2006;6:171.
22. Carlsson L, Strender L, Fridh G, Nilsson G. Types of morbidity and categories of patients in a Swedish county. Applying the Johns Hopkins Adjusted Clinical Groups System to encounter data in primary health care. Scand J Prim Health Care 2004;22(3):174-9.

23. Orueta J, Urraca J, Berraondo I, et al Adjusted Clinical Groups (ACGs) explain the utilization of primary care in Spain based on information registered in the medical records: A cross-sectional study. Health Policy 2006;76:38-48.

24. Calderon-Larranaga A, Abrams C, Poblador-Plou B, et al. Applying diagnosis and pharmacy-based risk models to predict pharmacy use in Aragon, Spain: The impact of a local calibration. BMC Health Services Research 2010;10:22.

25. Chang H, Weiner J. An in-depth assessment of a diagnosis-based risk adjustment model based on national health insurance claims: the application of the Johns Hopkins Adjusted Clinical Group case-mix system in Taiwan. BMC Medicine 2010; 8:7.

26. Lee W. Quantifying morbidities by Adjusted Clinical Group system for a Taiwan population: a nationwide analysis. BMC Health Serv Res 2008;8:153.

27. Lee W, Huang T. Explanatory ability of the ACG system regarding the utilization and expenditure of the national health insurance population in Taiwan–a 5-year analysis. J Chin Med Assoc 2008;71(4):191-9.

28. Kuo R, Lai M. Comparison of Rx-defined morbidity groups and diagnosis- based risk adjusters for predicting healthcare costs in Taiwan. BMC Health Services Research 2010;10:126.

29. Upakdee N. Outpatient casemix systems in Thailand: results from national health insurance database. Health policy and planning journal 2006;9:106-17.

30. Upakdee N. The adjusted clinical group(ACG) is adapted to predict costs of chronic disease. BMC Health Service Research 2009;9(S1):A14.

31. Upakdee N, Pannarunothai S, Sakunphani T, et al. Casemix adjustment for outpatient service: a tool for resource allocation of social security population in Thailand (Meeting Abstract). BMC Health Services Research 2007;7(Suppl1):A3.

32. Valderas J, Starfield B, Sibbald B, et al. Defining comorbidity: Implications for understanding health and health services. Annals of Family Medicine 2009;7(4):357-63.

33. American Diabetes Association. Standards of Medical Care in Diabetes-2011. Diabetic Care 2011;34(suppl 1):S11-S61.

34. Nathan D, Buse J, Davidson M, et al. American Diabetes Association, European Association for Study of Diabetes. Medical management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy: a consensus statement of the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care 2009;32:193-203.

35. Aekplakorn W, Abbott-Klafter J, Premgamone A, et al. Prevalence and management of diabetes and associated risk factors by regions of Thailand: Third National Health Examination Survey 2004. Diabetes Care 2007;30:2007-12.

36. Riewpaiboon A, Pornlertwadee P, Pongsawat K. Diabetes cost model of a hospital in Thailand. Value in Health 2007;10 (4):223-30.

37. Chatterjee S, Riewpaiboon A, Piyauthakit P. Cost of diabetes and its complications in Thailand: a complete picture of economic burden. Health and Social Care in the Community 2011:1-10.

38. Riewpaiboon A, Chatterjee S, Piyauthakit P. Cost analysis for efficient management: diabetes treatment at a public district hospital in Thailand. IJPP 2011;19:342-9.

39. Marshall C. Essentials of quality improvement with special reference to diabetes. Handbook of Diabetes Management. New York: Springer; 2006.

40. The Johns hopkins ACG® System: Reference Manual Version 8.2. Baltimore 2008.

41. Shadmi E, Balicer R, Kinder K, et al Assessing socioeconomic health care utilization inequity in Israel: impact of alternative approaches to morbidity adjustment BMC Public Health 2011;11:609.

42. Baldwin L, Klabunde C, Green P, et al. In search of the perfect comorbidity measure for use with administrative claims data. Does it exist? Medical Care 2006;44(8):745-53.

43. Carlsson L, Strender L, Fridh G, et al. Clinical categories of patients and encounter rates in primary health care - a three-year study in defined populations BMC Public Health 2006;6:35.

44. Verhulst L, Reid R, Forrest C. “Hold it—my patients are sicker!” The importance of case mix adjustment to practitioner profiles in British Columbia. British Columbia Medical Journal 2001;43:328-33.

45. Rosen A, Loveland S, Rakovski C, et al. Do different case-mix measures affect assessments of provider efficiency? Lessons from the Department of Veterans Affairs. Journal of Ambulatory Care Management 2003; 26(3):229-42.

46. Thomas J, Grazier K, Ward K. Economic profiling of primary care physicians: consistency among risk-adjusted measures. Health Services Research 2004;39(4):985-1004.

47. Adams E, Bronstei J, Raskind-Hood C. Adjusted clinical groups: predictive accuracy for medicaid enrollees in three states. Health Care Financing Review 2002;24(1):43-61.

48. Perkins A, Kroenke K, Unutzer J, et al. Common comorbidity scales were similar in their ability to predict health care costs and mortality. Journal of Clinical Epidemiology 2004;57:1040-8.

49. Chang H, Lee W, Weiner J. Comparison of alternative risk adjustment measures for predictive modeling: high risk patient case finding using Taiwan’s National Health Insurance claims. BMC Health Services Research 2010;10:343.

50. Wong S, Kao C, Crouch J, et al. Rural American Indian Medicaid health care services use and health care costs in California. American Journal of Public Health 2006;96(2):363-70.

51. Murphy S, Castro H, Sylvia M. Predictive Modeling in Practice: Improving the Participant Identification Process for Care Management Programs Using Condition-Specific Cut Points. Population Health Management 2011; 14:1-6.

52. Sylvia M, Griswold M, Dunbar L, et al Guided care: Cost and utilization outcomes in a pilot study. Disease Management 2008;11:29-36.

53. Sylvia M, Shadmi E, Hsiao C, et al Clinical features of high-risk older persons identified by predictive modeling. Disease Management 2006;9:56-62.

54. Forrest C, Lemke K, Bodycombe D, et al. Medicatiom, diagnostic, and cost information as predictors of high-risk patients in need of care management. AJMC 2009;15(1):41-8.

55. Starfield B, Lemke K, Bernhardt T, et al. Comorbidity: Implications for the importance of primary care in case management. Ann Fam Med 2003;1(1):8-14.

56. Reid R, Bogdanovic B, Roos N, et al. Do some physician groups see sicker patients than others? Implications for primary care policy in Manitoba. Manitoba: Manitoba Centre for Health Policy and Evaluation, Faculty of Medicine, University of Manitoba; 2001.

57. Zielinski A, Hakansson A, Beckman A, et al. Impact of comorbidity on the individual's choice of primary healthcare provider. Scandinavian Journal of Primary Health Care 2011;29:104-9.

58. Zielinski A, Kronogard M, Lenhoff H, et al. Validation of ACG case-mix for equitable resource allocation in Swedish primary health care. BMC Public Health 2009;9:347.

59. Siemens K, Gurol-Urganci I, Atun R, et al. Evaluating case-mix and predictive modeling measures within the British primary care sector. BMC Health Services Research 2007;7(Suppl 1):A8.

60. Bolanos-Carmona V, Ocana-Riola R, Prados-Torres A, et al Variations in health services utilisation by primary care patients. Health Services Management Research 2002;15:116-25.

61. Kuhlthau K, Ferris T, Beal A, et al Who care for Medicaid-enrolled children with chronic conditions? Pediatrics 2001;108:906-91.

62. Berlowitz D, Hoenig H, Cowper D, et al. Impact of Comorbidities on Stroke Rehabilitation Outcomes: Does the Method Matter? Arch Phys Med Rehabil 2008;89:1903-6.

63. Austin P, Walraven C, Wodchis W, et al. Using the Johns Hopkins Aggregated Diagnosis Groups (ADGs) to Predict Mortality in a General Adult Population Cohort in Ontario, Canada. Medical Care 2011;49(10):932-9.

64. Sibley L, Glaziera R. Evaluation of the equity of age–sex adjusted primary care capitation payments in Ontario, Canada. Health Policy 2011; doi: 10.1016/j.healthpol.2011.10.008.

65. Hanley G, Morgan S, Reid R. Explaining Prescription Drug Use and Expenditures Using the Adjusted Clinical Groups Case-Mix System in the Population of British Columbia, Canada. Med Care 2010;48:402–8.

66. Calderon-Larranaga A, Abrams C, Poblador-Plou B. Does the pharmacy expenditure of patients always correspond with their morbidity burden? Exploring new approaches in the interpretation of pharmacy expenditure. BMC Public Health 2010;10:244.

67. Aguado A, Guinó E, Mukherjee B. Variability in prescription drug expenditures explained by adjusted clinical groups (ACG) case-mix: A cross-sectional study of patient electronic records in primary care. BMC Health Services Research 2008;8:53.

68. Health Insurance Office. Standard data sets for health insurance. Nonthaburi: Ministry of Public Health; 1997.

69. WHO Collabolating Centre for Drug Statistics Methodology, Guidelines for ATC classification and DDD assignment 2011. Oslo,2010.

70. Bureau of trade and economic indices. Ministry of commerce. [Online] Available from: http://www.price.moc.go.th. [Access on November 4 th,2012].

71. Chunnguleum K. Drug utilization and clinical outcomes of diabetic outpatients in five hospitals, 2002-2003. [M.S. Thesis in Pharmacy Administration]. Bangkok: Mahidol University; 2006.

72. Tantivipanuwong S. Determination of factors affecting medical expenditures of diabetic patients from electronic database[M.S. Thesis in Pharmacy Administration]. Bangkok: Mahidol University; 2005.

73. Semangern K. Drug utilization of diabetic patients at Phare Hospital and Maharat Nakhon Ratchasima Hospital, fiscal year 2002-2003 [M.S. Thesis in Pharmacy Administration]. Bangkok: Mahidol University; 2005.

74. Zhao Y, Ash A, Ellis R, et al. Predicting pharmacy costs and other medical costs using diagnoses and drug claims. Med Care 2005;43:34-43.

75. Limwattananon C, Thammatacharee N, Waleekhachonloet O, et al. Expenditure of Civil Servant Medical Benefit Scheme and the use of non-essential medicines. Journal of Health Systems Research 2011;5:149-59.
76. Dilokthornsakul P, Chaiyakunapruk N, Nimpitakpong P. Effects of Direct Billing System on Prescribing Patterns in the Civil Servant Medical Benefit Scheme. Journal of Health Systems Research 2010;4:53-62.
77. Sriarwut T, Chindasu P. Why should we have medication reconciliation? Buddhachinaraj Medical Journal 2012;29:114-8.

APPENDICES

APPENDIX A
STANDARD DATA SETS FOR HEALTH INSURANCE

Standard dataset 12 file

1. มาตรฐานแฟ้มข้อมูลผู้สิทธิการรักษาพยาบาล ชื่อแฟ้ม INSyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
INSCL	C	2	0	สิทธิการรักษาที่ใช้
SUBTYPE	C	2	0	ระดับสิทธิของหลักประกัน
CID	C	16	0	หมายเลขบัตรเพื่อตรวจสอบ
DATEIN	D	8	0	วันเดือนปีที่มีสิทธิ ปีมีค่าเป็น คศ.
DATEEXP	D	8	0	วันเดือนปีที่หมดสิทธิ ปีมีค่าเป็น คศ.
HOSPMAIN	C	5	0	รหัสสถานพยาบาลหลัก
HOSPSUB	C	5	0	รหัสสถานพยาบาลรอง

2. มาตรฐานแฟ้มข้อมูลผู้ป่วยกลาง ชื่อแฟ้ม PATyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HCODE	C	5	0	รหัสสถานพยาบาล
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
CHANGWAT	C	2	0	ตามรหัสมหาดไทย
AMPHUR	C	2	0	ตามรหัสมหาดไทย
DOB	D	8	0	บันทึกวันเดือนปีเกิด ปีมีค่าเป็น คศ.

SEX	C	1	0	1 หมายถึง เพศชาย 2 หมายถึง เพศหญิง
MARRIAGE	C	1	0	รหัสสภาพภาพสมรส
OCCUPA	C	3	0	อาชีพ
NATION	C	2	0	สัญชาติ
PERSON_ID	C	13	0	รหัสประจำตัวประชาชนตามสำนักทะเบียนราษฎร์

3. มาตรฐานแฟ้มข้อมูลผู้ป่วยนอกที่ต้องส่ง ชื่อแฟ้ม OPDyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
CLINIC	C	4	0	ชื่อคลินิกที่รับบริการ
DATEOPD	D	8	0	วันที่ที่รับบริการ บันทึกปีในค่าเป็น คศ.

4. มาตรฐานแฟ้มข้อมูลผู้ป่วยนอก ชื่อแฟ้ม ORFyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
DATEOPD	D	8	0	วันที่มารับบริการ บันทึกปีในค่า คศ.
CLINIC	C	4	0	ชื่อคลินิกที่รับบริการ
REFER	C	5	0	สถานพยาบาลหรือคลินิกที่เกี่ยวข้องกับการส่งต่อตามรหัสสถานพยาบาล
REFERTYPE	C	1	0	ประเภทการส่งต่อ 1 = รับเข้า 2 = ส่งออก

5. มาตรฐานแฟ้มข้อมูลผู้ป่วยนอก ชื่อแฟ้ม ODXyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
DATEDX	D	8	0	วันเดือนปีที่วินิจฉัยโรค บันทึกปีในค่า คศ.
CLINIC	C	4	0	รหัสคลินิกที่ให้บริการ
DIAG	C	5	0	วินิจฉัยโรค ตามรหัส ICD 10
DXTYPE	C	1	0	ชนิดของโรค ระบุ 1 = Primary Diagnosis , 2 =Comorbidity , 3 =Complication, 4 =Others
DRDX	C	6	0	แพทย์ผู้รักษา ตามเลขที่ใบประกอบวิชาชีพเวชกรรม

6. มาตรฐานแฟ้มข้อมูลผู้ป่วยนอก ชื่อแฟ้ม OOPyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
DATEOPD	D	8	0	วันที่ที่รับบริการ บันทึกปีในค่าเป็น คศ.
CLINIC	C	4	0	ชื่อคลินิกที่รับบริการ
OPER	C	4	0	รหัสหัตถการตาม ICD 9 CM
DROP	C	6	0	แพทย์ผู้รักษา ตามเลขที่ใบประกอบวิชาชีพเวชกรรม

7. มาตรฐานแฟ้มข้อมูลผู้ป่วยใน ชื่อแฟ้ม IPDyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
AN	C	9	0	หมายเลขประจำตัวผู้ป่วยใน ไม่ควรใช้หมายเลขนี้ซ้ำ
DATEADM	D	8	0	วันรับเข้าในโรงพยาบาล บันทึกปีในค่า คศ.
TIMEADM	C	4	0	เวลารับเข้า บันทึกเป็นชั่วโมง นาที ตามนาฬิกาในระบบคอมพิวเตอร์
DATEDSC	D	8	0	วันจำหน่าย บันทึกปีในค่าเป็น คศ.
TIMEDSC	C	4	0	เวลาจำหน่าย บันทึกเป็นชั่วโมง นาที ตามนาฬิกาในระบบคอมพิวเตอร์
DISCHS	C	1	0	สถานภาพการจำหน่ายผู้ป่วย
DISCHT	C	1	0	วิธีการจำหน่ายผู้ป่วย
WARDDSC	C	4	0	ตึกที่จำหน่ายผู้ป่วยใช้รหัสที่โรงพยาบาลตั้งขึ้น
DEPT	C	2	0	แผนกที่รักษาผู้ป่วยเป็นหลัก

8. มาตรฐานแฟ้มข้อมูลผู้ป่วยใน ชื่อแฟ้ม IRFyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
AN	C	9	0	หมายเลขประจำตัวผู้ป่วยใน
REFER	C	5	0	ตามรหัสสถานพยาบาล
REFERTYPE	C	1	0	1 = IN, 2 = OUT

9. มาตรฐานแฟ้มข้อมูลผู้ป่วยใน ชื่อแฟ้ม IDXyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
AN	C	9	0	หมายเลขประจำตัวผู้ป่วยใน
DIAG	C	5	0	วินิจฉัยโรค ตามรหัส ICD 10
DXTYPE	C	1	0	ชนิดของโรค ระบุ 1 = Principal Diagnosis , 2 =Comorbidity , 3 =Complication , 4 = Others
DRDX	C	6	0	แพทย์ผู้วินิจฉัย ตามเลขที่ใบประกอบวิชาชีพเวชกรรม

10. มาตรฐานแฟ้มข้อมูลผู้ป่วยใน ชื่อแฟ้ม IOPyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
AN	C	9	0	หมายเลขประจำตัวผู้ป่วยใน
OPER	C	4	0	หัตถการที่ทำ ตามรหัส ICD 9 CM
OPTYPE	C	1	0	ชนิดของหัตถการ ระบุ 1=Prinicipal procedure, 2 = secondary procedure, 3= Others
DROP	C	6	0	แพทย์ที่ทำหัตถการ ตามเลขที่ใบ

				ประกอบวิชาชีพเวชกรรม
DATEIN	D	8	0	วันเดือนปีที่เริ่มทำหัตถการ บันทึกปีในค่า คศ.
TIMEIN	C	4	0	เวลาเริ่มบันทึกเป็น ชั่วโมง นาที ตามนาฬิกาในระบบ คอมพิวเตอร์
DATEOUT	D	8	0	วันเดือนปีที่ทำหัตถการสิ้นสุด บันทึกปีในค่า คศ.
TIMEOUT	C	4	0	เวลาสิ้นสุด บันทึกเป็น ชั่วโมง นาที ตามนาฬิกาในระบบ คอมพิวเตอร์

11. มาตรฐานแฟ้มข้อมูลการเงิน ชื่อแฟ้ม CHTyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
AN	C	9	0	หมายเลขประจำตัวผู้ป่วยใน ไม่ควรใช้หมายเลขนี้ซ้ำ
DATE	DATE	8	0	วันที่คิดค่ารักษา วันจำหน่าย หรือวันที่ผู้ป่วยเปลี่ยนสิทธิการรักษา บันทึก ปี ในค่า คศ.
TOTAL	N	7	0	จำนวนเงินค่ารักษารวม เป็นบาท ที่เรียกเก็บ
PAID	N	7	0	จำนวนเงินที่ผู้ป่วยจ่ายเอง ในกรณีที่โรงพยาบาลไม่ได้รับเงินไว้ = 0
PTTYPE	C	2	0	ชนิดการชำระเงิน

12. มาตรฐานแฟ้มข้อมูลการเงิน ชื่อแฟ้ม CHAyymm.dbf

FIELD NAME	TYPE	LENGTH	DECIMAL	QUALIFICATION
HN	C	9	0	หมายเลขประจำตัวผู้รับบริการ
AN	C	9	0	หมายเลขประจำตัวผู้ป่วยใน ไม่ควรใช้หมายเลขนี้ซ้ำ
DATE	DATE	8	0	วันที่คิดค่ารักษา บันทึกปีในค่า คศ.
CHRGITEM	C	2	0	ชนิดของบริการที่คิดค่ารักษาตามรหัสที่กำหนดในแฟ้ม
AMOUNT	N	7	0	จำนวนเงินค่ารักษาของบริการรายการนั้น เป็นบาท

APPENDIX B
DATAS TRUCTURES OF PHARMACY DATABASE

1. ตารางบันทึกใบสั่งยา (Orders)

File name	Description
RUNNO	หมายเลขใบสั่งยา
ORDERNO	เลขที่ใบสั่ง
SERIAL	ลำดับใบสั่งใน 1วัน
STATUS	รหัสสิทธิการรักษา
DOCTCODE	รหัสแพทย์ผู้สั่งใช้ยา
CLINCODE	รหัสคลินิก
VN	visit number
HN	hospital number
PATNAME	ชื่อ สกุล ผู้ป่วย
TIME_IN	เวลารับใบสั่งยา
TIME_OUT	เวลาจ่ายยา
CASHRET	ค่ายาที่สามารถเบิกได้
CASHNORET	ค่ายาที่สามารถเบิกไม่ได้
ITEM	จำนวนรายการยา
TOTALCASH	ค่ายาทั้งหมด
USERCODE	รหัสผู้กรอกข้อมูล
FREE_	ค่ายาที่ใช้สิทธิการรักษา
CANCELED	ยกเลิกใบสั่งหรือไม่
SERVICES	ค่าบริการ
STATION	หมายเลขเครื่องคอมพิวเตอร์ที่รับข้อมูล
REGDATE	วัน เวลาที่ลงทะเบียนรับการรักษา

2. ตารางบันทึกข้อมูลรายการยา (Orderdetail)

File name	Description
LINEID	หมายเลขข้อมูลยา
NO_	ลำดับในใบสั่งยา
ORDERNO	เลขที่ใบสั่ง
REFERCODE	รหัสค้นหายา
DRUGCODE	รหัสยา
ORDERTYPE	ประเภทใบสั่งยา
PERMIT	คำยินยอมให้ใช้ยา
ROUTCODE	รหัสทางการให้ยา
DOSE	รหัสขนาดยาที่ให้ผู้ป่วยที่ 1
UNITCODE	รหัสหน่วยการใช้ยาของผู้ป่วยที่ 1
USECODE	รหัสวิธีใช้ยาที่ 1
DOSE2	รหัสขนาดยาที่ให้ผู้ป่วยที่ 2
UNITCODE2	รหัสหน่วยการใช้ยาของผู้ป่วยที่ 2
WARNCODE	รหัสวิธีใช้ยาที่ 2
LABEL	รหัสคำเตือน คำแนะนำการใช้ยา
COST	พิมพ์ฉลากหรือไม่
PRICE	ราคาทุน
QTY	จำนวน
GRPRICE	ราคายาแยกตามประเภทยาใน-นอกบัญชีบัญชียาหลักแห่งชาติ
GRED	ประเภทยาใน-นอกบัญชีบัญชียาหลักแห่งชาติ
MX	ราคายาสำหรับเคมีบำบัด

APPENDIX C

DATAS TRUCTURES OF LABORATORY DATABASE

1. ตารางใบส่งตรวจทางห้องปฏิบัติการ (Specimen)

File name	Description
RUNNO	เลขที่ใบส่งตรวจทางห้องปฏิบัติการ
ORDERNO	หมายเลขใบส่งตรวจทางห้องปฏิบัติการ
HN	hospital number
VN	visit number
AN	admission number
PATTYPE	ผู้ป่วยนอก/ใน
STATUS	รหัสสิทธิการรักษา
PRSTATUS	ประเภทของสิทธิการรักษา
SENDER	รหัสผู้ส่งตรวจ
LABCODE	รหัสการตรวจทางห้องปฏิบัติการ
LABTYPE	ประเภทการตรวจทางห้องปฏิบัติการ
PROCESS	สถานะของใบส่งตรวจทางห้องปฏิบัติการ
DATESEND	วันที่ส่ง
TIMESEND	เวลาที่ส่ง
DATEOUT	วันที่ออกผล
TIMEOUT	เวลาที่ออกผล
COST	ราคา
USERPASS	รหัสผู้กรอกข้อมูล
REJECT	ยกเลิกหรือไม่
VALIDER	รหัสผู้ประเมิน

2. ตารางแสดงผลการตรวจทางห้องปฏิบัติการ (Specres)

File name	Description
NO	หมายเลขผลการตรวจทางห้องปฏิบัติการ
RUNNO	หมายเลขใบส่งตรวจ
LABCODE	รหัสการตรวจทางห้องปฏิบัติการ
RESULT	ผลการตรวจทางห้องปฏิบัติการ
NOTE	บันทึกเพิ่มเติม

APPENDIX D.1

THE MOST FREQUENT ACGS, DISTRIBUTION OF DIABETIC PATIENTS AND OUTPATIENT EXPENDITURE IN 2008

ACG	Description	Diabetic patients		Outpatient expenditures (Baht)/patient				
		Frequency	Percent	Mean	SD	Min	Median	Max
0900	Chronic medical, stable	1,527	27.59	14,256	20,895	110	6,125	193,670
2300	Chronic medical: stable and Acute minor	402	7.26	12,554	18,257	65	5,738	121,790
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	83	1.50	22,092	31,943	114	11,179	202,206
4100	2-3 Other ADG Combinations, Age 35+	2,041	36.87	22,168	32,995	50	9,465	471,310
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	236	4.26	17,167	21,457	968	8,452	128,125
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	370	6.68	24,809	30,929	335	11,782	245,647
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	309	5.58	34,592	40,869	735	15,716	229,012
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	159	2.87	24,560	23,934	842	15,443	142,796
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	140	2.53	33,378	34,858	1,378	21,192	172,710
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	73	1.32	39,057	57,494	1,989	22,518	437,978

APPENDIX D.2

THE MOST FREQUENT ACGS, DISTRIBUTION OF DIABETIC PATIENTS AND OUTPATIENT EXPENDITURE IN 2009

ACG	Description	Diabetic patients		Outpatient expenditures (Baht)/patient				
		Frequency	Percent	Mean	SD	Min	Median	Max
0900	Chronic medical, stable	1,639	29.61	11,574	15,185	290	5,770	161,420
2300	Chronic medical: stable and Acute minor	367	6.63	11,368	16,253	324	6,023	220,915
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	63	1.14	16,031	16,104	3,180	10,441	79,469
4100	2-3 Other ADG Combinations, Age 35+	1,962	35.45	22,263	32,585	50	10,855	364,777
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	196	3.54	18,323	22,297	1,979	9,192	132,740
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	392	7.08	23,694	23,701	500	15,279	160,267
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	324	5.85	34,545	45,330	1,202	19,357	509,400
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	133	2.40	27,416	29,570	2,893	17,555	221,422
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	155	2.80	33,719	44,610	1,772	17,869	281,224
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	88	1.59	33,748	30,414	1,721	23,935	161,497

APPENDIX D.3

THE MOST FREQUENT ACGS, DISTRIBUTION OF DIABETIC PATIENTS AND OUTPATIENT EXPENDITURE IN 2010

ACG	Description	Diabetic patients		Outpatient expenditures (Baht)				
		Frequency	Percent	Mean	SD	Min	Median	Max
0900	Chronic medical, stable	1,374	24.82	9,595	11,704	250	5,693	133,443
2300	Chronic medical: stable and Acute minor	272	4.91	10,569	19,135	250	6,019	229,663
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	59	1.07	14,943	17,008	1,079	10,117	107,634
4100	2-3 Other ADG Combinations, Age 35+	2,090	37.76	20,013	29,082	350	10,384	345,494
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	257	4.64	20,575	29,415	1,765	12,126	365,558
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	454	8.20	26,976	73,164	640	14,120	1,449,268
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	322	5.82	35,952	50,371	550	19,163	625,118
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	177	3.20	28,490	22,833	5,119	20,200	113,964
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	204	3.69	33,058	38,878	1,033	19,295	319,710
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	109	1.97	32,121	30,419	226	19,737	153,649

APPENDIX D.4

THE MOST FREQUENT ACGS, DISTRIBUTION OF DIABETIC PATIENTS AND OUTPATIENT EXPENDITURE IN 2011

ACG	Description	Diabetic patients		Outpatient expenditures (Baht)				
		Frequency	Percent	Mean	SD	Min	Median	Max
0900	Chronic medical, stable	1,380	24.93	9,998	11,103	230	6,632	113,104
2300	Chronic medical: stable and Acute minor	283	5.11	8,681	8,760	457	6,205	62,098
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	64	1.16	14,758	14,870	1,753	9,535	94,187
4100	2-3 Other ADG Combinations, Age 35+	2,016	36.42	17,788	26,163	56	10,337	363,418
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	208	3.76	17,314	16,031	2,169	12,033	145,717
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	424	7.66	27,476	80,518	300	14,293	1,570,346
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	411	7.43	27,594	38,072	50	16,891	430,551
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	210	3.79	22,780	17,276	2,043	17,691	115,243
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	231	4.17	30,425	37,734	51	20,226	346,118
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	128	2.31	31,454	34,869	220	21,069	234,399

APPENDIX E.1

THE MOST FREQUENT ACGS, DISTRIBUTION OF DIABETIC PATIENTS AND HOSPITALIZATION EXPENDITURE IN 2008

ACG	Description	Diabetic patients		Hospitalization expenditures (Baht)/patient				
		Frequency	Percent	Mean	SD	Min	Median	Max
0900	Chronic medical, stable	1,527	27.59	189	3,396	0	0	98,093
2300	Chronic medical: stable and Acute minor	402	7.26	979	11,586	0	0	186,362
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	83	1.50	5,058	9,505	0	0	49,859
4100	2-3 Other ADG Combinations, Age 35+	2,041	36.87	2,790	18,545	0	0	422,311
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	236	4.26	2,617	10,503	0	0	98,900
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	370	6.68	7,882	21,695	0	0	195,918
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	309	5.58	14,649	40,804	0	0	342,732
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	159	2.87	6,769	15,301	0	0	104,816
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	140	2.53	20,825	40,789	0	4,855	266,992
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	73	1.32	32,674	48,634	0	17,523	288,297

APPENDIX E.2

THE MOST FREQUENT ACGS, DISTRIBUTION OF DIABETIC PATIENTS AND HOSPITALIZATION EXPENDITURE IN 2009

ACG	Description	Diabetic patients		Hospitalization expenditures (Baht)/patient				
		Frequency	Percent	Mean	SD	Min	Median	Max
0900	Chronic medical, stable	1,639	29.61	202	5,968	0	0	225,362
2300	Chronic medical: stable and Acute minor	367	6.63	168	1,721	0	0	29,656
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	63	1.14	3,802	9,570	0	0	49,768
4100	2-3 Other ADG Combinations, Age 35+	1,962	35.45	2,829	17,238	0	0	342,949
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	196	3.54	1,932	5,626	0	0	31,285
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	392	7.08	5,886	28,950	0	0	509,243
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	324	5.85	13,254	40,659	0	0	344,210
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	133	2.40	10,333	31,967	0	0	274,929
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	155	2.80	14,893	27,058	0	5,718	172,205
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	88	1.59	37,739	58,603	0	12,749	306,545

APPENDIX E.3

THE MOST FREQUENT ACGS, DISTRIBUTION OF DIABETIC PATIENTS AND HOSPITALIZATION EXPENDITURE IN 2010

ACG	Description	Diabetic patients		Hospitalization expenditures (Baht)/patient				
		Frequency	Percent	Mean	SD	Min	Median	Max
0900	Chronic medical, stable	1,374	24.82	183	3,699	0	0	105,121
2300	Chronic medical: stable and Acute minor	272	4.91	550	7,426	0	0	121,207
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	59	1.07	15,102	58,234	0	0	441,091
4100	2-3 Other ADG Combinations, Age 35+	2,090	37.76	1,816	16,225	0	0	485,358
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	257	4.64	1,287	4,824	0	0	32,173
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	454	8.20	5,957	18,685	0	0	193,881
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	322	5.82	8,607	29,979	0	0	258,373
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	177	3.20	6,501	15,404	0	0	91,628
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	204	3.69	18,862	44,548	0	3,374	421,088
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	109	1.97	31,281	40,855	0	18,127	199,496

APPENDIX E.4

THE MOST FREQUENT ACGS, DISTRIBUTION OF DIABETIC PATIENTS AND HOSPITALIZATION EXPENDITURE IN 2011

ACG	Description	Diabetic patients		Hospitalization expenditures (Baht)				
		Frequency	Percent	Mean	SD	Min	Median	Max
0900	Chronic medical, stable	1,380	24.93	20	325	0	0	8,047
2300	Chronic medical: stable and Acute minor	283	5.11	395	4,823	0	0	79,732
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	64	1.16	18,031	92,184	0	0	730,631
4100	2-3 Other ADG Combinations, Age 35+	2,016	36.42	1,983	15,343	0	0	358,254
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	208	3.76	1,922	6,239	0	0	40,953
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	424	7.66	7,702	29,814	0	0	399,800
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	411	7.43	14,262	40,146	0	0	436,381
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	210	3.79	10,032	31,529	0	0	353,625
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	231	4.17	28,695	57,611	0	6,421	447,208
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	128	2.31	48,374	77,838	0	25,101	547,637

APPENDIX F.1

THE MOST FREQUENT ACGS WITH NUMBER OF RX-MGS AND DRUG EXPENDITURE IN 2008

ACG	Description	%N	No. of Rx-MGs (Mean±SD)	Drug expenditure (Baht)/patient				
				Mean	SD	Min	Median	Max
0900	Chronic medical, stable	27.59	4.62±2.02	12,804	20,422	0	4,878	192,270
2300	Chronic medical: stable and Acute minor	7.26	7.07±2.43	10,905	17,691	15	4,487	117,130
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	1.50	9.59±2.96	19,116	30,719	477	7,317	188,846
4100	2-3 Other ADG Combinations, Age 35+	36.87	6.15±2.49	19,976	31,376	0	7,633	458,610
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	4.26	8.96±2.62	14,214	20,803	182	6,166	124,095
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	6.68	7.98±2.83	22,451	30,511	150	9,962	244,697
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	5.58	7.64±2.88	33,746	45,439	137	13,917	363,000
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	2.87	11.08±2.90	20,597	21,946	967	11,250	98,756
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	2.53	10.68±3.60	31,360	34,117	3,046	18,385	166,708
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	1.32	9.55±2.83	40,058	59,196	569	21,108	445,985

APPENDIX F.2

THE MOST FREQUENT ACGS WITH NUMBER OF RX-MGS AND DRUG EXPENDITURE IN 2009

ACG	Description	%N	No. of Rx-MGs (Mean±SD)	Drug expenditure (Baht)/patient				
				Mean	SD	Min	Median	Max
0900	Chronic medical, stable	29.61	4.84±2.06	10,159	14,621	0	4,523	161,220
2300	Chronic medical: stable and Acute minor	6.63	7.20±2.37	9,458	14,764	142	4,638	197,770
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	1.14	9.75±2.44	13,430	15,701	1,204	7,029	76,365
4100	2-3 Other ADG Combinations, Age 35+	35.45	6.35±2.59	19,938	31,300	0	8,662	353,662
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	3.54	9.32±2.54	15,142	20,202	167	6,588	123,015
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	7.08	8.12±2.94	20,948	24,145	734	10,969	162,953
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	5.85	7.50±2.85	31,981	45,141	713	16,668	492,980
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	2.40	11.41±3.45	22,112	28,166	1,660	12,577	214,877
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	2.80	10.32±3.03	30,737	43,853	2,271	14,874	275,407
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	1.59	10.47±3.41	32,710	35,386	1,922	22,875	236,178

APPENDIX F.3

THE MOST FREQUENT ACGS WITH NUMBER OF RX-MGS AND DRUG EXPENDITURE IN 2010

ACG	Description	%N	No. of Rx-MGs (Mean±SD)	Drug expenditures (Baht)/patient				
				Mean	SD	Min	Median	Max
0900	Chronic medical, stable	24.82	4.76±1.89	8,138	11,260	95	4,312	129,303
2300	Chronic medical: stable and Acute minor	4.91	7.01±2.30	8,717	18,245	49	4,435	217,733
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	1.07	9.27±3.14	13,063	16,892	889	7,636	100,889
4100	2-3 Other ADG Combinations, Age 35+	37.76	6.16±2.56	17,426	27,972	0	7,919	328,969
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	4.64	8.93±2.86	16,405	27,957	535	8,086	359,128
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	8.20	7.88±3.02	23,218	70,966	351	10,097	1,407,588
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	5.82	7.31±2.74	32,783	48,508	40	16,090	585,800
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	3.20	11.07±3.17	23,348	21,515	2,737	15,222	104,484
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	3.69	9.90±3.51	30,645	39,766	1,544	15,578	314,974
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	1.97	9.48±3.37	30,529	29,863	728	21,488	142,863

APPENDIX F.4

THE MOST FREQUENT ACGS WITH NUMBER OF RX-MGS AND DRUG EXPENDITURE IN 2011

ACG	Description	%N	No. of Rx-MGs (Mean±SD)	Drug expenditures (Baht)/patient				
				Mean	SD	Min	Median	Max
0900	Chronic medical, stable	24.93	4.74±1.92	8,459	10,635	0	5,140	106,639
2300	Chronic medical: stable and Acute minor	5.11	7.07±2.36	6,821	7,950	281	4,432	60,468
3600	Acute Minor/Acute Major/Likely to Recur/ Chronic Medical: Stable	1.16	9.09±2.72	15,239	28,142	881	8,119	212,068
4100	2-3 Other ADG Combinations, Age 35+	36.42	6.02±2.53	15,191	25,035	0	8,033	360,228
4410	4-5 Other ADG Combinations, Age 45+, no Major ADGs	3.76	8.53±2.54	13,120	14,319	469	8,494	132,518
4420	4-5 Other ADG Combinations, Age 45+, 1 Major ADGs	7.66	7.88±2.95	24,228	78,594	13	11,459	1,535,336
4430	4-5 Other ADG Combinations, Age 45+, 2+ Major ADGs	7.43	7.07±2.82	25,595	37,315	434	14,556	412,994
4910	6-9 Other ADG Combinations, Age 35+, 0-1 Major ADGs	3.79	10.58±3.02	17,519	15,803	1,476	12,289	104,649
4920	6-9 Other ADG Combinations, Age 35+, 2 Major ADGs	4.17	9.78±3.29	29,604	38,021	1,955	19,366	328,628
4930	6-9 Other ADG Combinations, Age 35+, 3 Major ADGs	2.31	9.48±3.31	37,606	50,206	1,836	23,292	405,693

APPENDIX G.1

EXPENDITURE PER PATIENT PER YEAR FROM 2008 TO 2011

Year	**Outpatient expenditure** (Baht)				
	Mean	SD	Min	Median	Max
2008	20,647	30,704	50	8,945	471,310
2009	20,001	30,258	50	9,540	509,400
2010	19,870	35,243	220	9,952	1,449,268
2011	18,296	33,531	50	10,289	1,570,346
	Hospitalization expenditure (Baht)				
2008	4,261	20,814	0	0	422,311
2009	4,228	21,633	0	0	509,243
2010	4,487	24,387	0	0	674,176
2011	6,400	29,828	0	0	730,631
	Drug expenditure (Baht)				
2008	18,701	30,225	0	7,024	458,610
2009	17,793	29,133	0	7,371	492,980
2010	17,389	34,002	0	7,570	1,407,588
2011	16,187	33,108	0	8,172	1,535,336
	Total expenditure (Baht)				
2008	24,908	38,926	50	10,678	496,730
2009	24,229	39,043	50	10,887	540,803
2010	24,357	44,074	250	11,066	1,449,268
2011	24,695	46,419	100	11,820	1,570,346

APPENDIX G.2

EXPENDITURE PER PATIENT PER YEAR FOR OUTPATIENT SERVICE STRATIFIED BY HEALTH INSURANCE SCHEME FROM 2008 TO 2011

Health insurance scheme	**Drug expenditure** (Baht)					**Total expenditure**(Baht)				
	Mean	SD	Min	Median	Max	Mean	SD	Min	Median	Max
	2008					**2008**				
UC	7,164	10,782	0	4,614	336,872	9,330	12,576	110	6,291	352,897
SSS	8,167	11,690	135	4,505	106,004	10,852	14,622	425	6,096	112,729
CSMBS	31,606	38,163	0	18,714	458,610	34,630	39,582	50	21,492	471,310
	2009					**2009**				
UC	7,610	10,568	0	4,974	317,698	9,932	11,883	50	6,812	326,583
SSS	10,134	20,932	327	4,635	258,051	13,488	25,983	485	6,151	266,241
CSMBS	28,807	37,121	0	17,744	492,980	32,232	39,487	290	20,561	509,400
	2010					**2010**				
UC	7,945	10,603	0	5,336	288,180	10,744	11,893	226	7,733	295,830
SSS	14,590	89,774	218	4,930	1,407,588	18,576	93,222	998	6,918	1,449,268
CSMBS	27,015	36953	0	14,735	583,008	30,572	39,483	250	17,932	625,118
	2011					**2011**				
UC	8,511	11,000	0	5,925	338,215	11,403	12,796	50	8,254	348,865
SSS	17,233	98,951	0	6,060	1,535,336	20,863	101,822	615	8,261	1,570,346
CSMBS	22,261	32,248	0	11,850	400,886	26,028	34,816	56	15,080	430,551

APPENDIX G.3

EXPENDITURE PER PATIENT PER YEAR FOR HOSPITALIZATION STRATIFIED BY HEALTH INSURANCE SCHEME FROM 2008 TO 2011

Health insurance scheme	**Drug expenditure** (Baht)					**Total expenditure**(Baht)				
	Mean	SD	Min	Median	Max	Mean	SD	Min	Median	Max
	2008					**2008**				
UC	530	2,665	0	0	47,576	4,004	17,411	0	0	380,307
SSS	435	1,758	0	0	13,824	4,065	17,289	0	0	167,117
CSMBS	759	5,936	0	0	214,812	4,541	24,384	0	0	422,311
	2009					**2009**				
UC	564	3,482	0	0	74,175	3,832	17,081	0	0	344,210
SSS	408	2,308	0	0	26,368	2,845	14,322	0	0	182,643
CSMBS	780	6,603	0	0	214,890	4,827	26,424	0	0	509,243
	2010					**2010**				
UC	627	4,525	0	0	142,734	3,977	20,343	0	0	502,279
SSS	830	9,113	0	0	141,561	3,220	23,214	0	0	346,983
CSMBS	782	6,379	0	0	192,736	5,200	28,462	0	0	674,176
	2011					**2011**				
UC	1,065	5,627	0	0	97,628	5,946	26,408	0	0	447,208
SSS	905	3,859	0	0	32,709	6,383	27,175	0	0	289,436
CSMBS	1,387	11,837	0	0	400,186	6,835	33,517	0	0	730,631

BIOGRAPHY

NAME	Mrs. Roongkarn Pannarunothai
DATE OF BIRTH	March 11, 1968
PLACE OF BIRTH	Phitsanulok, Thailand
INSTITUTIONS ATTENDED	Chiang Mai University**,** 1984-1988: Bachelor of Pharmacy Naresuan University, 2000: Doctor of Pharmacy Program in Pharmaceutical Care Mahidol University, 2012: Master of Science in Pharmacy (Pharmacy Administration)
SCHOLARSHIP	The 60th Year Supreme Reign of his Majesty King Bhumibol Adulyadej Scholarship, granted by the Faculty of Graduate Studies Academic Year 2010, Mahidol University
POSITION & OFFICE	Buddhachinaraj Hospital, 90 Srithamtripidok Road, Nai Mueang, Phitsanulok, Thailand 65000 Position: Pharmacist Tel. 0-5527-0300 Email: roongkarnp@yahoo.com
HOME ADDRESS	47/3 Moo 5 Tumbon Plychumpon Ampher Muang Phitsanulok, Thailand 65000