all healthcare provider services during a 5-year period in a non-experimental environment. An econometric model was built to assess the effect of asthma profile and other factors on the cumulative costs. METHODS: Using the discharge registry of the Pulmonary Clinic of Helsinki University Hospital all patients who had visited the clinic during the 2000–2004 for diagnosis or for exacerbations of asthma were recruited. The comprehensive 5-year medical records of consented patients were processed for electronic assessment. All contacts with different health care providers were identified with text-mining methods and categorized according to the cost-determinant factors (location of the provider, personnel involved, type of event, urgency). Asthma-related contacts were identified and disease severity was graded according to different asthma medications. An econometric model of the health care cost function was specified with annual asthma care costs as the dependent variable and age, gender, smoking, co-morbidities and different types of asthma medication included as confounding variables. RESULTS: The annual costs for care of chronic asthma without medication were €270. Users of long-acting beta-agonists had non-medication costs of €75/yr and those with systemic corticosteroids of €700/yr more than those of the mild type. Smokers had €150 of yearly costs more than non-smokers. As the patient age increases, we see an additional cost of €5 per year. Gender, co-morbidities (diabetes, hypertension, coronary disease) and obesity did not increase significantly the annual expenses. Altogether, increased costs in severe asthma were mostly due to ER visits and hospitalizations. CONCLUSIONS: Our approach gives a unique in-depth analysis of the clinical course of chronic asthma, identifies different patterns of healthcare resource utilization and allows comparisons between various therapeutic approaches.

RELATIONSHIP OF PATIENT CHARACTERISTICS AND RESOURCE USE IN SEVERE ASTHMA
White AF1, Parasuraman S2
1University of Florida, Gainesville, FL, USA, 2Wyeth Pharmaceuticals, Collegeville, PA, USA
OBJECTIVES: Although severe asthma affects only 5% of all asthmatics, it is estimated to consume 80% of resources. The objective of this review was to summarize current literature to explore the relationship of patient characteristics and resource use in severe asthma. METHODS: A comprehensive literature search of the National Guidelines Clearinghouse and Medline from 1966 to July 2005 was conducted to identify relevant studies. Database-specific key words were used to identify studies in severe asthma and limited to Human and English. Additional key words were used to narrow the search (e.g. “economics”) to identify studies reporting resource use. Studies reporting at least one patient characteristic of age, race, gender and one resource use (e.g. hospitalization) were identified and analyzed using descriptive analysis. RESULTS: The search returned a total of 156 abstracts and/or full text articles and of those, 92 were subjected to further review and analysis. Twenty-eight of these studies were randomized controlled trials. Seventeen studies reported resource use in terms of a monetary value, which ranged from $1000 to $17,000 per patient per year. The most commonly reported resource category was physician visits followed by emergency room visits. Older patients required more asthma related medications than younger patients. Hospitalization rates were higher for minorities with severe asthma than for non-minorities. CONCLUSIONS: Few studies have investigated the relationship of patient characteristics and resource use in severe asthma. In general, there are patient characteristics that can predict resource use (i.e. lung function, age, gender, race). Compliance was not measured in the reviewed studies, which could impact resource use. Studies in severe asthma are warranted, which address compliance and economics. This review reports the current state on diagnosis, treatment and allocation of health care resources in severe asthma. Interventions that could improve compliance could positively impact asthma management.

ASTHMA—Health Care Use & Policy

COMPUTERIZED DECISION SUPPORT FOR ASTHMA MANAGEMENT
Duvvuri VRSK, Finkelstein J
University of Maryland School of Medicine, Baltimore, MD, USA
OBJECTIVES: To develop prediction rules to forecast asthma exacerbations using information collected by home tele-monitoring systems. METHODS: Development of predictive models was based on the data collected by a home telemedicine system from asthma patients. The data collected by the system included respiratory symptoms, peak expiratory flow (PEF), drug utilization and asthma severity. All patients used a 4-zone asthma action plan in which zones 1 (green) and 2 (high yellow) corresponded to low levels of severity, and zones 3 (low yellow) and
4 (red) corresponded to high level of severity. For our analysis we combined zones 1 and 2 into a “low severity” class whereas zones 3 and 4 were combined into a “high severity” class. Our goal was to build predictive rules which allow forecasting of the severity class one day ahead of time using methods of artificial intelligence. We used dependent variables from a day N to predict the severity class on the day N + 1. Overall, 7001 records collected from 26 asthma patients were used in this analysis. Classification and Regression Trees (CART) algorithm was employed to develop three predictive models. Model I utilized all predictive variables, model II employed only 3 variables identified by CART as the most powerful predictors, and model III used only asthma symptom variables. RESULTS: The CART algorithm prioritized three predictor variables (normalized number of puffs of quick relief inhaler, normalized PEF, and asthma symptom score) based on their level of influence on the “asthma severity class” variable. The resulting forecast rules yielded good overall prediction success rates from both the learning (87.2%; 98.6%; 96.2%) and testing (86%; 96.5%; 95.2%) samples of models I, II, III respectively. Moreover, it generated 63 decision rules accurately characterizing both “low” and “high” severity classes. CONCLUSIONS: CART algorithms showed acceptable accuracy in forecasting asthma exacerbations.

**ASTHMA—Methods and Concepts**

**PAS9**

THE PERFORMANCE OF BOOTSTRAPPING IN DISCRETE CHOICE MODELS

Baser O

Thomson-Medstat, Ann Arbor, MI, USA

OBJECTIVE: Discrete choice models are widely used in pharmaeconomics. If correctly applied, bootstrapping is a useful tool for these models because small sample distributions of the dependent variables are not known. In this paper, we will show how to apply bootstrapping to have consistent and efficient estimators under discrete choice models. METHOD: Four common bootstrapping techniques were analyzed: paired, non-parametric, parametric, and wild bootstrapping. The extension of parametric bootstrapping for linear regression to parametric discrete choice models is presented: Let $U$ be the probability that the binary dependent variable $y = 1$. Then for each application we choose $y^*$, which is the new independent variable for each bootstrap, from Bernoulli distribution with probability of success given by $U$. RESULTS: The Market Scan® private insurance database was used in this study. The analytic sample comprised 36,341 individuals with asthma whose healthcare was provided under a variety of fee-for-service (FFS), fully capitated, and partially capitated health plans. We estimated hospitalization for FFS and non-FFS asthma patients. Logit models were selected depending on the distribution of the dependent variable. The Pearson chi-square goodness of fit test ($p = 0.3742$) and the Hosmer and Lemeshow test ($p = 0.2904$) suggested that the model fit well. Treatment patterns had no significant effect on hospitalization after controlling for demographic and clinical factors. The illness severity of the patient (proxied by the number of three-digit ICD-9 codes), however, had a positive and significant effect on hospitalization. We would not have seen this significant effect if we had chosen paired, non-parametric, or wild bootstrapping as a way to bootstrap standard errors. CONCLUSION: Despite the obvious benefit of bootstrapping in discrete choice models, the method should not be used blindly. Once the model is estimated under parametric assumptions, as in logit or probit models, deviations of the assumptions for bootstrapping will yield inefficient estimators.

**PAS8**

IMPROVING ASTHMA SELF-MANAGEMENT AND PATIENT OUTCOMES USING AN AUTOMATED PROGRAM

Arnold RIG1, Kravet M2, Altieri L2, Rosen J3, St. John J1, Zhou Y1

1Pharmacon International, Inc, New York, NY, USA, 2ProHealth Physicians, Inc, Farmington, CT, USA, 3ProHealth Physicians, Inc, Bristol, CT, USA

OBJECTIVE: The high prevalence of asthma has emerged as a major public health issue. It has been shown that patient education on self-management is an essential and effective component of chronic illness management. The objective of the current study was to report on outcomes associated with implementation of an automated patient self-management system, ALERTS®, in a primary care group practice—ProHealth Physicians (PHP).

METHODS: A pre/post design was employed. Patients were identified using PHP’s billing database. ALERTS® was accessed via the Internet or via a toll-free number. Patients were given real-time feedback regarding their symptom zone and actions to take based on their Asthma Action Plan. ALERTS® made reports on patients’ peak flow meter (PFM) readings available to patients and their providers. Outcomes assessed included unscheduled outpatient visits, emergency room (ER) visits, days lost from work/school, medication prescriptions, and number of outpatient procedures. Comparisons of pre/post intervention outcomes were calculated using the paired t-test, McNemar’s test for dichotomous data and Chi-Square as a comparison of proportions.

RESULTS: Seventy-four participants were enrolled. Patients demonstrated reductions in the number of unscheduled office visits (p = 0.033) when comparing these prior to and after ALERTS® use. Additionally, 55.9% (33/59) of participants saw an increase in their personal best PFM measurement (p < 0.001); 100% (6/6) of participants under the age of 18 saw an increase in this parameter (p = 0.027). Furthermore, participants answering the question reported missing less school/work due to their asthma (p = 0.026). There was also a trend towards reduction in limited physical activity, ER visits and prednisone use. CONCLUSION: ALERTS® was successfully implemented in a multisite group practice, proving to be a useful program for improving care of chronic asthmatic patients.

**PAS10**

A SYSTEMATIC OVERVIEW OF THE MEASUREMENT PROPERTIES OF THE ST. GEORGE’S RESPIRATORY QUESTIONNAIRE IN ASTHMA

Wang SM1, Gwadry-Sridhar F2

1University of Southern California, Los Angeles, CA, USA, 2University of Western Ontario, and London Health Sciences Centre, London, ON, Canada

OBJECTIVES: The St. George’s Respiratory Questionnaire (SGRQ) is a disease-specific instrument used to measure health-related quality of life (HRQoL) in patients with asthma. It is a 76-item questionnaire comprised of three domains: symptoms, activities, and impact. We conducted a systematic review to determine the psychometric measurement properties.

METHODS: We used the search terms “St. George’s Respiratory Questionnaire” and “St. George’s Respiratory Questionnaire and asthma”. All published papers and abstracts were reviewed and assessed using MEDLINE 1966–2005, April Week 2 and OVID full-text via the University of Southern California library database and Google Scholar. Citations for all abstracts and articles citing the first validation study were identified using the Science Citation Index. Inclusion criteria included clinical trials and observational studies reporting measurement properties in a