

pled with the aging of the population, analysts predict that COPD will account for an increased proportion of deaths in the near future [2]. With respect to morbidity, COPD impairs both functional status and quality of life [1]. Economically, the costs of COPD associated with medical care and lost productivity are staggering, exceeding \$37 billion annually in the United States [3].

Anemia is commonly present among individuals with chronic illnesses. In a broad range of medical conditions, concomitant anemia is increasingly being recognized as a risk factor associated with increased mortality [4,5]. There is also growing evidence of increased health care utilization and costs associated with anemia in disease states such as chronic kidney disease, HIV, rheumatoid arthritis, inflammatory bowel disease, congestive heart failure, and cancer [6-8]. However, less is known regarding the impact of anemia on mortality, morbidity, and costs of care for patients with COPD. Cote and colleagues observed that anemia was associated not only with increased mortality but also with worsened dyspnea scores and functional capacity as measured by the 6-minute walking distance in a COPD cohort [9,10]. The effect of anemia was independent of age, forced expiratory volume in one second, and functional status. Similarly, a review of a French national database indicated that subjects with severe oxygen-dependent COPD and anemia experienced an increased risk of hospitalization and short-term mortality compared to those without anemia [11].

Despite the growing awareness of an association between worse clinical and functional outcomes and anemia in COPD patients, the financial implications of anemia in COPD have not been examined previously. To determine what incremental costs, if any, were associated with anemia in COPD patients, and to confirm the association of anemia with clinical and functional outcomes in a larger population, data from Medicare beneficiaries in the United States were analyzed.

Methods

Overview and database description

Medicare claims data for persons with COPD were analyzed; costs and outcomes for patients with anemia were compared to those of patients without anemia. The data source was the Medicare 5% beneficiary encrypted files (BEF) from a recent five-year period (1997–2001), available from the Centers for Medicare and Medicaid Services (CMS). The BEF represents a systematic 5% sample of all Medicare enrollees, which corresponds to essentially all U.S. residents age 65 and older as well as select groups younger than age 65 (e.g., patients with end-stage renal disease or certain disabilities). This analysis included all categories of the BEF data: Durable Medical Equipment (DME), Inpatient Facility, Hospice, Outpatient Facility,

Home Health Agency (HHA), Skilled Nursing Facility (SNF, nursing home), and Physician/Supplier (Part B) claims.

Subjects and definitions

To be included in the cohort, beneficiaries had to have at least two claims with diagnoses (primary or secondary) of COPD from either Part B (physician/supplier) or outpatient files. Persons under 65 years of age were excluded in order to limit the impact of age as a source of heterogeneity in the study population. Those persons who were not residents of either one of the 50 states or the District of Columbia were also excluded. In addition, those with known nutritional or hereditary anemias or with other disease states that are commonly associated with anemia (end stage renal disease, cancer, and gastrointestinal bleeding) were eliminated. COPD patients with co-morbid anemia were identified in two ways: claims with ICD-9 codes specific for anemia, or receipt of blood transfusions not associated with other apparent causes (e.g., acute blood loss from surgery, trauma, etc.). The appendix lists the specific ICD-9 codes used to identify and define the study cohort.

To control for variation in the utilization of medical care services over time and the inherent inter-patient variability in the need for healthcare encounters, an "index date" was determined for each patient. For those with COPD but without anemia, the date of the first medical claim with a COPD diagnosis at least six months after entering the database (at the time of either Medicare enrollment or the start of the data set's availability) served as the index date. For their anemic counterparts, the index date was the first medical claim with a COPD diagnosis that was both six months after that patient entered the data set and after or concurrent with the claim for anemia. Only patients with at least six months of Medicare enrollment prior to their index date and at least 12 months of enrollment following their index date were included in the analysis. Details regarding selection of case and control patients are illustrated in Figure 1.

Outcome measures

Costs to the Medicare system for all medical care served as the primary endpoint. To determine the attributable effect of anemia, costs among persons with anemia and COPD were compared to costs among non-anemic COPD patients. Costs of care were stratified by the type of service involved (e.g., durable medical equipment, inpatient facility, hospice, etc.). Costs based on claims (submitted charges) and actual payments (reimbursements) were analyzed separately. All costs were inflated to 2004 U.S. dollars by using the medical care component of the Consumer Price Index.