

# EFFECTIVENESS OF DISEASE MANAGEMENT CARE IN THE CASE OF HEART FAILURE

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## ABSTRACT

**Objective:** The main objective of this study was to evaluate the cost effectiveness of the managed care in the case of heart failure. Also, the proportion of patients with a hospital free year was compared using managed care and non-managed care the non-managed care.

**Method:** A meta-analysis was used to estimate the effectiveness (hospital free years). Cost effectiveness was analyzed in two perspectives: the program's and the payer's. In the program's perspective, the literature was used to estimate the cost. In the payer's perspective, Thomson Reuter's MarketScan data were used to estimate the cost.

**Results:** It was found that, in the program's perspective, a hospital free year's cost was \$8,872.60 while in the payer's perspective by using managed care; it saved an average of \$53,109.22. The proportion of individuals with a hospital free year in managed care and in the usual care were not found to be statistically significant.

**Conclusion:** Even though managed care did not have a different hospitalization usage than standard care, it was found to be cost-effective for the payer.

## INTRODUCTION

Heart failure is a disease highly prevalent in United States especially among individuals 65 years and older. This condition is characterized by frequent ED (Emergency department) visits and hospitalizations, which results in high financial expenditure.

In an effort to address this issue and help improve the patient's health, management strategies have been tested and implemented. Their effectiveness and efficiency have been widely discussed in the medical literature, but the conclusions are controversial and contrast with one another [1-5]. In the current study, an economic health evaluation study was undertaken using data from a literature review and Thomson Reuter's MarketScan data [6]. The Thomson Reuter's MarketScan Database contains person-level information on hospitalization usage, charges and enrollment. The annual datasets include data from about 100 payers and comprises inpatient, outpatient, prescription drug, and curve-out services from about 45 large employers, health plans, government and public organizations. The collective MarketScan Databases refers to five individual databases: Commercial Claims and Encounters Database, Medicare Supplemental and COB Database, Health and Productivity Management Database, Benefit Design Database and Medicaid Database [6]. For this analysis, we used the Commercial Claims and Encounters Database.

First, cost effectiveness analysis was performed on the data extracted from the literature using traditional meta-analysis. The model of this analysis was then applied to the in-hospital data of Heart Failure patients from the MarketScan database. The percentage of people who gained a hospital free year by being in the managed care group was used to compute the number of patients who did not have hospitalization in the Market Scan data.

The cost effectiveness analysis from the literature used the program's perspective and effectiveness was compared between the managed care group and the usual (non-managed) care group. The cost effectiveness analysis from the inpatient MarketScan data used a payer's perspective and actual data were compared to hypothetical managed care data.

It is very important to evaluate the disease management in a way that considers both the medical benefits for the patients and the financial spending of the payer. The literature offers reports of various clinical trials [1-5] that implemented the Nurse Management program and studied its medical benefits. In a Nurse Management strategy, a patient is assigned a nurse. This nurse usually helps the patient adhere to more disease-related appropriate lifestyle and comply with treatment. This help is delivered through educational sessions or through daily monitoring. The contact between a nurse and a patient can be direct in which case a nurse and a patient meet or indirect with the use of a phone. They constitute a solid model that can be applied to various Heart Failure populations. The MarketScan data offers complete hospitalization usage with associated costs. The cost effectiveness analysis of these data provides the impact of disease management on the payer.

The main objective of this analysis was to evaluate the cost effectiveness analysis of a disease management in the perspective of the program and of the payer. Also, the hospitalization usage of nurse management and the usual care were compared for statistical significance. It was expected that disease management would be found to be better in terms of preventing hospitalizations but not necessarily in cost.

## METHODS

Data used were from a literature review and also from the MarketScan data.

### Search strategy, selection criteria and data extraction

The MEDLINE database was searched with the use of the open-source software XplorMed. XplorMed is a web tool that summarizes results from a MEDLINE search [7, 8]. Of interest were studies that focused on heart failure and managed care published in English between 2000 and 2010. The searching keywords were patient, heart, failure, management. XplorMed returned a total of 378 abstracts. Using the papers to only those in which the relationship between words has a value of alpha 0.75 and a score of 0.05, 63 abstracts were returned and reviewed. Alpha and score are parameters used by XplorMed to compute the link of words. The full articles of the 63 abstracts were retrieved.

The effectiveness for the current study was measured as the number of people with a hospital free year gained. Eligible for the data abstraction were articles that reported the number of individuals hospitalized at least once. Other selection criteria included study design, study population, sample size and main outcome of interest. Excluded were studies that were not clinical trials, had a follow-up shorter than 12 months or longer than 12 months and did not record the 12 months results not conducted in the period of 1999-2001. Finally, two articles were considered to have relevance and deemed pertinent for the current analysis.

For these studies, the following data were extracted the total sample size and the size of each arm, the number of nurses involved in the trial, the total number of hospitalizations and the number of individuals hospitalized in each arm. These data were used to estimate effectiveness in the cost effectiveness analysis. Table 1 provides details on these articles and on the data extracted.

**Table1: Studies used in the Cost Effectiveness Analysis**

Study	Local and length	Type	Main outcome
Sisk et al [3]	New York, USA Sept. 2000-Sept. 2002	Clinical trial with 2 arms: nurse management intervention group vs. usual care	Hospitalizations, self-reported functioning
DeBusk et al [5]	California, USA May 1998- Oct. 2000	Clinical trial with 2 arms: telephone-mediated nurse management vs. usual care	Time to 1 <sup>st</sup> hospitalization, time to a combined endpoint (1 <sup>st</sup> hospitalization, 1 <sup>st</sup> Emergency Department visit or death)

### MarketScan data and preprocessing

The MarketScan data are person level data from 45 large employers, health plans and government and public organizations [6]. In the current study, the commercial claims and encounters databases records of 2000 were used. Heart failure patients were extracted using the following ICD 9 diagnoses codes:

- 428.0: Congestive Heart Failure, unspecified
- 428.1: Left Heart Failure
- 428.20: Systolic Heart Failure, unspecified
- 428.21: Systolic Heart Failure, acute
- 428.22: Systolic Heart Failure, chronic
- 428.23: Systolic Heart Failure, acute on chronic
- 428.30: Diastolic Heart Failure, unspecified
- 428.31: Diastolic Heart Failure, acute
- 428.32: Diastolic Heart Failure, chronic
- 428.33: Diastolic Heart Failure, acute on chronic
- 428.40: Systolic and Diastolic Heart Failure, unspecified

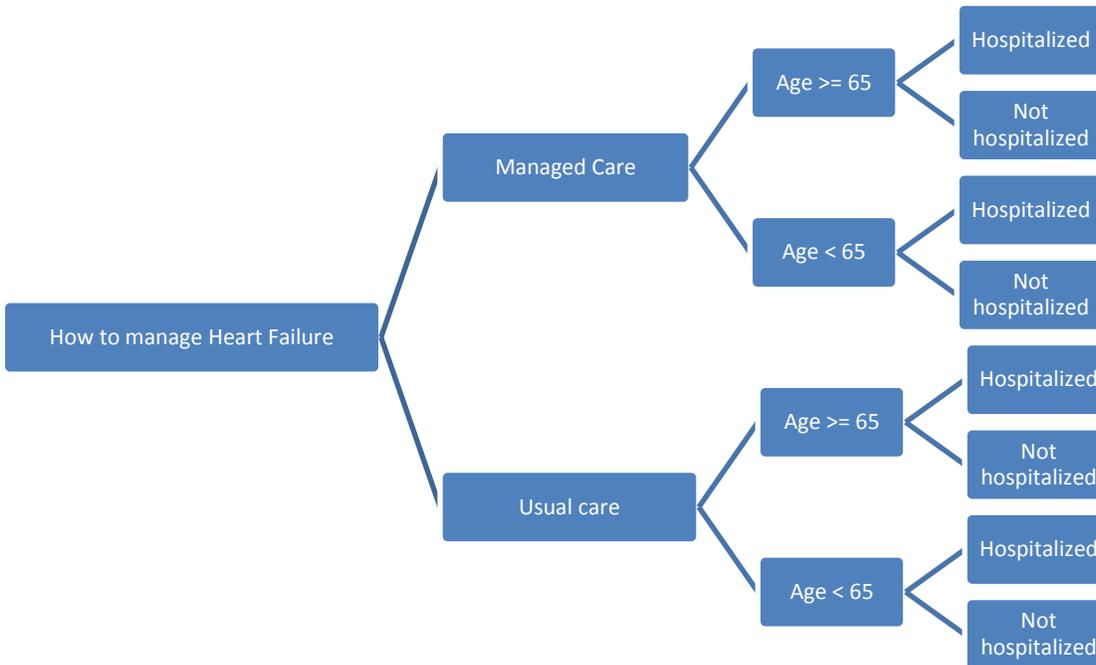
- 428.41: Systolic and Diastolic Heart Failure, acute
- 428.42: Systolic and Diastolic Heart Failure, chronic
- 428.43: Systolic and Diastolic Heart Failure, acute on chronic
- 428.9: Heart Failure, unspecified
- 398.91: Rheumatic Heart Failure (congestive).

For each patient, the number of hospitalizations, the average length of stay and the total charges were computed.

**Cost effectiveness analysis**

Cost effectiveness analysis is a health economic evaluation technique which compares the outcomes of decision options in terms of their monetary value [9-11]. The following decision tree was used to evaluate the alternatives.

**Figure 1: Decision tree**



In the current analysis, cost effectiveness was performed in the perspective of the program and of the payer. The effectiveness was the number of hospital free years gained which was expressed as the number of people who were not hospitalized in 12 months. Data obtained from pooled calculations were used to complete the decision tree. Only direct costs were considered.

In the program's perspective, the costs involved were those associated with the implementation of the program. Since the studies used [3, 5] for this analysis did not report any data on the possible training of the nurses, the costs of the phone calls to patients and/or traveling, only the nurses' salaries were used to estimate the cost of the program.

In the payer's perspective, the cost estimates included the cost of hiring nurses and the savings gained from a hospital free year.

**Statistical analysis**

Statistical analyses were performed in SAS 9.2 [12, 13]. The SAS codes used are the following:

**Code 1: Codes used**

```

/*Create the needed libraries*/
LIBNAME DATA "G:\DATA MINING\COST EFFECTIVENESS\DATA";
LIBNAME INPAT "G:\MEDSTAT\INPAT";
LIBNAME OUTPAT "G:\MEDSTAT\OUTPAT";
  
```

```

LIBNAME MED "G:\MEDSTAT\MED";

/*Concatenate diagnoses*/
DATA INPAT;
    SET INPAT.INPATIENT2000;
    DIAGNOSES=CATX(' ', OF DX:);
RUN;

/*extract CHF patients*/
DATA CHF;
    SET INPAT;
    IF (INDEX(DIAGNOSES, ' 4280')>0)
        OR INDEX(DIAGNOSES, ' 4281')>0
        OR INDEX(DIAGNOSES, ' 42820')>0
        OR INDEX(DIAGNOSES, ' 42821')>0
        OR INDEX(DIAGNOSES, ' 42822')>0
        OR INDEX(DIAGNOSES, ' 42823')>0
        OR INDEX(DIAGNOSES, ' 42830')>0
        OR INDEX(DIAGNOSES, ' 42831')>0
        OR INDEX(DIAGNOSES, ' 42832')>0
        OR INDEX(DIAGNOSES, ' 42833')>0
        OR INDEX(DIAGNOSES, ' 42840')>0
        OR INDEX(DIAGNOSES, ' 42841')>0
        OR INDEX(DIAGNOSES, ' 42842')>0
        OR INDEX(DIAGNOSES, ' 42843')>0
        OR INDEX(DIAGNOSES, ' 4289')>0
        OR INDEX(DIAGNOSES, ' 39891')>0 )
        THEN CHF=1; ELSE CHF=0;
RUN;

DATA CHFPATIENTS;
    SET CHF;
    IF CHF=1;
RUN;

/*Reduce variables*/
DATA REDUCEDCHF;
    SET CHFPATIENTS;
    KEEP PATID TOTPAY DAYS CHF AGE SEX RACE;
RUN;

PROC SORT DATA=REDUCEDCHF;
    BY PATID;
RUN;

DATA REDUCEDCHF1;
    SET REDUCEDCHF;
    IF (AGE LT 65) THEN AGEGP=1;
        ELSE AGEGP=2;
    IF FIRST.PATID;
    BY PATID;
RUN;

/*average charges, length of stay, #re-hospitalizations per patient*/
PROC UNIVARIATE DATA=REDUCEDCHF1 NOPRINT;
    VAR DAYS;
    OUTPUT OUT=LOS
        N=TIMES /*number of re-hospitalizations*/
        MEAN=AVLOS
        SUM=SUMLOS;
    BY PATID;
RUN;

/*totpay*/
PROC UNIVARIATE DATA=REDUCEDCHF1 NOPRINT;
    VAR TOTPAY;
    OUTPUT OUT=TOTPAY

```

```

        MEAN=AVTOTPAY
        SUM=SUMTOTPAY;
    BY PATID;
RUN;

/*study sample*/
DATA REDUCEDCHF2;
    SET REDUCEDCHF1;
    KEEP PATID AGE SEX AGE GP;
    WHERE CHF=1;
RUN;

DATA DATA.STUDYSAMPLE;
    MERGE REDUCEDCHF2 LOS TOTPAY;
    BY PATID;
RUN;

PROC SORT DATA=DATA.STUDYSAMPLE;
    BY PATID;
RUN;

/*summary statistics*/
PROC FREQ DATA=DATA.STUDYSAMPLE;
    TABLES AGE GP SEX;
RUN;

PROC MEANS DATA=DATA.STUDYSAMPLE;
    VAR AGE AVLOS SUMLOS AVTOTPAY SUMTOTPAY PRESCR
        TIMES AVDRUGCOST SUMDRUGCOST TOTALCOST;
RUN;

/*kernel density estimation*/
ODS GRAPHICS ON;
PROC KDE DATA=DATA.STUDYSAMPLE;
    UNIVAR TIMES/OUT=DATA.TIMES GRIDL=0 GRIDU=4;
    UNIVAR AVLOS/OUT=DATA.AVLOS GRIDL=0 GRIDU=80;
    UNIVAR AVTOTPAY/OUT=DATA.AVTOTPAY GRIDL=0 GRIDU=360000;
    UNIVAR AGE/OUT=DATA.AGE GRIDL=0 GRIDU=80;
    WHERE CHF=1;
RUN;
ODS GRAPHICS OFF;

/*total cost*/
PROC UNIVARIATE DATA=DATA.STUDYSAMPLE;
    VAR SUMTOTPAY;
RUN;

```

## RESULTS

The current study analyzed the cost effectiveness of disease nurse management in the case of heart failure using data from the literature review and the Thomson Reuter's MarketScan database.

### Meta-analysis

The two eligible studies were classified with respect to the age of the participants. Sisk et al's study [3] was considered to have more patients with age less than 65 because the mean age was 59.4 (standard deviation 13.7) while DeBusk et al's study [5] was considered to contain older individuals since only 15% were less than 60 years old. Table 2 contains data extracted from these studies.

**Table 2: Data extracted from studies used**

Study (size)	Arm* (size)	# of nurses	# of hospitalizations	# of patients hospitalized at least once	Period considered
Sisk et al (406)	MC (203)	3	143	62	Cumulative over 12 months
	UC (203)	NA	180	74	
DeBusk et al (462)	MC (228)	2	237	116	12 months
	UC (234)	NA	232	117	

\*MC: Managed Care, \*UC: Usual Care

Using the values in table 2, the following aggregated (pooled) probabilities were computed (table 2).

**Table 3: Pooled probabilities**

Arm (size)	Age group	Patients not hospitalized
Managed Care (431)	≥65	0.4912
	<65	0.6946
Usual Care (437)	≥65	0.4868
	<65	0.6355

The probabilities of being in a category of 65 years and older was or not were estimated by the national percentages of the US population from the 2000 census [14]. It was found that the population 65 and older constituted 12.4%.

#### Comparison of proportions of patients not hospitalized during trials

In the pooled data, about 58.70% of participants in Managed Care were not hospitalized in comparison to 41.16% in the Usual Care arm. However, this difference was not found statistically significant (p-value=0.5).

#### Cost Effectiveness analysis of the Managed Care from the program's perspective

The effectiveness was considered to be a hospital free year (12 months). It was shown that the probability of a hospital free year in the Managed Care strategy was 0.6694 while in the Usual Care strategy, it was 0.6171. Hence, for a 10,000 people, Managed Care prevented 523 people to be hospitalized.

A total of five nurses took care of 431 patients in Managed Care from the two studies [3, 5]. The salary of a nurse was estimated to be 40,000 a year. Thus, the cost of the program per patient enrolled in Managed Care was found to be  $200,000/431 = 464.0371$  per patient so, for 10,000 heart failure patients, the implementation of the program would cost \$4,640,371. The incremental cost-effectiveness of the Managed Care with respect to the Usual Care was estimated to be  $\$4,640,371/523 = \$8,872.60$  per Heart Failure hospital free year gained.

A sensitivity analysis was conducted on the percentage of individuals 65 and older to evaluate its effect on the cost effectiveness of Managed Care. The 2000 census reported the different percentages for the different regions and states in the USA. The state with the lowest percentage of elderly people was found to be Alaska with only 5.7% while Florida had up 17.6%. The incremental cost effectiveness ratios were found to be \$8,301.2 in Alaska and \$9,374.48 in Florida (table 4).

**Table 4: Sensitivity analysis**

Percentage of individuals ≥65	Individuals with a hospital free year gained by using the MC* over 10000 people	Incremental Cost Effectiveness Ratio (ICER)
12.4%	523	\$8,872.6
5.7%	559	\$8,301.2
17.6%	495	\$9,374.5

\*MC: Managed Care

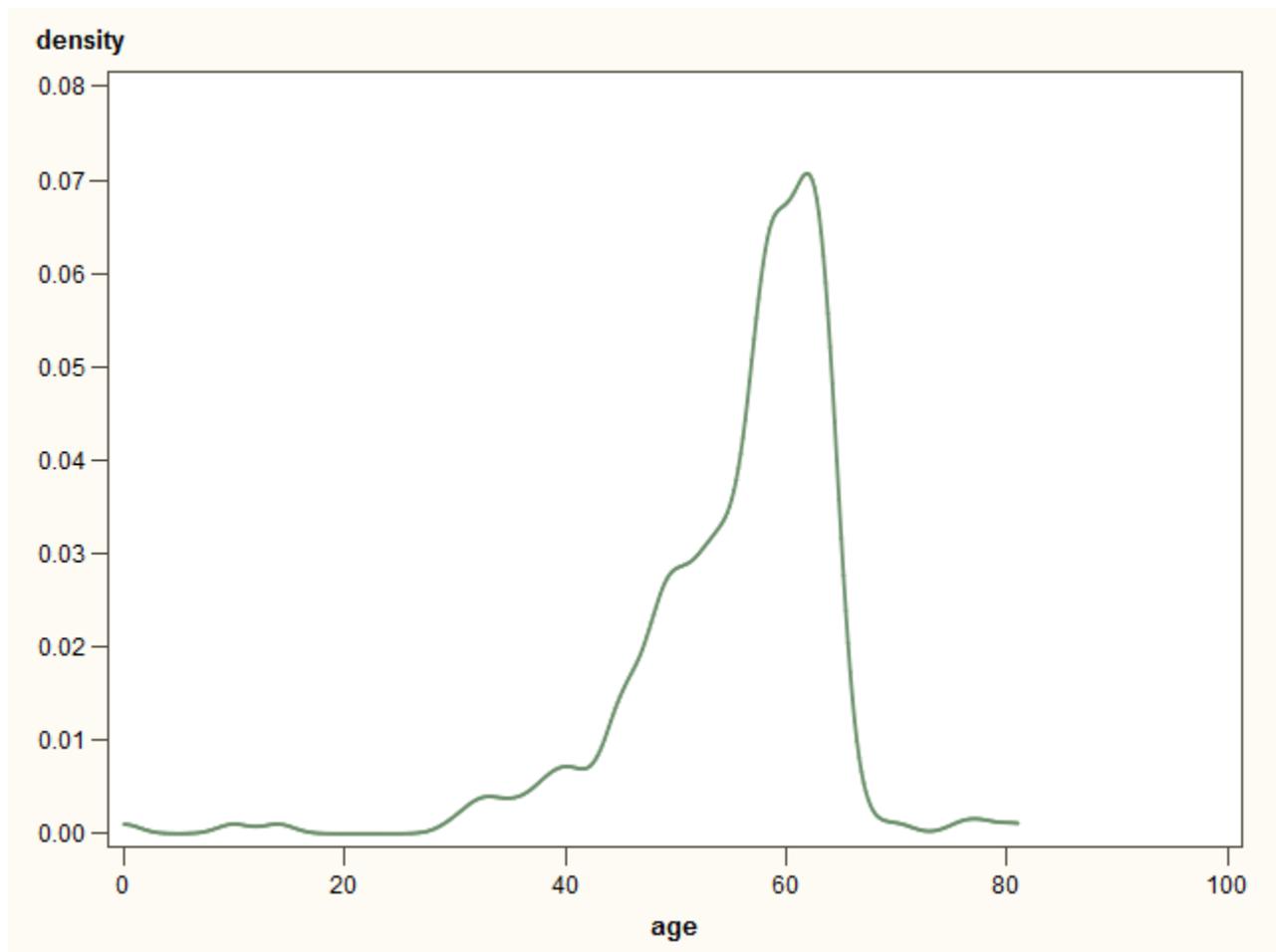
## MarketScan data

**Table 5: MarketScan data characteristics**

Variables	Values
Patients with Heart Failure	276
Demographics	
Age [mean (SD)]	56 (9)
Age $\geq 65$ [n (%)]	7 (2)
Hospitalization usage [mean (SD)]	
# of hospitalization	1 (0.2)
Average length of stay	9 (24)
Hospitalization charges [mean (SD)]	
Total charges per patient	\$60,609 (162,927)
Total charges for all patients	\$64,281 (165,031)

The preprocessing of the MarketScan data yielded a total of 276 patients with heart failure for the year 2000. The patients had an average age of 56 (standard deviation 9, table 5) and many patients were between the ages of 42 and 68 years old (figure 1). The population 65 and older constituted 2% of the population (table5) and Fifty one percent of this population was males (table 5).

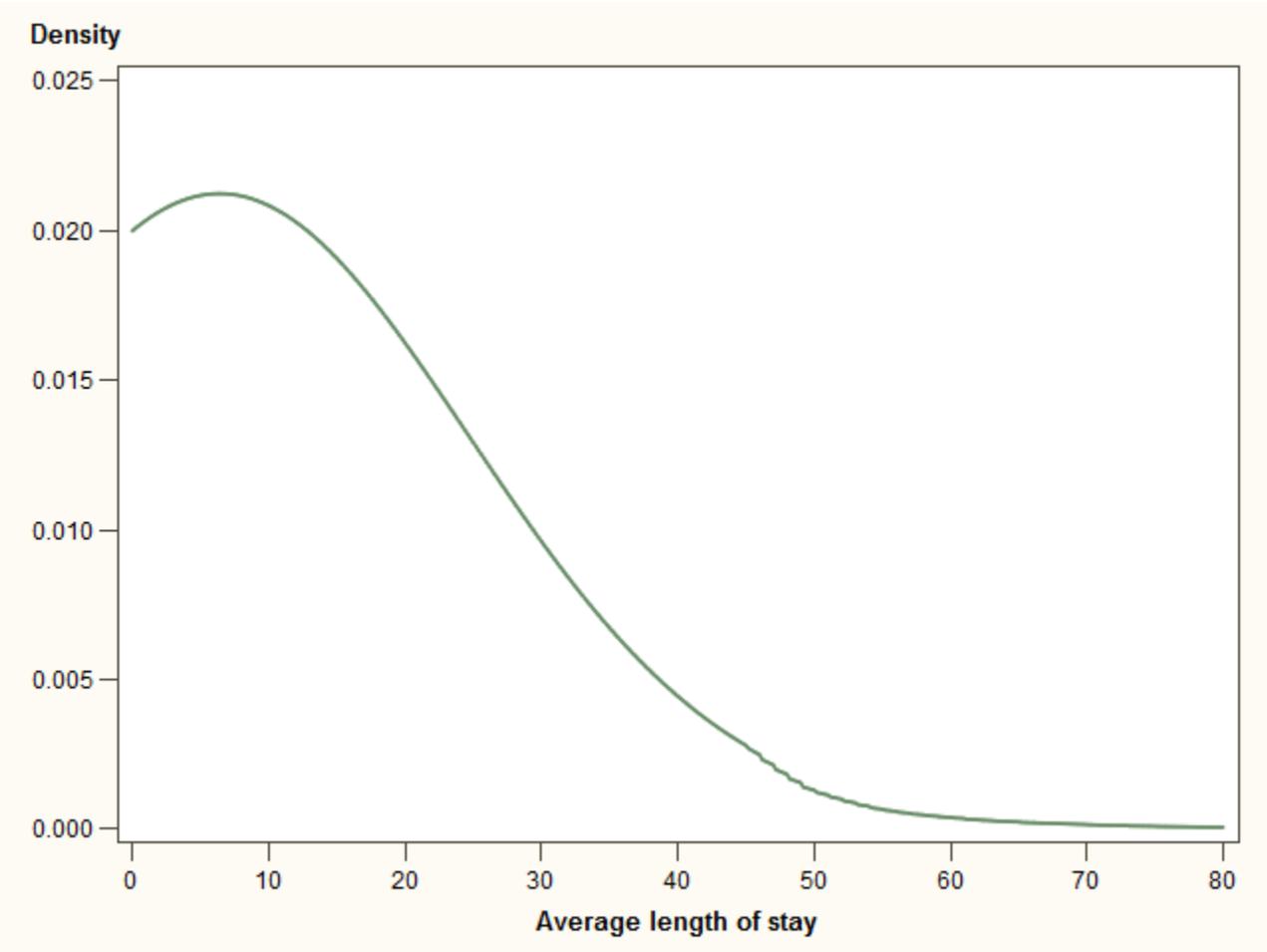
**Figure 1: Kernel density estimation for age**



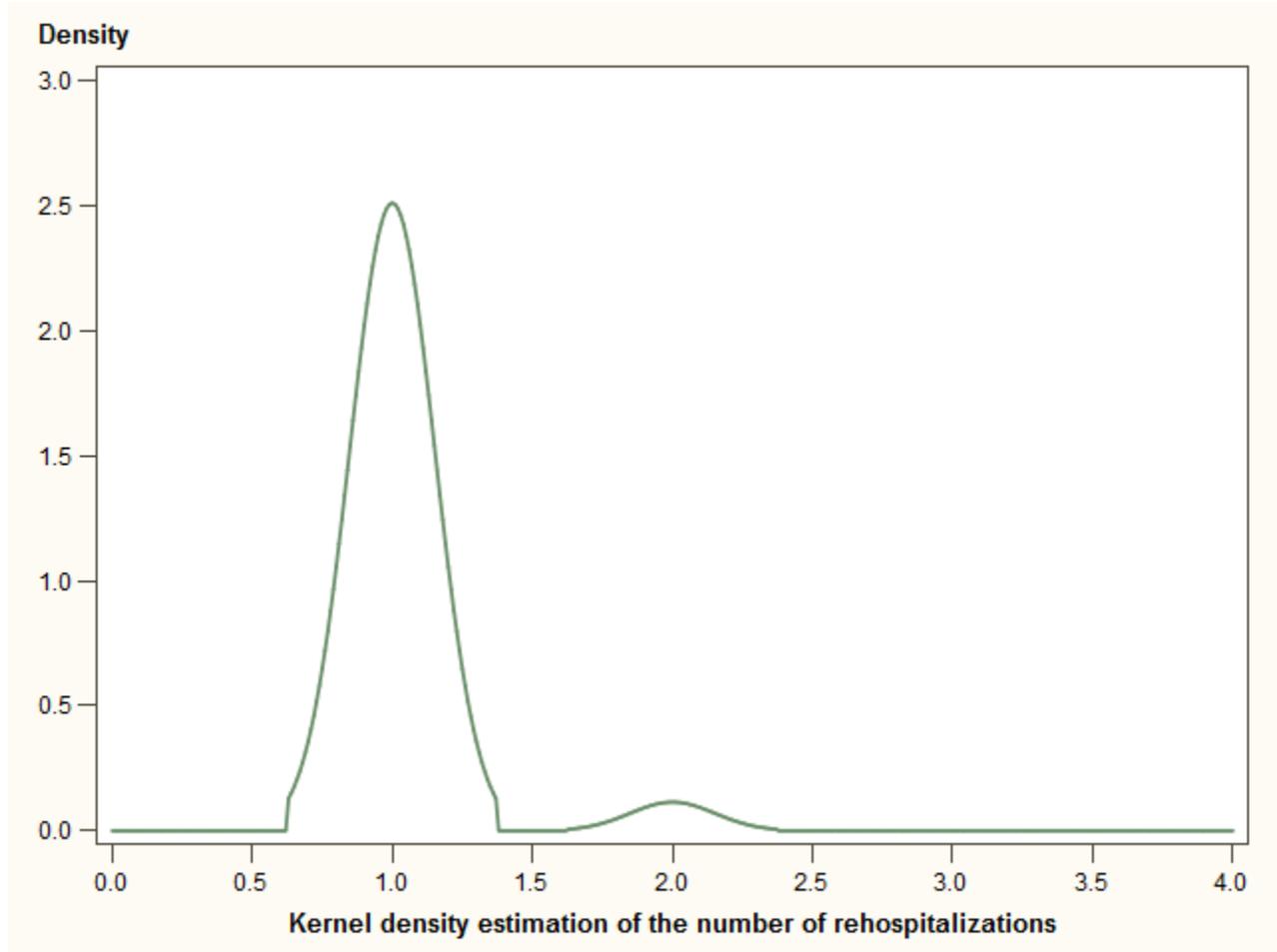
## Health outcomes

Hospital utilization variables were used as health outcomes of interest. Specifically, the length of stay and the number of hospitalizations were evaluated. The in-hospital stay had an average of 8 days (SD=24) and many patients were hospitalized for one to 30 days. On average, each patient was hospitalized once (SD=0.2) (table 5 figure 2 and figure 3).

Figure 2: Kernel Density estimation of the average in-hospital stay



**Figure3: Kernel Density estimation of the number of re-hospitalizations**



**Comparison of proportions of patients hospitalized in the actual and in the hypothetical managed care**

The actual data were taken from the inpatient files of the MarketScan data. Thus, all the 276 patients were hospitalized. The application of the managed care model to these data showed that 16 of these patients would avoid hospitalization. Hence, the idea was to compare the difference the proportion of patients not hospitalized in the managed care ( $p=0.0579$ ) to the zero (the proportion of patients not hospitalized in the actual data). The difference was found to be not statistically significant ( $p$ -value=0.488)

**Cost effectiveness analysis in the payer’s perspective**

The MarketScan data was used to evaluate the cost effectiveness of a hypothetical implementation of a managed care strategy among the 276 patients. Assuming a similar effect as in the Sisk et al and DeBusk et al’s studies, the percentage of individuals 65 and older was used to estimate the number of persons that would be avoided hospitalization with the use of a managed care.

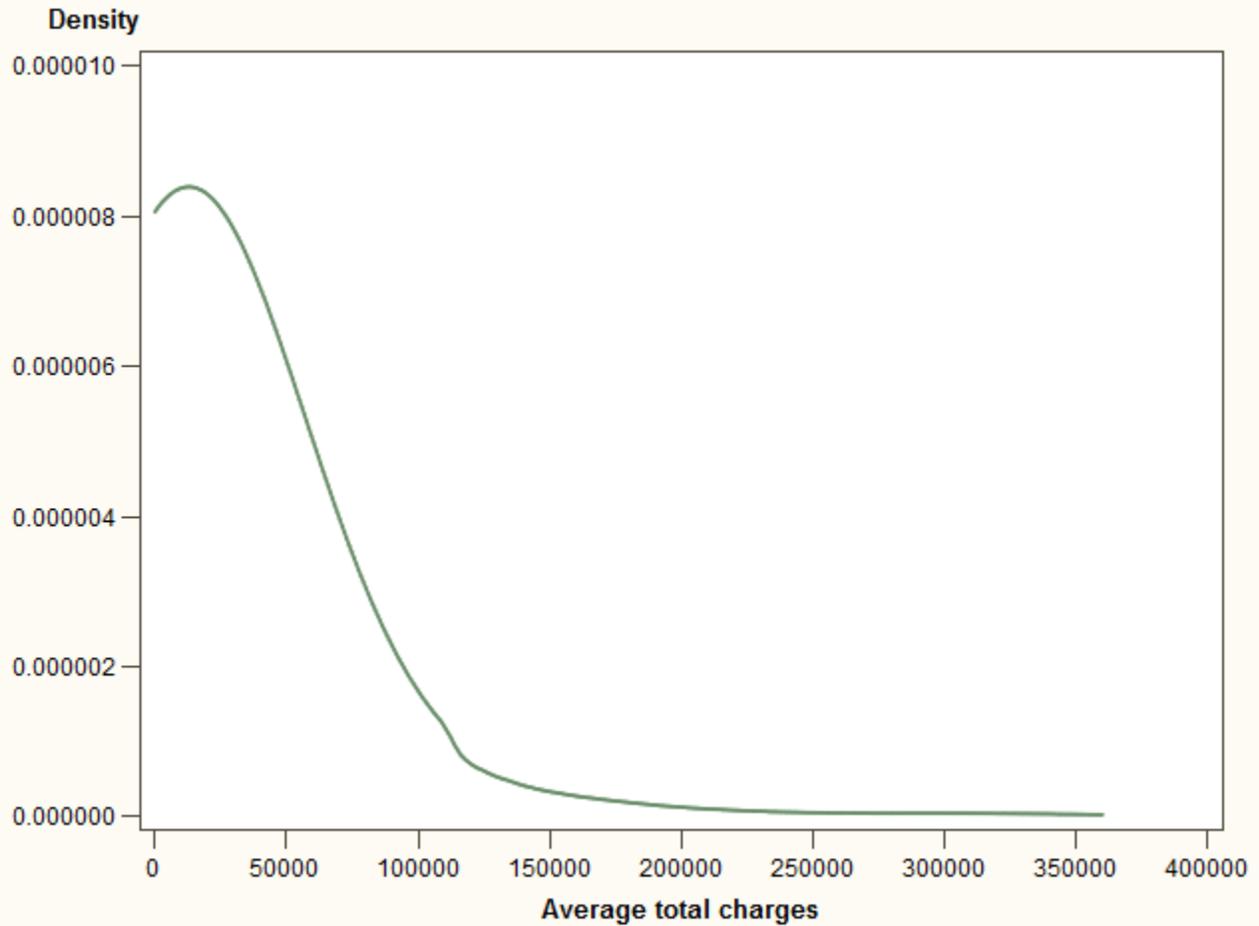
**Effectiveness**

It was found that most likely, if a nurse management method was used on these 276 patients, 5.77% (about 16) of them would not have been hospitalized at all.

**Cost**

From the MarketScan data, it was found that the hospital utilization had an average of \$60,609.22 for total charges per person (table 5) but for many patient, the average total charges per hospitalization was between \$0 and \$50,000 (figure 4) . The total charges for all the 276 patients was \$16,728,143.8 (table 5).

**Figure 4: Kernel Density Estimation of the average total charges per hospitalization per patient**



The savings associated with the 16 avoided hospitalizations are  $16 \times 60,609.22 = 969,747.52$ . Using a similar model as in Sisk et al and DeBusk et al's where five nurses managed 431 patients, it was estimated that to manage 276 persons, a minimum of three nurses would be needed. Their salary would total \$ 120,000 (assuming that a nurse makes \$40,000 a year).

For a payer, a managed care  $\$16,728,143.8 - \$969,747.52 + \$120,000 = \$15,878,396.28$  while the non-managed care (actual data)  $\$16,728,143.8$ . Thus, the incremental cost effectiveness ratio would be  $(\$15,878,396.28 - \$16,728,143.8) / 16 = -\$53,109.22$ . Implementing a nurse management would save the payer money.

**DISCUSSION**

The current study aimed to compare the nurse-management care with the usual care in terms of proportion of patients with a hospital free year. Also, the main objective was to evaluate its cost effectiveness.

From the two studies eligible for this analysis, the pooled proportions did not yield a statistically significant difference (p-value=0.5). Also, applying the nurse-management model from these studies [3, 5] to the heart failure patients from the MarketScan data did not significantly reduce the number of patients hospitalized at least once (p-value=0.488). Therefore, the results from the current study did not establish if nurse-management had better hospitalization usage outcomes than the usual care. This analysis's results are consistent with previously published articles [5, 15] in which researchers reported no statistical differences in health outcomes between managed and non-managed groups.

The cost effectiveness analysis was performed from two different perspectives. From the program's perspective, it was found that a hospital free year costs \$8,872.60 by using the nurse management method. But from the payer's perspective (such as an insurance company), this strategy saves \$53,109.22 per person with a hospital free year. The cost effectiveness analysis results of the program's perspective are in agreement with published reports [16, 17] which found that the implementation of a nurse management did not reduce cost.

## CONCLUSION

From the current study, it cannot be concluded that managed care has different hospitalization usage than the usual care. However, it was found that this strategy is cost-effective in the payer's perspective; even though, it was not in the program's perspective.

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