Delirium Superimposed on Dementia in a Community-Dwelling Managed Care Population: A 3-Year Retrospective Study of Occurrence, Costs, and Utilization

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Background. Dementia is a growing public health problem and a well-described risk factor for delirium. Yet little is known about delirium superimposed on dementia in community-dwelling populations. The purpose of this study was to examine the 3-year occurrence, healthcare utilization, and costs associated with delirium superimposed on dementia in community-dwelling persons.

Methods. We used a 3-year cross-sectional, retrospective design with an administrative database from a large managed care organization. Four individually matched samples of 699 individuals each were selected for comparison purposes: delirium superimposed on dementia (DSD), dementia alone, delirium alone, and a control group with neither delirium nor dementia. The occurrence rate of DSD was calculated by measuring those individuals with a dementia diagnosis that were also coded with an International Classification of Diseases, Ninth Edition Clinical Modification (ICD-9 CM) code for delirium or delirium with dementia.

Results. Of the total sample of 76,688 persons aged 65 years or older in the managed care organization, 7347 (10%) were coded as having dementia, and an additional 763 (1%) as having delirium alone. Among the 7347 with dementia, 976 (13%) had DSD, representing 1.3% of the total sample. After log transformation of total costs and adjustment for multiple covariates, the adjusted mean total health care costs remained significantly higher for the DSD group than for all other groups.

Conclusions. This study is the first to report the occurrence rate of DSD in a community-dwelling population, and to demonstrate the substantial health care costs and utilization associated with DSD.

D EMENTIA is a prominent and growing public health problem that impacts on patients, families, the health-care system, and society at large. By 2050, 14 million older persons in the United States are expected to have dementia (1). It is well known that persons with dementia are at increased risk of developing delirium or an acute confusional state (2). As increasing numbers of older adults are diagnosed with dementia, attention to preventable and treatable conditions such as delirium will be crucial. However, the problem of delirium superimposed on dementia (DSD) remains a neglected area of clinical investigation.

The few studies on delirium that have included persons with dementia demonstrate the high prevalence ranging from 22% to 89% (3) of DSD in both community and hospital populations, the frequent lack of recognition, and the efficacy of preventive strategies (4). Studies examining outcomes in patients with DSD have demonstrated increased rates of long-term cognitive impairment (2), increased rates of rehospitalization within 30 days (5,6), increased risk of admission to long-term care (6), and higher mortality rates (7–11). There have been a few studies examining pathophysiology of DSD and differences among dementia sub-

types (12,13). Although they provided important preliminary information, these studies were generally limited by highly selected samples (e.g., dementia registry patients), small sample sizes, and unvalidated measures of delirium.

The objectives of the present study were: (a) to describe the occurrence rate of DSD in a large community-dwelling insured population of older adults and (b) to estimate the health care resource utilization and costs associated with DSD by examining matched comparison groups comprising patients with dementia alone or delirium alone, and a control group with neither dementia nor delirium.

METHODS

Study Design and Sample

This retrospective cross-sectional study used an administrative database from a large managed care organization located in the southeastern United States to examine DSD in patients 65 years or older. We selected only those persons 65 years or older on January 1, 1998, who were enrolled for 36 consecutive months from January 1, 1998, through

December 31, 2000, giving us 76,688 unique individuals of which 7347 had dementia. Lines of service provided by the healthcare insurer included a mix of health maintenance organization (HMO) managed care, Preferred Provider Organization (PPO), and Fee For Service (FFS). Using International Classification of Diseases, Ninth Edition Clinical Modification (ICD-9-CM) codes (See Appendix), we then identified the individuals with dementia and/or delirium. Approval for this study was received from the Medical College of Georgia institutional review board for human subjects research.

Matching Procedures and Selection of Study Groups

Individuals with at least one claim during the study period with an ICD-9-CM diagnostic code consistent with dementia or delirium were selected as cases (see Appendix). An individual matching strategy was then used to form each of three comparison groups: (1) dementia alone, (2) delirium alone, and (3) a control group which was free of dementia and delirium. DSD individuals who were 65 years of age or older were individually matched (one-to-one), using a computerized algorithm, with individuals in each of the three comparison groups on sex, age (within 2 years), and Deyo-adapted Charlson comorbidity index (14,15) within 1 unit. Similar to that of the case groups, selection of the comparison group was limited to those individuals with at least one claim. Unmatched individuals were not included in the analyses. The resulting number of matched individuals in each of the four study groups was 699. Claims data were then collected for 3 years on all individuals in these comparison groups for analyses of utilization and costs of care.

Study Approach

Prevalence rates were initially calculated based on the entire population, which was aged 65 or older. Prevalence of dementia was calculated by obtaining the membership status for those persons 65 years of age or older and then calculating the number of unique individuals having an ICD-9 diagnosis code for dementia during the enrollment period. The occurrence rate of DSD was calculated by measuring the number of individuals with a dementia diagnosis who also had an ICD-9 code for delirium or delirium with dementia during the study period. Subsequently, analyses were restricted to the four matched study groups.

Study Variables

The main independent variable was group status, that is, DSD group, a dementia-only group, a delirium-only group, or a neither dementia nor delirium (control) group. Descriptive and control variables selected for this study were identified from a review of the literature on delirium, dementia, and DSD and included medical diagnoses and comorbidities, medication-related variables, and demographics (16–22). ICD-9 codes for medical diagnoses were taken from the discharge diagnosis listing (up to 10 per patient). Comorbidity was measured using the Deyo-adapted Charlson comorbidity index, designed for use with administrative databases (15). Comorbid conditions were identified using ICD-9 codes, then assigned a weighting that takes into account both the number and seriousness of different comorbid diseases (14). The Deyo-Charlson index has established reliability and validity in multiple populations (15).

Age was calculated based on birth date, as of January 1, 1998. Payor status was defined as: HMO, PPO, or FFS. HMO is a highly managed product that includes a primary care gatekeeper and minimal member co-payments. PPO is a moderately managed product where members receive an enhanced benefit and/or lower out-of-pocket costs in return for using the approved network of providers. FFS is a minimally managed product, and it generally includes deductibles. Nursing home visits were limited to short-stay skilled nursing home visits. Because our administrative database did not include socioeconomic status and race, the ZIP code of residence for each individual was used to approximate group proportions for these variables based on the Census 2000 database. Using previously published approaches (23,24), we obtained information that included: percentage of individuals living in rural communities within the ZIP code, median household income by age group within the ZIP code, and percentage of white, black, and Hispanic individuals within the ZIP code.

Health Care Utilization and Costs

Health care costs, for the purposes of this study, were based on the managed care organization claims data for payments in U.S. dollars made directly to the provider. Medical claims data for services performed in every setting were used. There were three different types of medical services from an insurance and/or payment standpoint (i.e., facility billed on UB-92 form, professional billed on HCFA 1500 form, or pharmacy). Places of treatment included inpatient, outpatient (including outpatient surgeries, radiology, outpatient clinics affiliated with hospitals, emergency rooms, homecare, and physician office visits). Costs included total, facility, provider, and prescription components. Individuals were community-dwelling at baseline; any nursing home visits were short-stay skilled nursing home visits. None of the patients were in the nursing home at baseline. Utilization included prescriptions in both inpatient and outpatient settings. Filled prescriptions are total numbers that included refills. Unique prescriptions do not include refills. All numbers presented are for the entire 3-year period.

Statistical Analyses

Chi-square tests, or Fisher's Exact tests as appropriate, were used to examine differences in rates of demographics, medical conditions, costs, and utilization among the four comparison groups. To examine differences among the four groups for costs and utilization, analysis of covariance (ANCOVA) was used with the four-level categorical variable: DSD, dementia only, delirium only, and control. To normalize the skewed cost data, a log transformation of the costs was used as the dependent variable in all ANCOVA models. Potential covariates in cost and utilization models included number of unique prescriptions filled, payor type, and community demographic data including proportion rural, median household income according to the age of the individual, proportion white, proportion black, and proportion Hispanic. All ANCOVA models incorporated the matched nature of the data by using a matched identifier

Table 1. Characteristics of Individuals in Four Matched Study Groups

Characteristic	DSD (N = 699)	Dementia Only (N = 699)	Delirium Only (N = 699)	Control (N = 699)	p Value
Female sex, %	60	60	60	60	1.000
Age, mean (SD)	76.0 (5.1)	74.3 (4.9)	76.0 (6.0)	74.4 (5.0)	<.0017
Charlson comorbidity index mean (SD)	3.2 (2.3)	3.0 (2.3)	3.1 (2.5)	2.8 (2.4)	<.001
Age ≥ 80 years (%)	20	12	26	14	1.000
Payor status, %					1.000
HMO	3	6	4	3	
PPO	73	70	70	86	
FFS	23	25	26	11	
Other	0	0	0	0	
Proportion rural community, mean (SD)	0.3 (0.3)	0.3 (0.3)	0.3 (0.3)	0.3 (0.3)	.888
Median household income, $*	27910.3 (11108.2)	28746.3 (11337.5)	27293.6 (10116.7)	28042.8 (10282.3)	.024
Proportion white community, mean (SD)	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	.473
Proportion black community, mean (SD)	0.3 (0.2)	0.3 (0.2)	0.3 (0.2)	0.3 (0.2)	.647
Proportion Hispanic community, mean (SD)	0.04 (0.06)	0.04 (0.05)	0.04 (0.05)	0.04 (0.06)	.773
Leading medical conditions, %					
Cerebrovascular disease	63	57	50	31	<0.001
Chronic obstructive pulmonary disease	38	34	38	35	0.151
Urinary tract infection[†]	49	32	34	21	<0.001
Noncomplicated diabetes	33	34	33	29	0.050
Peripheral vascular disease	26	24	23	17	<0.001
Dehydration[‡]	41	24	32	11	<0.001
Congestive heart failure	30	26	34	17	<0.001
Pneumonia[§]	35	20	29	15	<0.001

Note: *Median household income by census data matched ZIP code.

[†]Urinary tract infection occurred within 1 month of 31.1% of delirium-only patients and 42.3% of DSD patients.

[‡]Dehydration occurred within 1 month of 47.8% of delirium-only patients and 48.1% of DSD patients.

[§]Pneumonia occurred within 1 month of 34.3% of delirium-only patients and 34.7% of DSD patients.

DSD = delirium superimposed on dementia; SD = standard deviation; HMO = health maintenance organization; PPO = preferred provider organization; FFS = Fee For Service.

in the models. The overall alpha level of 0.05 was used to determine statistical significance.

Model performance was evaluated by calculating the overall model R^2 statistic. The independent effect of the four-level dementia and/or delirium variable was evaluated using partial r^2, F value, and p value. A Tukey–Kramer multiple comparison adjustment to the overall alpha level was used to examine differences among the four groups post hoc. All statistical analyses were performed using SAS (version 8.2; SAS Institute, Cary, NC).

RESULTS

Of the total sample of 76,688 persons aged 65 years or older, 7347 (10%) were coded as having dementia, and an additional 763 (1%) as having delirium alone. Among the 7347 with dementia, 976 (13%) had DSD, representing 1.3% of the total sample. Only one episode of delirium was counted per patient, thus, the occurrence rates are conservative. On average, the DSD group had 2.9 (± 3.1) claims with a delirium diagnosis coded, and the delirium-only group had 2.4 (± 3.4) claims with a delirium diagnosis coded over the 3-year study period.

The demographic characteristics and medical conditions for the four matched study groups are shown in Table 1. These groups included 699 persons with DSD, 699 with dementia alone, 699 with delirium alone, and 699 in the control group. The majority of patients were female, white, and urban. The mean age of DSD and delirium alone patients

was 76 years (74 years for the dementia alone and control groups). The control group has fewer individuals in FFS plans. Additionally, those individuals in the control group had fewer prescriptions filled than did those in the DSD, dementia-only, and delirium-only groups. There were no differences in race or income. Although significant differences in some of the matching variables persisted after the matching procedures, the differences were quantitatively small and of questionable clinical significance. Controlling for these matching variables in further analyses of total costs did not affect the overall results.

The distribution of medical conditions that precipitated claims is presented in Table 1, with the eight leading conditions presented across the four groups. Persons with DSD were treated for higher rates of cerebrovascular disease, urinary tract infection, dehydration, and pneumonia. Delirium diagnoses occurred within 1 month following the coding of the medical diagnoses in Table 1 in only 21%–60% of cases in the delirium-only group, and in 16%–52% of cases in the DSD group.

Among those persons with DSD, the delirium diagnoses preceded the dementia diagnosis in 33.48% (234/699) of cases and followed the dementia diagnosis in 66.52% (465/699) of cases. The mean time between the dementia and delirium diagnoses among those persons whose delirium diagnosis preceded the dementia diagnosis was 6.40 months (standard deviation [SD] = 7.73, range 0.03–32.33 months). The mean time between the dementia and delirium diagnoses

Table 2. Paid Costs and Utilization in U.S. Dollars by Matched Comparison Groups

Cost and Utilization Variable	DSD (N = 699)		Dementia Only (N = 699)		Delirium Only (N = 699)		Control (N = 699)		Overall p Value
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Total cost, $	9566*†‡	(18232)	7557	(13056)	9422	(23341)	4766	(6644)	<.001
Facility cost, $	5582*‡	(14215)	3654	(9212)	5312	(18751)	2471	(4565)	<.001
Provider cost, $	2603‡	(3754)	2303	(5779)	2407	(3497)	1630	(2070)	<.001
Prescription cost, $	1067‡	(3103)	1309	(3152)	1368	(3581)	424	(1497)	<.001
Inpatient admissions, No.	3.1	(4.0)	2.0	(3.1)	2.6	(3.3)	1.4	(2.6)	<.001
Outpatient visits, No.	5.7	(7.8)	5.6	(7.4)	5.8	(7.4)	4.7	(5.8)	0.021
Office visits, No.	44	(39)	49	(42)	55	(44)	56	(50)	<.001
Emergency room visits, No.	3.1*†‡	(4.2)	2.2	(4.0)	2.2	(3.0)	1.2	(2.2)	<.001
Skilled nursing home visit stays, No.	0.5*†‡	(1.7)	0.2	(0.9)	0.2	(1.0)	0.0	(0.3)	<.001
Filled prescriptions, No.	28	(72)	37	(75)	39	(86)	14	(42)	<.001
Unique prescriptions, No.	4	(10)	6	(11)	6	(11)	2.6	(7.4)	<.001

Note: Alpha was adjusted for multiple comparisons and p values for two-way comparisons based on the post hoc tests from log-transformed costs and utilization.
*DSD vs dementia only; $p <$ adjusted Tukey–Kramer alpha.
†DSD vs delirium only; $p <$ adjusted Tukey–Kramer alpha.
‡DSD vs control; $p <$ adjusted Tukey–Kramer alpha.
DSD = delirium superimposed on dementia; SD = standard deviation; $ = U.S. dollars.

among those individuals whose delirium diagnosis followed the dementia diagnosis was 8.72 months (SD = 9.48, range 0–35.27 months). We further analyzed the proportion of costs that occurred after the delirium diagnosis in our 3-year study period in the delirium groups. Of the total costs, 40% (SD 34%) in the delirium-only group and 50% (SD 32%) in the DSD group occurred after the initial delirium diagnosis. However, because this is a cross-sectional study of secondary data, we cannot be sure that a delirium diagnosis did not occur in the months or years preceding our study period.

Table 2 shows the unadjusted total, facility, provider, and prescription costs (in U.S. dollars) and utilization across the four groups, with the DSD group having higher utilization and costs. Total costs over the 3-year period averaged $9,565 for the DSD group, $7,556 for the dementia-only group, $9,422 for the delirium-only group, and $4,765 for the control group.

ANCOVA results on the log-transformed cost and utilization models are shown in Tables 3 and 4. The four groups demonstrated statistically significant differences in all cost types and utilization types, even after controlling for number of unique prescriptions, payor type, and community demographic data (including proportion rural, median household income according to the age of the individual, proportion

white, proportion black, and proportion Hispanic). The only exception was for prescription paid costs and office visits. For log-transformed total costs, the adjusted mean was significantly higher for the DSD group than for all other groups ($p = .0001$ for overall test for differences). The DSD group had significantly higher facility costs, more emergency room visits, and more nursing home visits than did all other groups. Table 5 illustrates the settings where the delirium claim occurred between the two groups with delirium, with the majority of diagnoses for both groups occurring in the inpatient hospital and the emergency room.

DISCUSSION

DSD is a growing public health concern that is potentially preventable, yet poorly understood. This study describes the occurrence of DSD in a community-dwelling population (1.3% overall population and 13% in patients with dementia), and documents the high health care utilization and costs associated with this problem, with total health care costs exceeding those of matched comparison groups with dementia alone, delirium alone, and controls.

The 10% prevalence of dementia alone and 13% occurrence rate of delirium in patients with dementia in this study are higher than what has been reported in other

Table 3. ANCOVA Models on Costs and Independent Effect of DSD Variable

Model (Dependent Variable)	Model R^2	DSD Variable		
		Partial R^2	F Value	p Value
Total costs	0.4447	0.0518	29.46	<.001
Facility costs	0.4459	0.0564	32.24	<.001
Provider costs	0.4006	0.0471	23.48	<.001
Prescription costs	0.8474	0.0021	1.13	.337

Notes: Covariates in the model were proportion rural, median household income, proportion white, proportion black, proportion Hispanic, payor, and number of unique prescriptions. Analyses with ANCOVA models using log-transformed costs.

ANCOVA = analysis of covariance; DSD = delirium superimposed on dementia.

Table 4. ANCOVA Models on Utilization and Independent Effects of DSD Variable

Model (Dependent Variable)	Model R^2	DSD Variable		
		Partial R^2	F Value	p Value
Inpatient visits	0.4405	0.0637	36.71	<.001
Outpatient visits	0.3535	0.0036	1.93	.122
Office visits	0.3857	0.0216	11.89	<.001
Emergency room visits	0.4059	0.0616	35.42	<.001
Skilled nursing home visit stays	0.2865	0.0291	16.18	<.001

Notes: Covariates in the model were proportion rural, median household income, proportion white, proportion black, proportion Hispanic, payor, and number of unique prescriptions. Analyses with ANCOVA models using log-transformed utilization.

ANCOVA = analysis of covariance; DSD = delirium superimposed on dementia.

administrative studies, but lower than what was found in some recent prospective studies (3,6). Gutterman and colleagues (25) examined dementia in managed Medicare and found a prevalence rate of dementia of 0.86% in those 60 years old or older. Baker found a prevalence of delirium of 25% in persons with Alzheimer's disease using a medical record review, whereas Marcantanio reported a prevalence or 66% in hospitalized persons with dementia (19,21,25,26). In older adults in the United States, the overall occurrence found for DSD is actually higher than the prevalence for other chronic conditions, such as congestive heart failure, which is analogous in having low overall prevalence rates of 2%–6%, and which is a costly and devastating chronic condition that affects older adults disproportionately (27–29).

Costs and utilization were significantly higher in the DSD group than in the dementia-only and the control groups. Costs in the DSD and delirium-only groups were almost twice as high as those in the control group, and significantly higher than those in the dementia-only group. A previous review of DSD (3) highlighted the potential costs savings from early recognition and management of delirium, and this study suggests that recognizing and treating delirium in persons with dementia may have important cost implications. Our underlying hypothesis is that delirium increases costs and utilization (beyond dementia alone). Our matching on comorbidity was one important methodologic approach to address differences in utilization rates. However, we cannot eliminate the possibility that higher rates of utilization might have resulted in higher rates of detection of the delirium and dementia diagnoses. A recent literature review by Bloom and colleagues of 21 studies (30) estimating the costs of Alzheimer's disease highlighted the difficulties of attributing specific medical services and their costs to each dementia diagnosis, but also points out that costs are likely to rise in the future with a greater need for evaluation of cost variability. The present study is important for describing the cost impact of delirium on dementia by examining comparable dementia cohorts with and without delirium.

Some important caveats deserve comment. The major limitations of this study include the use of claims data, the classification of cases on diagnosis codes reported on paid claims, and the use of retrospective data for acute and chronic conditions. The major limitation of a cross-sectional design and the use of administrative claims data is that the temporal ordering of the diagnoses and utilization rates is not known. Although this remains a major limitation in our study, we have provided data on the order of the dementia and delirium diagnoses in our claims data. Studies that rely on medical record or administrative data review for the diagnoses of delirium are likely to underestimate the prevalence of delirium compared to prospective (direct) measures of delirium (31,32). It is also possible that some persons without dementia and delirium were falsely coded as such on claims (7–9). As with other studies of economic costs, our estimates of costs were skewed. We used the alternative models of square root and log transformation, which produced similar results. In addition, we did not discount our costs. Lastly, the cross-sectional nature of the study limits the ability to make any causal inferences regarding the medical conditions associated with DSD. Our

Table 5. Setting Where Delirium Diagnosis Occurred

Place of Service	DSD % Delirium Diagnosis	Delirium Only % Delirium Diagnosis
Office visit	14.5	17.3
Home	0.6	1.4
Inpatient hospital	40.3	33.8
Emergency room	34.1	28.0
Ambulatory surgery	0.4	0.0
Skilled nursing home visit stays	2.7	1.7
Inpatient psychiatric	1.4	0.1
Laboratory	0.1	0.9

Note: DSD = delirium superimposed on dementia.

inability to establish the temporal ordering of the medical diagnoses and delirium in this study is another limitation of the administrative data used for this study.

Despite these limitations, this is the first large-scale study to address the problem of DSD in a community sample and to measure cost and utilization of DSD. A recent survey of physician management of delirium found that physicians varied widely in the management of this problem (33), and, despite over 20 years of research on delirium, we still do not know the natural history of and effective treatment strategies for persons with dementia who develop delirium. Additionally, a recent study (34) found administrative data to be able to accurately measure clinical quality even in the face of significant data loss. Future studies are needed to evaluate prospectively the risk factors for DSD, and to evaluate and test intervention strategies for prevention of this condition. The present study highlights the importance of the common and costly problem of DSD for the older community-dwelling population.

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APPENDIX

ICD-9-CM Codes Used for Cases

Code	Diagnosis
290.0	Senile dementia, uncomplicated
290.20	Senile dementia with delusional features
290.21	Senile dementia with depressive features
290.30	Senile dementia with delirium
290.10	Presenile dementia, uncomplicated
290.11	Presenile dementia with delirium
290.12	Presenile dementia with delusional features
290.13	Presenile dementia with depressive features
290.40	Arteriosclerotic dementia, uncomplicated
290.41	Arteriosclerotic dementia with delirium
290.42	Arteriosclerotic dementia with delusional features
290.43	Arteriosclerotic dementia with depressive features
203.0	Acute delirium
293.1	Subacute delirium
294.10	Dementia without behavioral disturbances
294.11	Dementia behavioral disturbances
294.8	Other specified organic brain syndromes (chronic)
331.0	Alzheimer's disease
331.2	Senile degeneration of brain
291.0	Alcohol withdrawal delirium
292.81	Drug-induced delirium