The Lost Alzheimer's and Related Disorders Search Subject: New Research & Perspectives

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Introduction:

Wandering among the elderly, especially those suffering from possible Alzheimer's disease and Related Disorders (ADRD)[1], has only recently begun receiving much attention. Possible Alzheimer's and Related Disorders includes Alzheimer's disease and the less well known dementia causing disorders of Multi-Infarct Dementia, Parkinson's dementia, Symptomatic Hydrocephalic, Korsakoff's Syndrome, Pick's Disease, Huntington's Disease, and Spongiform Encephalopathy. However, almost all studies have focused how these disorders cause wandering within the walls of an institution.[2,3,4] Many other papers mention wandering, but only as a behavioral disturbance,[5,6] management challenge in an institutional setting,[7] or as a correlation with further loss of cognitive ability.[8] Several other articles provide institutional care providers strategies for managing the wanderer.[9,10,11] The emerging importance of wandering and dementia is evidenced by the first time symposia addressing the problem at the American Gerontological Society.[12]

Little research has looked at wandering beyond the walls of the institution or residence. Anecdotal case studies are recorded in the literature by Burnside[4] and Hindlian.[13] Butler and Barnett report one critical wanderer per year for every 1000 persons over the age of 65, resulting in four deaths in 450 episodes in one county.[3] They did not provide any information that would aid search planners. A critical wanderer is defined as anyone with dementia who has wandered away (disappeared of their own free-will) from their caregiver. This definition characterizes critical wandering from the perspective of the caregiver, who is available to search and rescue investigators, unlike the missing subject. Nova Scotia's Emergency Measures Organization reported a mortality rate of 7 of 15 (47%) among "walkaways."[14] Hill has updated these figures with seven additional cases and the mortality rate was stable at 45%[15]. However, both studies included mentally retarded and psychotic subjects, which obscures characterizing elderly dementia subjects, especially considering the small number (n=15, 22) in the studies. Silverstein and Salmons in a study of 463 Safe Return registrants in Massachusetts found 72% of wanderers are repeat wanderers, caregivers search themselves preferring not to call for assistance, the police are called in 50% of the cases, and 69% of wandering cases are associated with severe consequences[16]. Koester and Stooksbury in a preliminary investigation of critical wanderers with Dementia of Alzheimer's type noted lost subjects have usually wandered before, are generally unresponsive even when uninjured, leave few physical clues concerning their location, often attempt to travel to a former residence, and they will wander across roads.[17] This study has been cited frequently in the Search and Rescue Community, including primary SAR textbooks[18,19]. However, it fails to take in account regional/topographical differences and may be misleading to non-researchers. A follow-up investigation, also by Koester and Stooksbury found in search and rescue incidents nine of forty-two (21%) of Dementia of Alzheimer's Type (DAT) subjects were found deceased due to hypothermia, dehydration, or drownings. All

subjects found within 24 hours of disappearance survived while only 54% of those requiring greater than 24 hours survived. DAT subjects were usually located (89% of all cases) within one mile (1.2 km) of the point they were last seen. If the wanderers were not found on the road itself (14%), they are usually found in a creek/drainage (28%), and/or caught in briars/bushes (33%).[20] Koester and Stooksbury's original studies were retrospective, used a loose criteria for determining dementia, relied upon field investigators with no training in Alzheimer's related disorders, collected a small sample size (n=42), and only collected information from Virginia.

Growing Problem

The prevalence of critical wanderers can be expected to grow. The increase is believed to be due to both an increase in awareness of AD and an increase in the age of the U.S. population.[21] Using the incident rate of one critical wanderer per year per 1,000 persons over the age of 65,[3] the expected total of critical wanderer incidents reported to local law enforcement comes to 31,000 cases a year. Regional demographics will also greatly affect the percentage of Alzheimer's cases found in each state. Indeed there appears to be a higher prevalence in rural areas[22] and among those with less education.[23] It is this particular subset of DAT patients that often results in SAR incidents. Koester and Stooksbury found an increase in the number and percentage of searches for DAT patients.[20]

Severity

One of the most important characterizing features of dementia is its severity. Those with severe dementia might travel shorter distances, demonstrate non-goal directed behavior, and have shorter survivability time-frames than those with mild dementia. However, no studies have addressed this issue for critical wanderers. Determining the severity and even the presence of dementia may present a considerable challenge in search and rescue incidents. During the search effort the subject by definition is not present. Therefore, the administration of a test battery[24] or use of the NINCDS-ADRDA criteria[1] is not possible. Furthermore, any tool developed must be easy for law enforcement and search investigators to use. In order to determine the severity of dementia during an incident a search investigator must rely upon information provided by informants (family or non-kin). Fortunately, tools have been developed that allow an investigator to obtain information from caregivers. A more demanding set of activities is incorporated into the instrumental ADL scales.[25,26] These tools are known instrumental activities of daily living (IADL). They gather information on the subjects ability to carry-out daily activities such as finances, hygiene, and navigation. IADLs also have strong correlations with MMSE scales.[27] The use of appropriate test in prospective studies will allow the collection of information relating the severity of the dementia with search behaviors and outcomes.

Mechanism of Lost Wanders

Alzheimer's Disease (AD) is known as a disease of exclusion since it can only be diagnosed positively after the subject's death.[28] Autopsy shows neuritic plaques and neurofibrillary tangles are found in greater numbers in the neocortex, hippocampus, and amygdala in Alzheimer's disease.[29] Granulovacuolar degeneration and Hirano bodies are also found, but almost entirely in the hippocampal formation.[30] The hippocampal formation is an integral component of several forebrain neural systems thought to play a role in memory processes.[31] AD causes the destruction of afferents and efferents which functionally isolates the hippocampus from the other cortical and subcortical areas known to be important for memory.[32] The hippocampus may also be the site of true allocentric spatial learning.[33] Place cells within the hippocampus provide a spatial topography of a particular environment.[34] One may

hypothesize that in severe dementia where the hippocampus has been completely disassociated from the cortex the wanderer may have no access to spatial maps (both long term and short term). This may lead to non-goal or aimless wandering or at least no discernable goal to an outside observer. In more mild cases of dementia the patient may still have access to spatial maps, can begin moving to a target location, but then become easily disoriented. It has already been shown that wandering significantly increases with further deterioration of the AD patient. Among mild cases of AD, 18% of the patients wander, while in severe cases, wandering increases to 50%.[5] Other studies have made estimates of the prevalence of wanderers ranging from twelve to thirty-nine percent.[35] Another study reported twenty-six percent of AD patients getting lost in the outdoors in the preceding week.[36] If a relationship is found between severity of dementia and the type of wandering, this information may greatly assist search planners. The pathophysiology of Alzheimer's Disease has been recently linked to cerebrovascular accidents along with Multi-Infarct Dementia[37,38]. It is possible the location, type, and size of brain lesions may be linked to laterally of wandering, direction of vector departure (from initial direction of travel), and type of wandering. If a relationship is found between distance traveled and severity of dementia or the type of wandering, this information may greatly assist search planners.

Defining a Search Area

Search planners rely heavily on lost person behavior profiles and statistics for the initial deployment of resources and development of search objectives. Modern search theory involves a four step process to determine the deployment of search teams. The search area is initially defined by the theoretical distance the subject could have traveled since being last seen. Since this area grows exponentially as time passes (especially if transportation is available) the theoretical area is not usually useful in limiting the search area. Next search planners limit the size of the search area by the use of empirically derived statistics that give probabilities for distanced traveled zones. These statistics have the greatest impact upon actual search planning. These boundaries are further limited by any geographical features that may make travel impossible or unlikely. Finally, analysis of the subject's behavioral profile, past incidents, and investigation delineate the most likely area. Subject behavior profiles and survivability statistics are also used throughout the search and help with the always difficult decision of when to suspend the mission. Unfortunately, no data gives guidance to search planners to help predict who may travel further than 94% zones (statistical outlier). While, all the major textbooks and field guides used by search planners and law enforcement officials incorporate statistical and behavioral information,[18,19] elderly search subjects suffering from dementia have been grouped with all elderly subjects.[39] This information is critical in rapidly locating the subject with the most efficient types of resources, when the chances of survival are the highest.

Straight Line Hypothesis

Identifying behavioral patterns can also assist search planners attempting to decide how to search for a missing critical wanderer. The working hypothesis for their overall behavior is they wander in a basically straight line until they get stuck in some type of barrier. A similar rationale is seen in recommendations to create barriers in institutional settings in order to reduce critical wandering. Preventing exiting by placing a yellow strip of plastic across the door, painting the exit doors the same colors as walls, covering doors with curtains or movable screens, or placing mirrors on doors all depend upon a physical or mental barrier.[40] The critical wandering may be seemingly random or it may be goal seeking. This is in agreement with several other studies describing wandering within an

institution. It is not uncommon to locate the subject in or heading to a former residence.[17] If a direction of travel is obtained at the point the subject is last seen it serves as an excellent predictor of the subjects location. Search planners from California have found this to be true within 10 degrees of the last sighting.[41] However, search teams in Louisiana report a general circle pattern.[42] Hebard also reports in the general press a circle pattern dependent upon being left or right handed[43]. Bartlow reports a ping-pong pattern of course alterations upon contact with travel barriers[44]. No data or studies were presented for the circle or ping-pong patterns cited. Silverstein and Salmons data found no difference in the direction traveled between right or left handed subjects.[16] Koester and Stooksbury also reported the straight line observation without supporting data. However, much more data needs to be collected and regional factors need to be considered. They also reported as the critical wanderer travels they will cross over roads (67% of the cases) until they get stuck in brush (25%) or in a drainage (38%). Another important undocumented observation is the distance they travel once they leave or cross a road is usually small. Unfortunately, no numbers have been collected to quantify this key planning factor. Critical wanderers once they are lost appear to leave few clues and seldom seek help (shout or signal). Only three cases of physical clues have occurred out of 43 searches. In none of these searches did the critical wanderer call out for help.[17] In fact their behavior may be described as evasive. This may be due to previous hallucinations or suspiciousness common among DAT patients.[5]

Weather and Climate

Weather and climate should have a major impact on both survivability and the frequency of wanderers. In addition, predicting a season or time of year when critical wandering increases can be important in developing prevention programs. No studies have answered this question. Synder et al make an undocumented observation that wandering increases after a cold spell.[2] Koester and Stooksbury noted experienced search mangers have made the same observation.[18] Furthermore, they showed the incidence of searches generally increased with warmer weather and decreased during cooler weather. Due to the small sample size no conclusions could be drawn. No studies have looked at how season affects survivability. However, the mortality rate of critical wanderers in Nova Scotia was 47% while it was only 22% in Virginia.[14] Therefore, we predict the colder weather will lead to a higher mortality rate. If this relationship is shown to be valid, survivability tables must be adjusted to reflect current and past weather conditions. Temperature, precipitation, wind, and humidity influence environmental disorders and are potential factors in creating a more specific and useful survivability chart.

Topology

Data must be specific for the type of topology, otherwise information can lead a search planner to give up too early, not search a large enough area, or to look in the wrong place. Three major types of topology exist in Virginia. They include a flat tidewater, the rolling hills of the Piedmont, and the Appalachian Mountains. Preliminary analysis and discussions indicate differences will appear among critical wanderers. Personal discussions with search and rescue team leaders from the West indicate critical wanderers travel further than the 0.5 mile median found in Virginia.[41] Important topological differences have already been documented for hikers, elderly, children, and hunters.[18,19] Since no other studies on critical wanderers have been conducted it is impossible to analyze any other topology differences at this time.

Urban versus Rural Searches for Wanderers Search and Rescue resources in Virginia have only recently started being called into cities or urban environments to conduct searches for critical wanderers. It is expected that several differences in the

subject profile may be found. Due to the higher density of people it is expected that a larger number of finds can be attributed to non-searchers, road patrols, and media involvement. Due to a vast network of roads and public transportation, the distances these subjects travel should be greater. Coupled with potentially shorter times to locate subjects and the availability of shelter the survivability rates should be higher. No studies have specifically addressed these concerns. Preliminary results of the investigator included only 11 urban searches and 31 rural searches.[20] It may be necessary to make different recommendations if they are located in an urban or rural location.

Wandering from Nursing Homes versus Residence Similar analysis between those who wander away from their residence versus a nursing home may also elicit important differences. Those patients in a nursing home may have a more severe dementia that those still in a private residence. The wandering behavior in a nursing home may be directed towards returning home or even escapist while the wandering seen from a residence may be caused by disorientation or seeking a favorite place. No studies have directly assessed this issue. Preliminary results of the investigator (n=42) showed no difference in age, sex, race, distance found from the point last seen, and time required to locate subject between the two groups.[20] In any case, recommendations for initial actions for a primary Caregiver in a home setting and those responsible in an institution will be different.

Wandering Sociedemographics Age, sex, and race are demographic characteristics that a search planner may easily obtain and which may help predict the subject's behavior. It is conceivable that the older the search subject, the higher the chance of mortality and the smaller the distance they might travel. Alternatively, it has been shown that age has no relationship with cogitative or behavioral disturbance or the rate of progression of AD.[45] In fact, AD sufferers may be healthier than other age controlled elderly [46] and by definition only suffer initially from a loss in cognitive domains.[1] Synder *et al* showed wanderers do not differ from non-wanderers on the basis of age, sex, or martial status.[2] Koester and Stooksbury also found no difference in survivability or distance traveled due to age or sex.[20]

Directionality

No current studies have addressed the issue of directionality among lost subjects. Directionality is the examination of a lost subjects tendency to travel in specific compass directions. Directionality is an innate behavior among migrating animals and the possibility exists it may occur in those suffering from dementia. A search and rescue incident commander has suggested the possibility of an East-West trend related to the phenomena of sundowning, common among AD wanders.[2]

Materials and Methods

Database Source:

In 1986, The Virginia Department of Emergency Services (VDES) introduced a new management system that used selected operations personnel to handle all request for SAR assistance. The new management system initiated a record-keeping and database system. This study looked at data from June 1986 with the first state recorded mission to December 1996. This includes over 550 cases. Only searches issued a DES incident or mission number will be included in analysis. The database is used for both the retrospective and prospective studies.

The principle investigator collected from VDES copies of Missing Person Reports, After Action Reports, and Virginia SAR Council Mission Summaries. The principle investigator followed up with Virginia Search organizations for any missing data. Search and Rescue organizations keep all original search related materials on permanent file for training and

legal purposes. The point last seen (PLS) and the find location of the subject was plotted on 7.5 minute United States Geological Survey topographic maps. The distance from the PLS will be calculated as a straight line connecting the two points regardless of any actual path taken. The topology will be classified as either mountainous, Piedmont (rolling hills), or flat (tidewater). Using U.S. Census maps and definitions the area will be classified as wilderness, rural, suburban, or urban.

Prospective Study Methods

Once contacted by a local law enforcement official, VDES coordinates the response of state search and rescue resources (search managers, blood hounds, air-scent dogs, horses, helicopters, mantrackers, and ground searchers). The principle investigator as a part time employee of VDES was notified of all possible AD related searches that occurred from June 1996- December 1997. The principle investigator responded to possible AD searches to collect information from caregivers and in some cases to function as the Incident Commander. Incidents were classified as a possible AD, AD related disorders, healthy elderly, or excluded from the study.

Criteria for Inclusion:

The criteria for inclusion as a possible AD: 1) Subject is a critical wanderer (subject location unknown and disappeared of their own free-will). 2) Age on onset between 40 and 90. Greater weight given to those older than 65. 3) No history of alcoholism or mental retardation. 4) No history of psychosis prior to loss of cognitive ability. 5) Caregiver states subject experiencing memory impairment or behavioral disturbances for more than 6 months. 6) Positive history of decline in behavioral characteristics with DAD. 7) Positive deficits on DAD with a score at or below 30 OR 8) A previous diagnosis of possible or probable Alzheimer's, made by a physician or researcher.

The criteria for inclusion as possible AD related disorders will involve the same criteria as 1-7. Criteria number eight will be substituted with those diagnosed with Multi-Infarct, Parkinson's Dementia, Symptomatic Hydrocephalic, Korsakoff's Syndrome, Pick's Disease, Huntington's Disease, or Spongiform Encephalopathy by a physician or researcher.

If the subject is excluded from the above categories they will be evaluated for the normal elderly category. Borderline cases of AD or AD related that were rejected for the aforementioned were not considered for healthy elderly. Lost normal elderly should show significant differences and will serve as a control group. The criteria is (1) age 60 or older, (2) no history indicating dementia of any form, (3) no history of psychosis, hallucinations, or mental retardation (3) no history of being despondent (suicidal), (4) no searches caused by murders, kidnapping, or other related crimes, (4) no searches caused by water related accidents (boating, crossing stream, etc). If the subject does not met the normal elderly category they will be excluded from the study. The principle investigator will make the determination.

Data Coding:

The principle investigator completed the data questionnaire during or at the conclusion of the search. The principle investigator questioned the caregiver. The test was given during the search incident. In incidents that were concluded before the arrival of the Principle Investigator, data was collected within one week. Data forms were reviewed for simplicity by the twenty-six search and rescue organizations and law enforcement agencies belonging to the Virginia Search and Rescue Council.

The data questionnaire collects information on the location of the search, location last seen, activity when last seen, time and date when last seen, time caregiver noticed subject missing, time local law

enforcement notified, initial efforts of the caregiver, initial efforts of law enforcement, time search and rescue teams notified, time search and rescue teams deployed into field, time and date subject located, topology of area, verifiable clues found during search, subject distance from the point last seen, subject responsiveness, search techniques used during the search, search technique used to locate subject, specific type of terrain subject located in, change in elevation of subject, subject's activity at time of find, distance from nearest trail or road, medical condition when found, and length of evacuation to road head (time and distance). Search teams were also be requested to supply a copy of the topographical map displaying point last seen, location of verifiable clues, clues giving a direction of travel, location subject found, and the location(s) the subject was found on any previous caregiver conducted searches.

Basic epidemiological information was also collected. Information will include sex, race, age, marital status, and living quarters, A series of questions relating to past life experiences, physical activity, current and past personality traits, and possible target locations will be included.

In order to determine the severity of AD in a missing subject requires the evaluation of existing tests and administration of a test to the caregiver. Cognitive ability will be estimated by the informant-derived Blessed dementia scale,[47] disability assessment for dementia (DAD), and Progressive Deterioration Scale (PDS/CGIC) which are similar to an ADL scale,[48,49] and an IADL.[25]

After a search with a successful outcome (survival of subject) the principle investigator will follow-up after the patient has stabilized from any disorders due to the search (dehydration, hypothermia, etc.). The follow-up will include the MMSE a standard cognitive tests to precisely measure the severity of the disease.

Retrospective Study

The same eight step criteria used in the prospective study for classification as a possible AD, AD related disorder, or normal elderly subject was used with two modifications. Due to the retrospective nature of the data it was impossible to obtain a DAD or PDS score. The lost person questionnaire contains medical information that allows validations of a possible AD or related AD diagnosis.

The previous maps plotting the subjects start and end points will be used. In addition the clue map and log will be used to determine those searches where a direction of travel was obtained. In those searches with a direction of travel the find location can be expressed as a vector off of the predicted location.

Statistical Analysis

The study collects a wide array of information from caregivers and searchers. In order to determine which information is useful in predicting the subject's location and survivability, statistics will be used. Data will be entered into MS Excel 5.0, a spreadsheet computer program. Several statistical tests to analyze the continuous and qualitative variable will be used. The statistical packages, SPSS and Statistica will analyze this data. Descriptive statistics will describe the mean, median, and variance. Traditional ANOVA will test for significant differences between categorical variables (independent) on continuous response variables (dependent)(e.g., race versus distance found from place last seen).[50] Linear regression will analyze the continuous variables. The regression equations will be evaluated for use as a predictive tool (e.g., distance found from the place last seen as a function of age).[51] Discriminant factor analysis will allow (using the behavioral tests) the development of a set of predictive equations for lost subject survivability.[52] Contingency tables and chi square test will test the relationship between qualitative

values. This will also allow testing for race or sex differences in lost person behavior and survivability.[53] Analysis of the factor loadings from factor analysis will allow the behavioral test to be a predictive instrument. Regression of the factor scores on the continuous variables will produce predictive instruments.[52] Significant relationships between a predicted direction of travel and the actual direction is determined by the modified Raleigh test.[51] Whether there is a significant difference between two groups (survivors versus non-survivors) can be tested by the Mardia, Watson, and Wheeler test.[54]

Results

Eighty-seven (15%) of 565 recorded state incidents involved possible ADRD sufferers (**Figure 1**). One search involved two ADRD patients that remained together. This particular category was the second largest in

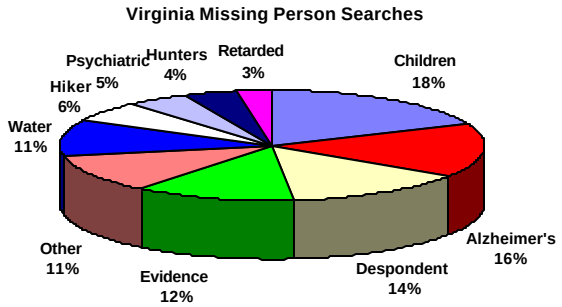


Figure 1

the data set. In all but one search, the search effort or others located the patient. The other most prevalent search types included children (18%), suicidal (14%), drowning (11%), murders (12%), and hikers (5%). The drowning and murder cases usually reflect requests for dog teams only. The ADRD searches occurred over a ten year period.

Patients fall into three classes based on their medical condition at the time of the find. Team leaders with at least basic first-aid training make the field classifications of uninjured, injured, or deceased.

The medical condition of the ADRD patients after being found varied greatly. Forty-two patients (51%) could be escorted back to their residence and required no medical attention. Twenty-three patients (28%) required an evacuation team. The state forms do not always specify the specific medical problem and any field diagnosis was not verified by hospital records. Experienced EMTs with supplemental training in wilderness disorders made the field diagnosis. ADRD patients requiring an evacuation suffered from hypothermia (67%) and/or dehydration (33%). In two cases, patients were field diagnosed as suffering from both disorders. All evacuated patients survived and were discharged from the hospital. Eighteen patients (21%) were found deceased and appeared to have succumbed to hypothermia (n=10), dehydration (n=3), or drowned (n=2). For one patient, the cause of death was neither determined nor recorded. No evacuated or deceased patients demonstrated any trauma based upon field evaluation.

In searches for normal elderly subjects (n=33), thirteen subjects were found uninjured (48%); four subjects required evacuation (15%) due to hypothermia and dehydration; and ten subjects (37%) were deceased (heart attack, drowning, hypothermia, and unrecorded).

There is no relationship between the age of the ADRD patient and outcome of the patient. There is also no relationship between the age of elderly patients and the outcome of the subject. Fifty-nine (59) of the ADRD searches and twenty (20) elderly searches had the patient's distance from the Point Last Seen (PLS) recorded. The missing data points represent a failure to complete the data form correctly. The mean distance the DAT patient was found from the PLS is 0.9 km (0.6 miles). The median distance is 0.8 km (0.5 miles) with a range of 0-3.2 km (0-2 miles). For elderly cases without ADRD the mean distance found from the PLS is 2.6 km (1.6 miles). The

median distance is 0.8 km (0.5 miles) with a range of 0-8.0 km (0-5.0 miles) (**Table 1**). There is no relationship between the DAT patient's age and distance from the PLS.

Survivability

There was a significant increase in morbidity and mortality as the total time elapsed to find the patient increased. There was also a significant increase in morbidity and mortality

Statistic	Alzheimer's	Elderly
n	87	33
Mean	0.6 miles**	1.8 miles
s	0.5 miles	0.5 miles
Median	0.5 miles	0.5 miles
x Age	76	70
s	9.2	8.3
Males	67%**	67%**
Females	33%**	33%**
Uninjuried	51%	48%
Injuried	27%	15%
Deceased	22%	37%
50% Zone	0.3-0.6 miles	0-0.5 miles
75% Zone	0.7 miles	2.5 miles
Max Zone	1.5 miles 94%	4.8 miles 95%

as the time increased from when trained SAR resources were notified and the patient was located (**Table 2**). The two uninjured ADRD patients located after a considerable delay were in an uninhabited former residence. Among those patients located within 12 hours of being last seen, no deaths occurred (**Table 3**). In six cases the search was suspended without the patient being found. These searches are not included in the time to find analysis though in five cases the body was eventually located within the search area.

Total Time to Locate Subject	Hours
Subject DOA	**83**
Subject uninjured	**36**
Mean SAR contact time	**Hours**
Subject DOA	50.0
Subject uninjured	12.3

Table 2

	<12 h	>12 h	> 24 h
Walk-out	40 93%	19 48%	7 32%
Evacuated	3 7%	13 33%	8 36%
DOA	0 0%	8 20%	7 32%

Table 3

Local Terrain

Most ADRD patients are last seen at either their own residence or a nursing home (Table 4). In addition, all twelve patients spotted on a road initially departed from a nursing home or residence. The local terrain in which the patient was located was recorded in fifty-six cases (**Table 5**). The majority of patients are in drainages/creeks or heavy brush/briars. In the ten cases in which patients were in a house, half were hiding in their own house and half traveled to a previous residence. In most searches the patient is not found by search teams but found wandering by others. This includes searches where the state issued a mission number but the patient was found before the arrival of search and rescue resources. Sweep, scratch (hasty) teams, and helicopters are the most successful organized technique used to find ADRD patients (**Table 6**).

Topology

The topology could be classified for Forty-six searches. Searches were classified as Mountainous (n=7), Piedmont (n=24), or Mountainous (n=15). Preliminary classification was based upon the geographic location. Those searches occurring in counties that contain mountains were further examined to determine if the actual search area occurred in rolling hills (Piedmont) or in a mountainous area. ANOVA showed no significant difference between the means of the distance from the point last seen (p=0.32). The median for the tidewater area was 0.3 miles and 0.5 for both the Piedmont

and mountain topology.

Place Last Seen		
Personal Home	**26**	**37%**
Nursing Home	**22**	**31%**
Roadway	**12**	**17%**
Vehicle	**3**	**4%**
Day-Care	**2**	**3%**
Camping	**2**	**3%**
Field	**1**	**1%**

Table 4

Environment of Find		
Bushes/Briars	**16**	**29%**
Creeks/Drainages	**10**	**18%**
Open Field	**10**	**18%**
House	**10**	**18%**
Road	**4**	**7%**
Woods	**4**	**7%**
Swamp	**2**	**4%**

Table 5

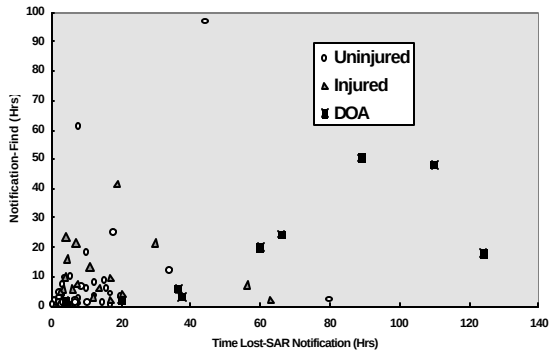


Figure 2

Find Techniques		
Non-searchers	**22**	**35%**
Scratch (Hasty)	**10**	**16%**
Sweep	**9**	**15%**
Helicopter	**9**	**15%**
Air-Scent dog	**6**	**10%**
Road Patrol	**3**	**5%**
Other	**3**	**5%**

Table 6

Time of day: The times at which patients were last seen by caregivers or a member of the general public are distributed equally over the daylight hours. No critical wanderers departed between 0001 and 0530. This indicates a cluster during the hours of 0700 and 2400. The Rayleigh test for significant clustering indicates this clustering is significant ($r=0.45$, $p<0.001$) compared to random clustering with a vector at 1500 (225E)[54].

Time of year: **Figure 3** depicts the occurrence of critical wanderer searches in Virginia by month. The warm season or frost-free period for Virginia starts in April and runs to October[55]. Fifty-nine (69%) of the searches occurred during the frost-free period. While 31% of the searches occurred

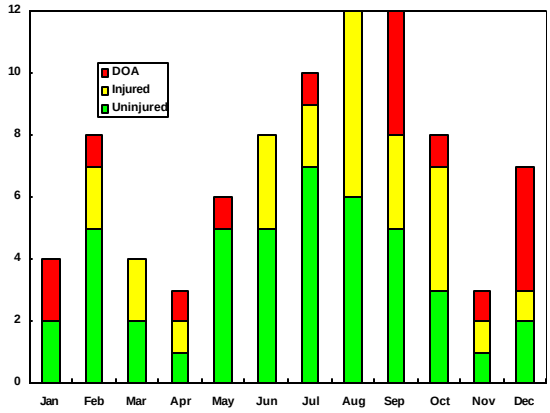


Figure 3

during the five cold months, accounting for 47% of the fatalities. The difference in case distribution of cold versus warmer months just missed standard statistical significance ($P^2=3.73$, $p<0.053$). The cold versus warm distribution of fatalities also just missed standard statistical significance ($P^2=2.57$, $p<0.10$).

Location: In 26 cases (54%), the patient lived in their own residence or with family in a residential setting. In 32 cases (46%) the patient lived in a nursing care facility. Only one search occurred at a Alzheimer's special

care unit. That subject was located within the facility in another resident's bed. Using Discriminant analysis there was no significant differences in age (p=0.65), time required to find (p=0.68), time elapsed till SAR resources were contacted (p=0.30), or distance from the point last seen (p=0.64) between those living in a care facility or in the community.

Fifty-one (67%) of the searches were rural, sixteen urban (21%), and nine suburban (12%)[56]. ANOVA indicates no differences between the three settings when analyzing age (p=0.40), time required to find (p=0.83), time elapsed until resources called (p=0.70), or the distance from the point last seen (p=0.87). The most notable differences occurred among the percentages of subjects found by searchers, thru investigative efforts, or suspended searches. The greatest difference is between rural and urban searches for percentage of investigative finds. This difference just misses standard statistical significance (P^2 =5.51, p<0.06).

Population Density Outcomes			
	Rural	**Suburban**	**Urban**
Subject Found	45 88%	7 78%	10 63%
Investigative Find	2 4%	1 11%	4 25%
Search Suspended	4 8%	1 11%	2 12%

Table 7

Resource Requests: **Figure 2** depicts the relationship between the time elapsed until state SAR resources were contacted and the time state SAR resources required to locate the patient. The abscissa includes the time required to contact state SAR resources. The contact time includes the time for someone to realize the patient is missing, contact local law enforcement, and finally the time local law enforcement officials take to request state resources. The ordinate includes the time required for the state SAR resources to locate the patient. The locate time includes the time required for SAR resources to mobilize, travel to the search, collect initial information, and find the patient. The data does not include six searches which were suspended without the patient being found. We did not include these searches even though the body was located eventually within the search area. The sooner SAR resources respond, the sooner the patient is located is indicated by the tight cluster (**Figure 2**). There was only one death when the patient was found within 24 hours. The average time to contact SAR resources was (83.6 hours F=39.0) for searches that resulted in a fatality. The average time to contact SAR resources was 10.3 hours (F=9.8) for searches that resulted in the patient being uninjured. The delays in contacting SAR resources were due to caregivers not noticing the missing patient, failure to contact local law enforcement, or the failure of local law enforcement to request state SAR resources in a timely fashion.

Sex: Fifty-eight (67%) of the searches were for males and 28 were for females (33%). Using estimates of the prevalence of Alzheimer's Disease among each of the three age brackets[57] and the 1990 Census for Virginia[56] expected values are 25,939 males (33.4%) and 51,749 females (66.6%) in Virginia. Chi-squared analysis indicates that this falls outside the expected distribution (P^2 = 44.8, p<0.00l). There are no other significant differences between sexes for age, time required to find, time elapsed until resources called, or distance traveled from the point last seen.

Race: The race of the patient was recorded in 71 searches. Twenty-four patients (34%) were African-American and 47 (66%) were white. Using Evans *et al* [56] estimates of the prevalence of Alzheimer's Diseases and the 1990 Census, it is expected that 12,377 (15.9%) African Americans and 65,311 (84.1%) whites in Virginia are afflicted. The observed racial distribution is outside our expected distribution (P^2 = 17.0, p<0.00l). There is also a significantly greater (P^2 = 82.5, p<0.00l) number of African Americans patients found

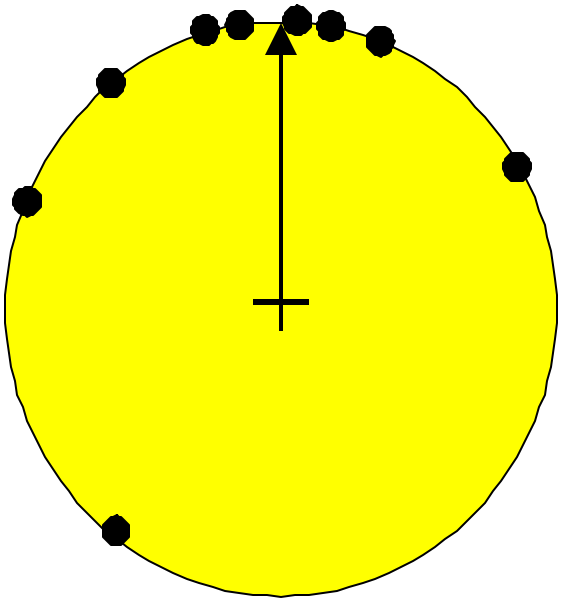
Race Differences				
Status	**Negro**		**Caucasian**	
Uninjured	**8**	**(40%)**	**23**	**(53%)**
Injured	**4**	**(20%)**	**12**	**(28%)**
DOA	**8**	**(40%)**	**8**	**(19%)**
Notification Time	**29.5 hours**		**19.1 hours**	

Table 8

deceased than whites patients during searches (**Table 8**). Discriminant analysis indicated a difference ($p<0.01$) in the time required to locate African American patients over white patients. The difference was due to the longer time ($p<0.001$) from the time last seen to the activation of search resources. There was no difference in the time required to locate African American patients once SAR resources are activated.

Direction of Travel

Documentation of a direction of travel only occurred for nine searches. The direction of travel was usually established by a combination of the Initial Planning Point (IPP) and a verifiable clue. Bloodhound trails were not considered a verifiable clue. Once a direction a direction of travel was obtained it was normalized to represent a vector of 0 degrees. The location of the subject is expressed as an angle off the direction of travel. Five of the nine finds (56%) occurred within 30^o degrees of the direction of travel. The Rayleigh test for significant clustering indicates this in non-random ($p<0.001$). In the one case where the subject was located in nearly the opposite direction of the predicted direction of travel, the subject was located 83 yards (75m) from the clue and 33 yards (30m) from the IPP.



Distance off Travel-Aid: A travel-aid was defined as a road, trail, or other feature that would aid travel. The find location was recorded in 56 searches. Fourteen of these searches (25%) resulted with a find along a travel-aid. The distance from a travel aid was recorded in 23 searches. The distance was calculated my measuring the shortest distance from a travel aid to the find location. The descriptive statistics are reported in **table 9**.

	Distance (Yards)	**Distance (M)**
Median	**33**	**30**
Mean (x)	**100**	**91**
(s)	**138**	**126**
Range	**1-500**	**1-457**
n	**23**	**23**

Table 9 Distance from Travel Aid

Directionally Twenty-three cases had sufficient documentation to plot the compass vector and distance the subject was found relative to the IPP. The plots of the find location are shown in **figure 5**. Five subjects (22%) were found north of the IPP, while eighteen (78%) of the subjects were found south of the IPP. This distribution is outside expected distributions ($P^2 = 8.2$, $p<0.01$). No East-West difference was seen ($P^2 = 1.4$, $p=0.24$). A closer examination of the South-East and the South-West quadrants found that 75% of the subjects found in each quadrant was last seen in the afternoon.

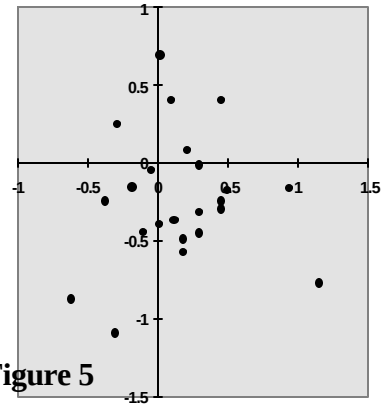


Figure 5

Previous wandering: Information on previous wandering was collected solely from the prospective phase of the study. The principle investigator was able to collect data on eight searches during the one-year study period. Information on previous wandering

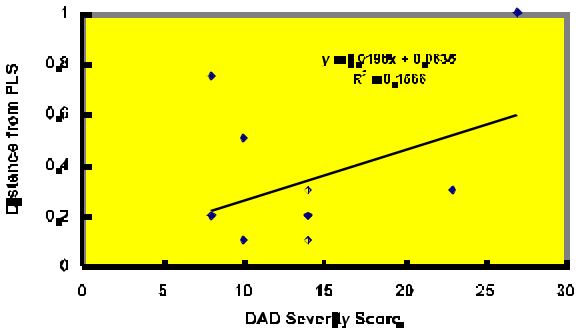


Figure 6

incidents were collected on six of these incidents. Five of the six (83%) had a previous history of wandering with an average of 2.8 incidents and a range of 1-5. The distance from the point last seen varied greatly from the data previously collected. The distance of previous incidents ranged from 0-12 miles with an average of 2.5 miles and a median of 0.2 miles.

Severity: The severity of ADRD was measured using three different tests. During the search the DAD and the Subjective Severity Index (SSI) was administered to the caregiver. After a successful search (subject found alive) the principle investigator also administered the MMSE to the search subject. With the limited number of fully documented cases (n=6) all results are preliminary. DAD scores ranged from 8-33. The SSI classified three subjects as mild, one with moderate, and two with severe dementia. The SSI classifications agreed with DAD and MMSE scores. Further data is required for meaningful statistical analysis. The average distance from the IPP for mild ADRD (n=4) was 3.4 miles, moderate (n=4) 3.15 miles, and severe cases (n=7) 0.28 miles. The additional cases were obtained from multiple incidents from some of the search subjects. An ANOVA found no statistical difference (p=0.27) between the three groups. A regression line (Figure 6) between the DAD severity score and the distance from the IPP also found no significant correlation (p=0.5, R^2 =0.13).

Discussion

During the retrospective component of the study, the caregivers along with medical records provided the data characterizing missing persons as suffering from ADRD. Investigators within Virginia are suspicious of the potential of ADRD in all elderly subjects. The Lost Person Questionnaire, a standard data collection tool used on all state searches, prompts the investigator to pursue mental alterations. There was no follow-up behavioral testing due to both the circumstances of a search and the retrospective nature of this phase of the study. The distribution of search incidents for the different patient profiles reflects two major study factors. In Virginia state mission numbers are only given after local law enforcement efforts have failed to locate the subject. In addition, the terrain and number of trails and roads make it difficult to become truly lost in the state. In fact, the profiles of ADRD, mentally retarded, despondent, psychotic, and child all represent decreased spatial and/or cognitive abilities

and together account for 56% of the state case load. Using current estimates of the prevalence of AD[58] and the 1990 population of elderly within Virginia[56], an estimated 68,500 Virginians suffer from ADRD. This represents 1% of the population compared to the 16% of all searches for ADRD patients. The data allows the development of a preliminary ADRD patient profile. Patients usually disappear from their private residence or a nursing home. More recently, an increasing number of cases are occurring from day-care centers. Once the patients become lost they are generally found close to the PLS. This data supports the few anecdotal case studies reported in the literature[4,13]. In addition, it supports the personal experience of the author reported elsewhere[20]. This finding is somewhat surprising considering DAT sufferers may be healthier than other age controlled elderly[59] and by definition only suffer initially from a loss in cognitive domains[1]. A possible explanation is that moderate DAT patients who showed shorter step length, lower gait speed, lower stepping frequency, greater step-to-step variability, and greater sway path[60]. While the investigators have heard many reports of Alzheimer's patients walking great distances (10-15 miles), no such case appeared in the Virginia retrospective case load. It is possible that as a larger data pool develops the mean distance of 0.9 km will increase. The median distance of 0.8 km will most likely remain stable. During three different studies by the author (n=24, n=42, n=87) both the median and mean have remained the same with additional data points. However, the prospective study, which included searches not involving law enforcement or state resources did include several statistical outliers that traveled 12, 8, and 4 miles. It is unknown if patients spend considerable time wandering or if they walk a fairly direct path. The considerable number (18%) of DAT patients found in drainages or creeks supports the following a path of least resistance hypothesis. This indicates they walked downhill. Another 29% of the patients appear to have become stuck in thick brush or briars (a feature untrained searchers often avoid). Together (47%), both terrain features indicate a scenario of the patient traveling a path of least resistance till they reach a creek or get stuck in briars.

The age of the patient has no predictive value in the patients' outcome (class) or distance from the PLS. This corresponds well to studies that show that age has no relationship with cognitive or behavioral disturbance or the rate of progression of ADRD[45]. The relationship between patients' outcome and the time elapsed to locate does have clear implications. Family members must not hesitate to contact law enforcement officers when an ADRD patient becomes missing. In turn, once law enforcement officials have determined the need for a search effort they must not hesitate to activate specialized SAR resources. These resources include management teams, trackers, tracking dogs, air-scent dogs, helicopters, and clue aware scratch (hasty) teams. The twenty-four hours for optimal results requires an immediate and aggressive response from all parties concerned.

Unfortunately, the state forms do not consistently provide information about the exact medical condition of the patient when found. If the patient was deceased, the Incident Commander did not receive a copy of the autopsy or the autopsy did not specify the exact cause of death. In those patients requiring evacuation, making a field diagnosis is often difficult. However, none of the data forms report trauma. This is rather surprising considering the large number of DAT patients (29-36%) that experience serious falls[5,36]. In fact, falls are more likely to occur in ADRD patients than in elderly controls[61]. The lack of any falls may be due to either the small database, lack of any autopsy results, or perhaps the difficulty in detecting evidence of a fall in a hypothermic patient. The only recorded disorders included hypothermia, dehydration, drowning, and unknown. Therefore, it appears ADRD patients are most likely to succumb to the environment and not to any

injuries or pre-existing diseases.

The data suggests critical wanderers are last seen between 06:00 and 24:00. There was no particular tight cluster of time, supporting Martine-Saltzman *et a1*.findings and suggesting the critical wanders in this study suffer from severe dementia[62]. Although no case was reported between 00:01 and 06:00 this does not preclude nocturnal wandering. Several cases of critical wandering were initiated after sunset. Furthermore, in one case while the patient was last seen at 22:30 the caregiver also reported hearing the patient leave the house at 02:30. The small sample size may have resulted in the lack of critical wanders between 0001 and 0600. Finally, care givers or institutional staff may not be present or awake to see the patient depart during these times.

The greatest number of searches occurred during the warm season. We defined the warm season as the frost free period and the cool season is the period in which freezing temperatures are likely to occur. The number of searches generally increased during the warm season and decreased during the cool season. We observed a slight increase in searches during February. Due to the small sample size no conclusions are drawn. Virginia's February often experience warm spells after protracted periods of cold. This increased wandering in February agrees with the undocumented observation of an increase in wandering after a cold period[2].

There are no significant differences between searches in urban and rural locations. This may be due to the small sample size. Alternately, Virginia SAR resources only respond into urban locations when significant parks or wooded areas exist. A larger percentage of searches with investigative finds in urban areas is not surprising. Subjects had ready access to public transportation and more opportunities to wander into public buildings or private residences.

This study indicates the need for an immediate and aggressive response to a critical wanderer. A critical window of 24 hours becomes apparent for survival. While there was only one fatality when the patient was located within this time frame, 30% of those found still required assisted evacuation. It is possible that any delay in initiating the search may have resulted in even more fatalities. In order to locate patients within the 24 hour window, an early activation of SAR resources is required. There was a positive relationship between the longer the time to activate SAR resources the longer it takes SAR resources to locate the patient. This may be due to a larger search area, decay of clues such as footprints and scent trails, or a greater chance of an unresponsive patient. More important was the relationship between the longer it takes to find the patient and the greater chance of mortality. This relationship has two confounding explanations. Unresponsive deceased patients are often more difficult to find. In addition, the longer the patient is exposed to the elements, the greater is the risk of mortality.

The lack of any statistical difference among the three types of topology was not predicted. This might have resulted from the small distances ADRD patients travel. A small insignificant difference was seen in the flat tidewater area with the subjects showing a mean of 0.2 miles less than Piedmont or Mountain areas. This would agree with the pattern seen among children and hikers in flat versus vertical topology. Another explanation may be that vegetation and barriers are more important in predicting travel than actual topology.

To better predict DAT missing patient behavior requires a much larger data pool. As Alzheimer's continues to increase in prevalence it unfortunately will become easier to collect data. We expect that the distances traveled by ADRD patients will be greater in less densely vegetative regions. Numerous roads and paths criss-cross even the most wilderness regions in the East thus limiting the distance that one can travel

without crossing a road. An obvious need to expand the database on a national basis in various types of terrain under must be pursued.

Summary

These preliminary findings indicate Dementia of Alzheimer's Type patients generally:

- Leave their own residence or nursing home and start traveling along roads.
- The patient is usually located (89% of all cases) within one mile (1.2 km) of the Point Last Seen.
- If the patients were not on the road itself (14%), they are usually in a creek/drainage (28%), and/or caught in briars/bushes (33%).
- Subject usually found a short distance from a road. Median 33 yards.
- The majority of patients succumb to the environment (hypothermia, dehydration) and require evacuation (35%) or are deceased (19%).
- Subject will not cry out for help or respond to shouts.
- Subject will not leave many physical clues.
- Subject may attempt to travel to a former residence or to a favorite location.
- Subject has previous history of wandering.
- Coexisting medical problems that limit mobility are common.

Suggested Search Techniques:

- Early use of trackers at point last seen (PLS)
- Early use of tracking dogs at PLS and along roadways.
- Early deployment of air scent dog teams into drainages and streams, start near PLS.
- Thoroughly search the residence/nursing home and surrounding grounds and buildings; repeat every few hours.
- Cut for signs along roadways and trails.
- Search heavy briars/bushes; remind field team leaders of this.
- Dog teams and ground sweep teams (in separate sectors) expanding from PLS.
- Air scent dog teams and ground sweep team tasks 100 yards (initially) parallel to roadways.
- Search nearby previous homesites and the region between homesites and PLS.

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