Therapeutic Error Calls Among Older Adults Reported to a Regional Poison Control Center in Alabama

Sophie Willis, PharmD, Ann Slattery, DrPH, RPh, William King, DrPH, MPH, and Kimberley Benner, PharmD

Objectives: Although Americans aged 65 years and older account for only 13.0% of the population, they consume one-third of all prescription medications each year. Increased life expectancy, age-related deterioration in health, and polypharmacy lead to a significant risk of potential medication errors. National Poison Data System studies have evaluated the older adult population and their interaction with poison centers; however, descriptive studies using regional poison center data to evaluate older adult–related medication errors, specifically in Alabama, have not been conducted. Our study assessed therapeutic errors in patients aged 65 years and older to evaluate the need for potential interventions by pharmacists and preventive education to reduce errors reported to the Regional Poison Control Center (RPCC) at Children's of Alabama.

Methods: A four-year retrospective analysis was conducted by gathering call-specific data from the RPCC toxiCALL database. Calls were included if they were made to the RPCC between January 1, 2010 and December 31, 2013, involved patients aged 65 years and older, and were coded as unintentional therapeutic errors. Analysis of call data was conducted using the Centers for Disease Control and Prevention's EpiInfo version 7.0.9.7.

Results: A total of 1699 calls were evaluated for patient demographics (sex, age), call data (month, year, shift, caller site), reason for therapeutic error, clinical effects, medical outcome, management site, and reported substance details. Nearly 40.0% of the therapeutic errors were caused by patients taking or being given the same medication twice. Five of the 15 reasons for therapeutic errors accounted for nearly 82.0% of all calls reported. The reasons included taking or being given the same medication twice (37.3%), taking or being given the wrong medication (14.6%), using an incorrect dosing route (13.1%), other incorrect dosing errors (9.9%), and taking doses too close together (7.5%). The top individual substance involved in a therapeutic error was reported verbatim by callers as Spiriva inhalation capsules (10.5%).

Conclusions: Therapeutic error calls represent a significant and increasing proportion of calls made by older adults to the RPCC. The frequent interactions between healthcare providers and patients create opportunities to prospectively prevent medication problems in older adult patients. Healthcare providers, specifically pharmacists, should encourage clients to always read the label on medications and should counsel patients carefully when dispensing a product that is not an oral preparation. In addition, although national drug take-back days are conducted biennially, patients should be encouraged to dispose of old medications and expired over-the-counter medications. The RPCC toll-free telephone number (800-222-1222) may be displayed to educate patients on its 24-hour/day availability. Current data will be used to implement programs for pharmacist interventions and to create appropriate educational material.

Key Points

- Longer life expectancy contributed to deteriorating health and increases in chronic conditions and polypharmacy, thereby resulting in an increased number of medication-related errors.
- Therapeutic error calls represent a significant and increasing proportion of calls made by the older adult population to the Regional Poison Control Center in Alabama.
- The results of this study provide a basis for further development of appropriate educational material and programs for pharmacist interventions.

From the McWhorter School of Pharmacy, Samford University, Birmingham, and the University of Alabama at Birmingham, Children's of Alabama.

Correspondence to Dr Sophie Willis, PharmD. E-mail: swillis0611@gmail.com.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal's Web site (http://sma.org/smj-home).

A.S. is employed by the Regional Poison Control Center, Children's of Alabama, as the managing director. The remaining authors have no financial relationships to disclose and no conflicts of interest to report.

Accepted March 7, 2016.

0038-4348/0–2000/109-356
DOI: 10.14423/SMJ.0000000000000467

Key Words: Alabama, epidemiology, medication errors/prevention and control, older adult, poison control centers

Each year, poisonings account for hundreds of thousands of hospitalizations and emergency department visits, with more than 40,000 deaths from unintentional poisonings.[1] In 2012, approximately 75% of more than 4 million calls annually to the poison centers resulted from exposures to poisons.[2] There are 55 poison centers located throughout the United States staffed by nurses, pharmacists, and physicians who are highly trained in toxicology and certified as poison information specialists to provide a 24-hour/day, toll-free telephone hotline resource.

Based on the National Poison Data System (NPDS) annual report, which gathered data from the 55 regional poison centers from 2002 to 2012, pediatric-related hotline calls remained constant, accounting for approximately half of human-exposure calls.[2,3] Exposure calls related to those aged 60 years and older continued to increase, from 4.4% (2002) to 7.0% (2012), however.[2,3] The 2015 North American Congress of Clinical Toxicology update reported that in 2013, the Health Resources and Services Administration's Poison Control Program started a 4-year initiative to increase awareness among Medicare beneficiaries about poison control resources and the toll-free hotline number. The Administration on Aging of the Department of Health and Human Services reported a 24.7% increase in the older adult population from 2003 to 2013 compared with the 6.8% increase for those younger than age 65, and projects that by 2030 this age group will account for 21.3% of the population of Alabama and 19.7% of the US population.[4–6] Based on current mortality conditions, those who survive to age 65 can expect to live, on average, an additional 19.3 years.[7] With increased life expectancy, the potential for chronic conditions and subsequent medications may increase. Although older adults account for only 14.1% of the population, they consume one-third of all prescription medications each year.[4,8,9] Increased life expectancy, age-related health deterioration, and polypharmacy result in significant risks for potential medication errors.

Although several studies based solely on NPDS reports previously examined older adult–related therapeutic errors, the results demonstrated nonspecific geographical analyses. As such, the results cannot be extrapolated because the studies limit us from taking into account region-specific variables such as comorbidity prevalence, literary levels, and resources.[10–16] When compared with national averages, Alabama's older adult population had higher poverty rates (11.5% vs 10.1% nationally), lower literacy rates, and a higher prevalence of many chronic disease states, including hypertension (33.1% vs 27.8% nationally) and hyperlipidemia; it ranked second overall for the prevalence of diabetes mellitus.[17–19] Lifestyle also plays a large role with Alabama ranking third highest in adult obesity in the United States (32%), which subsequently serves as a risk factor for many disease.[18]

With many factors differing between Alabama and national data, analysis of regional-specific data is vital to provide an epidemiological assessment to tailor educational material and potential pharmacist interventions to older adults in Alabama. The Regional Poison Control Center (RPCC) serves as the only poison information resource for the state of Alabama. The RPCC has conducted studies on therapeutic errors in pediatric and pregnant female patients; however, descriptive studies evaluating therapeutic errors involving only the older adult population are nonexistent. We undertook this study to examine the therapeutic errors reported to the Alabama RPCC involving individuals 65 years and older.

Methods

A 4-year retrospective data analysis was conducted to provide a descriptive epidemiologic profile of the telephone calls to the RPCC involving therapeutic errors in the older adult population. The inclusion criteria consisted of calls related to adults 65 years old and older who called the RPCC between January 1, 2010 and December 31, 2013, and were documented as "exposure" and "unintentional therapeutic error."[20,21] An "unintentional therapeutic error" was defined as "an unintentional deviation from proper therapeutic regimen that results in the wrong dose, incorrect route of administration, administration to the wrong person, or administration of the wrong substance."[21]

Data were collected via toxiCALL (Computer Automation Systems, Aurora, CO), an electronic medical record-keeping system housed on RPCC computers that complies with NPDS coding guidelines to produce consistent and unbiased data. Protocols exist for the collection of poison center information. Responses to each call are individualized to the exposure, regardless of age, and recommendations are based on such indicators as substance toxicity and symptoms. Medical and health histories are taken for all patients; these are key components because drug–drug interations may be identified. Raw data were collected with the following toxiCALL limits to meet the specified inclusion criteria: year code (2010, 2011, 2012, 2013), reason for exposure (unintentional therapeutic error), patient/caller age and age units (≥65, years), scenario (also called reason for therapeutic error, Appendix http://links.lww.com/SMJ/A49), and therapeutic outcome (also called medical outcome, Appendix). A search including all scenarios was conducted, which identified a total of 1795 medical records. There were 96 multiple reasons for exposure cases (ie, scenario codes 580 and 583 applied to the same case), which were counted as 1 medical record. As such 1699 medical records were analyzed.

An individual search with the above limits was conducted for each of the 15 scenarios and 8 medical outcomes. The data were exported from toxiCALL and saved as text-ASCII files, which were then imported into an Excel spreadsheet (Microsoft, Redmond, WA) and stored on an IronKey flash drive (Kingston Technology, Fountain Valley, CA), with data access limited to

Table 1. Demographics

	n (%)	95% CI
Sex		
Female	1169 (68.8)	66.5–71.0
Male	530 (31.2)	29.0–33.5
Age, y		
65–69	477 (28.1)	Total: 1699
70–74	388 (22.8)	Mean: 75.2
75–79	339 (20.0)	SD: 7.4
80–84	288 (17.0)	Min: 65.0
85–89	145 (8.5)	Max 99.0
90–94	52 (3.1)	Median: 74.0
95–99	10 (0.6)	

CI, confidence interval; SD, standard deviation.

the primary researchers. After compiling the raw data for each of the 15 scenarios, further searches were conducted to provide clinical effects, sex, and management site. Clinical effects were obtained for medical outcomes categorized as death, major, moderate, minor, and unable to follow via the toxiCALL "case detail reports with no patient data" option, which removed all patient identifiers to allow an in-depth review. Only clinical effects that were recorded as "related" were included. To fill the remaining sex data and site management gaps, the "case-list advanced" display option in toxiCALL was used. Each toxiCALL case number was coded in black (managed at home), green (referred to the hospital), or red (en route to or in the hospital) text color to correspond to the management site.

All raw data were collected after the completion of these searches, with further modifications made to the data collection spreadsheet. Caller start times were divided into the three shifts of the RPCC staff. Each substance was assigned corresponding substance pharmacological classifications and substance formulations. The number of combination and nonprescription products was identified, along with the total number of substances that each patient reported.

The data were analyzed using EpiInfo version 7.0.9.7 (Centers for Disease Control and Prevention, Atlanta, GA). Frequency table analyses were constructed for each variable with the resulting 95% confidence intervals for the estimated frequency percentages. The study was approved by the institutional review boards of the University of Alabama at Birmingham and Samford University.

Results

The ages of those reporting exposures ranged from 65 to 99 years, with a mean age of 75.2 years (±7.4). Calls from women accounted for nearly 70.0% of all therapeutic error calls to the RPCC (Table 1). The highest call volume occurred in the month of November (10.4%), whereas the lowest occurred in May (6.8%). Nearly half of the calls were received during shift 2 between 3:01 PM and 11:00 PM (46.6%). When compared with the total RPCC human exposure call volume regarding therapeutic errors, there was a significant increase in the proportion of calls to the RPCC made by older adults, from 2010 (20.1%) to 2013 (34.5%).

Five of the 15 reasons for therapeutic errors accounted for nearly 82.0% of all calls reported. Those reasons included taking or being given the same medication twice (37.3%), taking or being given the wrong medication (14.6%), using an incorrect dosing route (13.1%), other incorrect dosing errors (9.9%), and taking doses too close together (7.5%; Table 2). Each individual substance and pharmacological category was correlated to one or more reasons for therapeutic errors as indicated.

The medical outcomes of "no effect" (43.9%) and "not followed with the possibility of minimal effects" (33.6%) accounted for 77.0% of the outcomes. Furthermore, asymptomatic, drowsiness/lethargy, bradycardia, and others accounted for 50.0% of all clinical effects reported. The majority of cases were managed onsite (73.8%), with 78.6% of calls originating from home (Table 3).

The primary individual substance involved in therapeutic errors was reported verbatim by callers as Spiriva (Boehringer Ingelheim Pharmaceuticals, Ridgefield, CT) inhalation capsules (10.5%; henceforth here referred to as tiotropium). Cardiovascular medications were the top substance pharmacological category (36.4%) involved in therapeutic errors. In addition, the majority of medications reported were oral tablet or capsule

Table 2. Reason for therapeutic error

	n (%)	95% CI
530: Took/given medication twice	633 (37.3)	(35.0–39.6)
576: Wrong medication taken/given	248 (14.6)	(13.0–16.4)
527: Incorrect dosing route	223 (13.1)	(11.6–14.9)
533: Other incorrect dose	168 (9.9)	(8.5–11.4)
580: Doses given/taken too close together	128 (7.5)	(6.4–8.9)
575: Took/given someone else's medication	120 (7.1)	(5.9–8.4)
535: Other/unknown therapeutic error	108 (6.4)	(5.3–7.7)
581: Confused units of measure	23 (1.4)	(0.9–2.1)
579: More than one product with same ingredient	15 (0.9)	(0.5–1.5)
577: Health professional iatrogenic error	13 (0.8)	(0.4–1.3)
531: Incorrect formulation or concentration given	11 (0.7)	(0.3–1.2)
529: 10-fold dosing error	4 (0.2)	(0.1–0.7)
532: Incorrect formulation or concentration dispensed	3 (0.2)	(0.1–0.6)
528: Dispensing cup error	1 (0.1)	(0.0–0.4)
534: Drug interaction	1 (0.1)	(0.0–0.4)

CI, confidence interval.

Table 3. Outcomes

	n (%)	95% CI
Medical outcomes		
4: No effect	745 (43.9)	41.5–46.3
5: Not followed, min effects	570 (33.6)	31.3–35.9
7: Unable to follow, potentially toxic	153 (9.0)	7.7–10.5
3: Minor	116 (6.8)	5.7–8.2
2: Moderate	102 (6.0)	4.9–7.3
6: Not followed, nontoxic	7 (0.4)	0.2–0.9
1: Major		
Clinical effects		
Asymptomatic	63 (19.4)	15.4–24.3
Drowsiness/lethargy	37 (11.4)	8.3–15.5
Bradycardia	33 (10.2)	7.2–14.1
Other	31 (9.6)	6.7–13.4
Hypotension	19 (5.9)	3.7–9.2
Irritation/pain	19 (5.9)	3.7–9.2
Nausea	18 (5.6)	3.4–8.8
Dizziness/vertigo	13 (4.0)	2.2–6.9
Hypertension	10 (3.1)	1.6–5.8
Ataxia	7 (2.2)	
Hypoglycemia	7 (2.2)	
Caller site		
Home	1335 (78.6)	76.6–80.6
Other	229 (13.5)	11.9–15.2
HCF	122 (7.2)	6.0–8.5
Work	12 (0.7)	0.4–1.3
Management site		
1: Onsite	1245 (73.8)	71.6–75.9
2: Referred to HCF	296 (17.6)	15.8–9.5
3: En route to HCF	146 (8.7)	7.4–10.1

CI, confidence interval; HCF, healthcare facility.

formulations (88.1%), and most cases reported exposure to only one substance (77.8%). There were 137 combination products and 302 nonprescription products (Table 4).

Discussion

Although women make up 55.5% of the population aged 65 and older, nearly twice as many calls came from women as came from men.[22] The higher number of exposure calls regarding therapeutic errors in older adults from 2010 (20.1%) to 2013 (34.5%) strongly correlates to the growing older adult population and the increasing calls nationwide during the past 10 years.[2,3] In addition, the high call volume during the months of October, November, and December may demonstrate correlation between adherence and the many calendar holidays that occur. During these holidays, distractability increases as does older adult travel to warmer climes. The high frequency of calls during shift 2 between 3:01 PM and 11:00 PM suggests that evening doses pose problems; however, few of the top substances revealed in this analysis require evening administration. Because many physician offices are closed during this shift, patients may seek help from additional resources including the RPCC, thereby affecting call volume.

The primary reason for therapeutic error was taking or being given the same medication twice (37.3%). These errors may result from misunderstanding dosing schedules or forgetting whether medications were administered previously. Confusion related to administration errors may reveal the need for cognitive impairment tests or additional methods to decrease therapeutic errors. With each exposure call, a thorough medical/health history is taken as to how the exposure occurred and how the product was accessed (ie, in the original bottle, from a compliance aid). All of the responses are individualized to the exposures, regardless of age. Few studies have examined the most appropriate and effective method by which to decrease errors in older adults.[23–26] Electronic alarms and applications on cellular telephones can serve as administration reminders, compliance aides (eg, pill boxes) may decrease the risk of duplicate administration, and medication diaries that record adminstration times and adverse effects can be used during periods of uncertainty.[23–26] Personal medication records (PMRs) are not commonly reported, although they may be used as administration reminders and provide complete medication lists for other healthcare providers (HCPs) to better assess a patient's needs. Pharmacist-prepared PMRs include medication names, strengths, doses, clear directions for dosing frequency, indications for use, and special instructions. One study reported that multicompartment compliance aids improved clinical biomarkers such as blood pressure but only under close follow-up and care by pharmacists.[25]

Taking or being given the wrong medication (14.6%) and taking someone else's medication (7.1%) also were commonly reported scenarios. This confusion may be caused by similar appearances of the medications or poor eyesight, requiring ophthalmologic examinations. Modified PMRs, which contain previously mentioned components and additional descriptions of the appearance, such as shape, size, color, and imprints to correctly identify medications, may be beneficial. Furthermore, the font on prescription bottles often is difficult to read. Some pharmacies use methods to differentiate prescription bottles among patients; however, individuals may use alternative methods such as assigning each individual medication different stickers based on color/shape that are easily identifiable and may be placed on the bottle, ensuring visibility of the instructions.

The third most common reason for error was using the incorrect dosing route (13.1%). This error is largely the result of the common mistake of ingesting the tiotropium capsule, which also served as the primary substance reported. The tiotropium capsule contents are intended to be inhaled via the Spiriva HandiHaler device. Often, patients and/or family members are not aware of the toxicity of exposures; therefore, the free services that the RPCC provides can assist in preventing

Table 4. Substances reported

	n (%)
Substance	
Tiotropium (Spiriva) inhalation capsule	179 (10.5)
Amlodipine (Norvasc)	38 (2.2)
Levothyroxine (Synthroid)	32 (1.9)
Hydrocodone/APAP (Lortab, Norco)	31 (1.8)
Metformin (Glucophage)	26 (1.5)
Diltiazem (Cardizem, Taztia)	25 (1.5)
Carvedilol (Coreg)	25 (1.5)
Lisinopril	24 (1.4)
Plavix	22 (1.3)
Warfarin (Coumadin)	21 (1.2)
Donepezil (Aricept)	21 (1.2)
Acetaminophen (Tylenol)	20 (1.2)
Metoprolol tartrate (Lopressor)	20 (1.2)
Clonidine	17 (1.0)
Vitamin D	17 (1.0)
Substance pharmacologic category	
Cardiovascular	137 (36.4)
Anticonvulsant	22 (5.9)
Antidepressant	21 (5.6)
Benzodiazepines	21 (5.6)
Dementia	15 (4.0)
Lipid agent	15 (4.0)
Miscellaneous	15 (4.0)
Antidiabetic	14 (3.7)
Antiplatelet	12 (3.2)
Genitourinary	11 (2.9)
Supplement	11 (2.9)
Formulation	
Oral solid	1495 (88.1)
Topical	51 (3.0)
Injectables	46 (2.7)
Other	37 (2.2)
Oral inhalation	19 (1.1)
Otic	16 (0.9)
Oral liquids	16 (0.9)
Ophthalmic	9 (0.5)
Suppository	
Total no. substances reported per case	
1	1321 (77.8)
2	145 (8.5)
3	70 (4.1)
4	52 (3.1)
5	34 (2.0)
6	27 (1.6)
7	19 (1.1)
8	12 (0.70)
9	7 (0.4)
11	3 (0.2)
13	3 (0.2)
14	2 (0.1)
10	1 (0.1)
12	1 (0.1)
No. nonprescription products per case	
1	267 (88.4)
2	29 (9.6)
3	3 (1.00)
4	2 (0.7)
6	1 (0.3)
No. combination products reported	
1	127 (92.7)
2	8 (5.8)
3	2 (1.5)

unnecessary emergency department visits and expenses. Tiotropium is an excellent example of how repeated pharmacist-led counseling with patients and their families and counseling to always read the label are beneficial. This complies with Alabama Board of Pharmacy administrative code 680-X-2-21, which states that in the best interest of the public health patients are to be offered counseling for all new prescriptions. In addition, the newly developed Spiriva Respimat uses a solution that may reduce the errors associated with use of the capsules, although it may be difficult for patients to rotate the device as directed. The National Council on Patient Information and Education's Medication Use Safety Training Seniors program is an additional resource to decrease medication errors.[27,28]

Analysis also revealed a majority of medical outcomes as no effect or not followed because minimal effects were expected, although some were lost to follow-up because there was no answer or an incorrect telephone number was given. The 2013 State of Aging and Health in America report revealed that older adults account for 66% of the US healthcare budget.[29] With nearly 80% of the calls originating from home, there was a large amount of healthcare cost savings because 75% of the cases were managed onsite. The 2012 report of the American Association of Poison Control Centers (AAPCC) revealed that poison centers save more than $1.8 billion annually in medical costs, with the RPCC saving the state of Alabama more than $20 million/year.[30] Per RPCC data, more than 72% of human exposure cases received follow-up care, which exceeds that of national follow-ups (46.2%). Follow-up calls allow patients to be managed at home without seeking unnecessary medical care.[17] An overall decrease in calls to poison centers in the past 10 years has caused the AAPCC to express concern that many people are seeking medical care for

exposures that could have been managed at home by the poison centers.[20] At the same time, many are gathering incorrect information from Internet resources, contributing to the growing trend of self-diagnosis and self-prescribing. The AAPCC is concerned that those experiencing minor exposures are not contacting poison centers, and without proper monitoring, these situations may progress to more severe morbidity and mortality outcomes.[20] Data reveal the importance of the RPCC as a resource for improving morbidity- and mortality-related disease progression, as well as being a cost-saving system.

According to a 2012 Centers for Medicare and Medicaid Services report, the top 10 chronic disease states include multiple cardiovascular diseases, depression, and dementia.[31] These disease states correlate appropriately to cardiovascular medications (36.4%) being the top substance pharmacological category reported, with depression medications being the third most common (5.6%) and dementia medications as the fifth (4.0%). The NPDS revealed that the most common substances reported to be taken by patients aged 20 years and older were analgesics, sedatives/hypnotics/antipsychotics, antidepressants, and cardiovascular drugs.[20] The differences in substance categories are largely the result of the differing prevalence of disease states in those aged 20 and older versus those aged 65 and older. Although anticonvulsants, antidepressants, and benzodiazepines were the next most frequent classes reported, no medications within these classes were present in the top 15 substances. The many medications available within these classes may prevent one substance from being the standard of care. Furthermore, many older adult patients use Medicare insurance, whose preferred formulary may contribute to the use of specific medications. The correlation of disease states and substances reported demonstrates the potential need for additional patient education and detailed drug utilization reviews by pharmacists.

Although 137 combination products were reported, it is unclear whether decreased pill burden from these products reduces therapeutic errors. In addition, the majority of substances were solid formulations; however, the advancing field of compounding pharmacy could prove beneficial because products are used in differing formulations such as topicals, with age-related physiological changes always being considered.

The retrospective design of our study may be associated with the primary limitation of selection bias, because all calls to poison centers are voluntary; therefore, the "self-selected" sample may not be representative of all older adult therapeutic errors. It is unknown whether this is representative of all older adults taking medications without a random sample of the population. Furthermore, the substance analysis (Table 4) included only the first substance noted in the cases and excluded remaining substances. Pharmacological classifications in this study do not correlate to those of the NPDS. For example, the NPDS uses "antimicrobials" terminology, whereas our analysis used "antibiotics," "antifungals," and "antivirals." Furthermore, data cannot be extrapolated against NPDS data because NPDS data are based on individuals 20 years and older and lack older adult–specific analyses.[20,30]

Conclusions

Our study is the first advancement toward examining and understanding the health care of older adults in Alabama. Older adult–related therapeutic error calls represent a significant and increasing proportion of calls to the RPCC. The results of this study indicate that future studies may be required to examine gender roles, prevalence of comorbidities between the sexes, and the effect of the Medicare formulary on the substances involved in error. For many of the variables analyzed in this study, the root of the problem is unclear. A study that mirrors the substance pharmacological classifications of the NPDS may provide a more uniform analysis in which data may be compared between the RPCC and the NPDS.

Analysis of data related to patients aged 65 years and older is essential to determine how to develop HCPs that may optimally target the health of the growing older adult population in Alabama. Pharmacists possess the knowledge and training to provide optimal medication recommendations and the ability to create and implement programs; however, pharmacists are highly underused. The frequent interactions between HCPs and patients create opportunities to prospectively prevent medication errors in older adult patients. HCPs should encourage patients to always read the medication labels and counsel patients carefully when dispensing a product that is not an oral preparation. Although national drug take-back days are conducted biennially, patients should be encouraged to dispose of old medications and expired over-the-counter medications. Also, the RPCC toll-free telephone number (800-222-1222) may be displayed to educate patients about the 24-hour/day availability of the RPCC. Further research may assist in advancing the profession's role in preventing therapeutic errors, developing educational material tailored to the older adult population of Alabama, and ultimately advancing toward improved healthcare outcomes.

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