

**NEW PARADIGMS IN  
ALZHEIMER'S RESEARCH:  
**REVIVING THE TREATMENT  
LANDSCAPE****



Alzheimer's Association  
<http://www.alz.org/facts/overview.asp>

**There is scientific knowledge. And there is public perception. And often, the two collide.**

Nowhere is this reality more explicit than with the current state of Alzheimer's (AD) disease research.

Scientists hypothesize, but cannot definitively prove, that tangles of tau protein and build-ups of beta-amyloid plaque contribute to the hallmark cognitive decline of Alzheimer's disease. There is no specific test for the disease, no defining treatment, and no reliable yardstick to measure its progression.

Without a definitive cause or diagnosis – and no cure in sight – many aging adults see no reason to assess their risk, or determine their cognitive status, if little can be done to stave off the disease.

Perceptions such as these present a growing challenge to Alzheimer's research. While mounting evidence validates the benefits of early identification in keeping symptoms at bay, patients and their families often feel they have nothing to gain by seeking treatment or joining a clinical trial. Still others deny they have symptoms, due to fear of social reprisal or loss of independence.

Understanding these clinical research barriers is critical to developing strategies to overcome them.

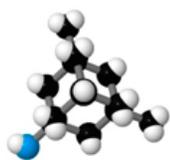
**Research failures and their impact on patient perceptions**

Both patients and the public have reason to be skeptical. No new Alzheimer's drugs have entered the market since memantine in 2003, and 229 unique compounds failed in clinical trials between 2002 and 2012 because they did not show benefit in patients.<sup>1</sup> Moreover, the small number of approved Alzheimer's drugs – only five on the market – do nothing to prevent or slow the disease. Rather, they attempt to alleviate symptoms in one of two mechanistically different ways.

Acetylcholinesterase inhibitors work by reducing the breakdown of an important neurotransmitter, acetylcholine, which regulates motor and memory functions. NMDA-receptor antagonists, such as memantine, help protect brain cells by blocking the activity of the neurotransmitter glutamate.

At normal levels, glutamate promotes memory and learning, but if the levels are too high, glutamate can overstimulate healthy brain cells and cause their demise. While evidence shows memantine can reduce specific symptoms, such as disorientation, delusions and aggression in mid- to late-stage patients, it has not slowed progression of the disease. And in a significant setback, a widely anticipated new class of drugs that target the tau protein failed to improve the majority of patients' cognition or daily functioning.

**229** unique compounds  
Failed in trials from 2002 – 2012



**1379** clinical trials  
Since 2003 have not shown benefit



The cumulative failure of Alzheimer's research to produce new and innovative drugs creates yet another obstacle to clinical trial enrollment in a field where engaging participants is already fraught with complications.

### Expanding potential targets

Today, Alzheimer's research is poised to develop promising new therapies and more precise screening and diagnostic tools. Recent studies have implicated a wide range of previously unexplored processes in the progression of Alzheimer's, from leakiness in the blood-brain barrier membrane<sup>2</sup> to an inflammatory response involving the brain's microglial immune cells.<sup>3</sup> Each of these mechanisms presents a potential target for treating symptoms or slowing disease progression.

Likewise, the landscape of investigational drugs is expanding, with 381 Alzheimer's drug candidates in various stages of clinical trials,<sup>4</sup> and nearly 100 industry-sponsored trials demanding a sizeable cohort of more than 50,000 patients to test their safety and efficacy.<sup>5</sup>

**381** new drugs in preclinical - phase 3 development



**77** compounds in industry-sponsored trials today



One of the most widely anticipated class of drugs being tested are immunotherapies designed to target and clear the build-up of toxic beta-amyloid protein, which causes the characteristic deposits of plaque in the brain. While the recent failure of the solanezumab trial in patients with mild Alzheimer's disease is a serious setback to drugs in the anti-amyloid category, the results of the aducanumab, crenezumab and gantenerumab trials will now be even more important, should they demonstrate efficacy.

Meanwhile, companies are increasingly broadening their targets beyond beta-amyloid and tau to identify proteins and pathways that may alter the course of Alzheimer's through unexplored mechanisms. Developing drugs that will slow the progression of the disease is one of the most pressing needs in medicine today, as 76 million baby boomers continue to age.

Among the new targets are 5-HT<sub>6</sub> receptors, which are abundantly located throughout the brain's learning and memory regions such as the hippocampus, nucleus accumbens and striatum. Drugs that target these receptors, known as 5-HT<sub>6</sub> antagonists, work by promoting the release of acetylcholine as well as other neurotransmitters known to affect cognition and memory. While recent results from 5-HT<sub>6</sub> clinical trials have been disappointing, this class of drugs could ultimately improve symptoms in subsets of patients, and several phase 3 trials are progressing as planned.

Yet another mechanistically different class of drugs targets the brain's alpha-7 nicotinic acetylcholine receptors, which may influence brain function by acting directly on neuronal pathways and by reducing inflammation in the central and peripheral nervous systems. Compounds in this class of drugs have not yet shown clinical benefit, but research continues to move forward.

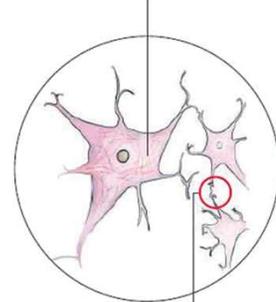
## Alzheimer's Brain Changes

### IN A HEALTHY BRAIN

Protein fragments known as amyloid peptide develop between the neurons. A healthy brain can dissolve them.

### A NORMAL NEURON

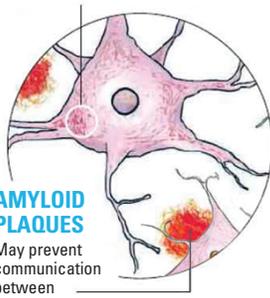
Normal transmission of nutrients within brain cell



Normal transmission of signals between two neurons

### IN AN ALZHEIMER'S BRAIN NEUROFIBRILLARY (TAU) TANGLES

Stunt the transmission of nutrients and/or other substances within the neuron.



### AMYLOID PLAQUES

May prevent communication between neurons

### IN A BRAIN WITH ALZHEIMER'S BRAIN DISEASE

Beta-amyloid proteins build up and form hard plaques in the spaces between neurons. Tau proteins malfunction and form twisted threads or "tangles" inside the neurons.

## Phase 3 Development

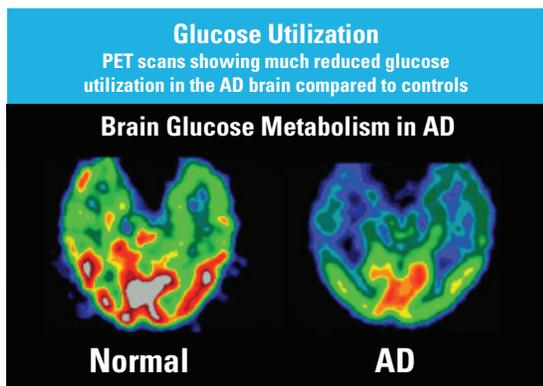
Product Name	Sponsor	Indication
AC-1204 (glucose stimulant)	Accera Broomfield, CO	mild to moderate Alzheimer's disease
aducanumab (BIB037) (amyloid beta protein inhibitor)	Biogen Cambridge, MA Neurimmune Zurich, Switzerland	Alzheimer's disease
ALZT OP1 (amyloid beta protein inhibitor)	AZTherapies Boston, MA	Alzheimer's disease
ARC-029 (nilvadipine)	Archer Pharmaceuticals Sarasota, FL NILVAD Dublin, Ireland	Alzheimer's disease
AVP-786 (dextromethorphan analogue/quinidine)	Avanir Pharmaceuticals Aliso Viejo, CA Concert Pharmaceuticals Lexington, MA	agitation in Alzheimer's disease (Fast Track)
azeliragon (TTP488) (RAGE antagonist)	vTv Therapeutics High Point, NC	Alzheimer's disease (Fast Track)
brexipiprazole (dopamine partial agonist)	Lundbeck Deerfield, IL Otsuka Pharmaceutical Tokyo, Japan	agitation in Alzheimer's disease
crenezumab (beta-amyloid protein inhibitor)	Genentech South San Francisco, CA	mild to moderate Alzheimer's disease
gantenerumab (amyloid beta protein inhibitor)	Genentech South San Francisco, CA	early-stage Alzheimer's disease
idalopirdine (serotonin 6 receptor antagonist)	Lundbeck Deerfield, IL Otsuka Pharmaceutical Tokyo, Japan	Alzheimer's disease
immune globulin	Grifols USA Los Angeles, CA	Alzheimer's disease
pioglitazone (insulin sensitizer)	Takeda Pharmaceuticals Skokie, IL	mild cognitive impairment due to Alzheimer's disease (prodromal Alzheimer's disease)
RVT-101 (serotonin 6 receptor antagonist)	Axovant Sciences New York, NY	mild to moderate Alzheimer's disease (adjunctive treatment)
solanezumab (amyloid beta protein inhibitor)	Eli Lilly Indianapolis, IN	Alzheimer's disease, pre-clinical Alzheimer's disease
TRx0237 (tau protein aggregation inhibitor/TDP-43 aggregation inhibitor)	TauRx Pharmaceuticals Singapore	mild Alzheimer's disease
verubecestat (MK-8931) (BACE1 protein inhibitor)	Merck Kenilworth, NJ	Alzheimer's disease, prodromal Alzheimer's disease

### Improving detection

On the diagnostic front, the Alzheimer's community is making great strides toward earlier and less invasive methods for detecting the disease and its precursors. According to Datamonitor Health's Alzheimer's disease report, "A substantial opportunity thus exists for pharmaceutical companies to drive an increase in the wider Alzheimer's disease market by improving diagnostic capabilities, dispelling the notion that cognitive decline is a normal fact of aging, and increasing awareness of the benefits of obtaining an early diagnosis."<sup>7</sup>

Among the latest studies, researchers have definitively linked four biological markers found in cerebrospinal fluid – T-tau, P-tau, Aβ42, and NFL – to the eventual onset of Alzheimer's disease.<sup>8</sup>

Sophisticated imaging techniques are illuminating structural and functional brain changes caused by Alzheimer's, from shrinkage of the hippocampus, the brain's central memory repository; to the slowing of glucose metabolism, which serves as brain fuel for nerve cells. Pinpointing these hallmark changes will help scientists find new ways to thwart them.



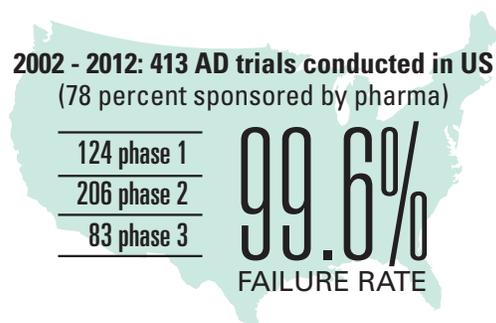
New Jersey Institute for Successful Aging, Rowan University. Robert Nagele, PhD; Anita Chopra, MD.

Even more exciting, researchers at several institutions have developed experimental blood tests that do not require a lumbar puncture to detect proteins that signal the onset of Alzheimer's brain changes. In a proof-of-concept study published in the journal

*Alzheimer's and Dementia*, researchers identified a set of 50 antibodies in blood samples that predicted with 100 percent accuracy whether a patient with mild cognitive impairment would eventually develop Alzheimer's disease. The test, while experimental, was so sensitive that it was able to distinguish between mild cognitive impairment caused by Alzheimer's versus Parkinson's or multiple sclerosis.<sup>9</sup>

### Rapid drug screening

Behind the scenes, researchers are fervently working toward expediting the screening of promising compounds that could block, activate or otherwise influence Alzheimer's pathways to alter the disease trajectory. While animal research models have long been the mainstay for testing a drug's potential, a staggering number of Alzheimer's drugs – 99.6 percent between 2002 and 2012 – have failed once they enter human trials.<sup>10</sup> The current mouse models of Alzheimer's can't fully reproduce the genetic, cellular, or behavioral complexity of Alzheimer's disease.



Researchers around the world are in the midst of testing intriguing new models of the human brain that are more robust and predictive of how investigational drugs will behave in humans. From a "mini-brain" organoid model of Alzheimer's disease<sup>11</sup> to a 3D human neural culture model that produces beta-amyloid plaques and tau tangles,<sup>12</sup> these brain models are designed to provide faster, cheaper, and more reliable screening platforms to test new Alzheimer's agents.

**A new research paradigm**

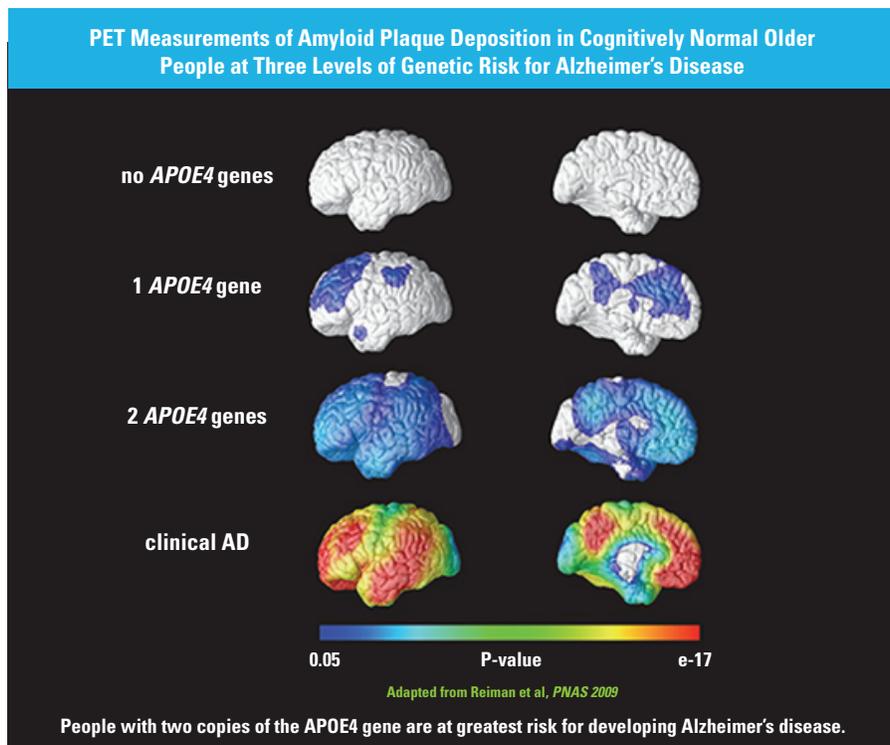
To energize the field, a significant shift in Alzheimer's clinical practice is underway worldwide, where providers are increasingly treating patients with mild cognitive impairment or assessing at-risk individuals with no symptoms at all. In part, this shift is dictated by practical matters. Medicines that have failed in moderate or severe Alzheimer's disease have performed better in its earlier or preclinical stages. But from a macro level, halting the disease before it inflicts major damage is a more viable approach than trying to reverse damage once it has occurred.

Evidence supports this change in approach. A range of new studies has identified subtle brain changes as early as four years old in children with the APOE4 version of the gene, along with corresponding deficits in tests of executive function and working memory.<sup>13</sup> A similar study found that young adults who scored high on a test measuring all the high-risk Alzheimer's gene variants were more likely to have a smaller hippocampus – a brain structure critical for learning and memory.<sup>14</sup>

Yet early treatment requires early identification of high-risk patients, a challenge that has plagued the

clinical research community for decades. Currently, 80 percent of Alzheimer's studies are delayed because of insufficient patient enrollment,<sup>15</sup> and this delay significantly impedes the testing and approval of new drugs. To speed the clinical trial enrollment process, collaborative programs such as GENEMATCH are building huge databases of high-risk older adults in order to pre-screen subjects who can then be matched to Alzheimer's clinical trials that best fit their qualifications. Thus far, more than 222,000 older adults with the APOE4 gene variant but no cognitive impairments have signed up for the registry.

Clinical trials have already begun to enroll at-risk, asymptomatic patients to test investigational drugs designed to arrest brain changes before they cause irreparable damage. Among the drug trials currently underway is an industry collaboration between two of the world's largest pharmaceutical companies to assess the effects of two investigational therapies on cognition and underlying pathology in older individuals with the APOE4 gene variant. The ultimate goal is to determine whether either drug can prevent or delay the onset of symptoms in people who are genetically at risk for developing Alzheimer's but are not yet displaying symptoms.



### Barriers to clinical trial recruitment

Despite these advances, substantial barriers are slowing the clinical testing of new drugs on the horizon. Among them is the unpredictability of human behavior. People with few or no symptoms may perceive a low risk of Alzheimer's or attribute their forgetfulness to normal aging, thereby ignoring clinical trials. Those with substantial cognitive decline are unreliable witnesses to their symptoms, and caregivers may not be fully aware of, or agree upon, their loved one's deficits. In addition, symptoms progress along a continuum,

not in the distinct phases that clinical trials delineate for inclusion.

Each of these factors could dictate whether patients meet study trial criteria and whether the right patient with the correct symptoms is placed in the appropriate trial.

Experts in the field acknowledge that recruiting and retaining clinical trials participants is "currently the greatest obstacle to developing new Alzheimer's treatments."<sup>16</sup>

#### Patient barriers to participation include:

- **Stigma.** Social exclusion is a major theme for people with dementia, with 40 percent of survey respondents reporting they were avoided or treated differently because of their dementia.<sup>17</sup>
- **Concomitant health factors.** Patients may rank acute conditions such as cancer, diabetes or hypertension as more pressing issues.
- **Treatment risks.** Invasive testing of cerebrospinal fluid or imaging modalities such as PET or MRI may deter healthy patients from enrolling in trials.
- **Perceived benefit.** In the absence of clear benefit to early diagnosis or treatment, patients may choose to forgo a clinical trial.
- **Logistics.** Trials require frequent and often lengthy visits. Some patients lack a caregiver to transport them to clinical visits, and not all patients are healthy enough to attend regularly.
- **Lack of awareness.** Mild symptoms may be attributed to normal aging, thus deterring people from seeking a medical evaluation.
- **Placebo.** Patients may worry about the potential for receiving a placebo and not active drug.

#### Clinician barriers include:

- **Lack of standard AD test.** The number and variety of tests makes it difficult to uniformly assess symptoms. Some tests measure cognitive abilities while others measure functional decline.
- **Primary Care Physician (PCP) vs. Specialist.** Specialists have access to more precise and sophisticated screenings and computerized tests than PCPs, which could affect the patient's diagnosis and/or clinical stage.
- **Interpretation.** AD occurs along a continuum rather than distinct stages. Without clear consensus on the staging of Alzheimer's progression, clinical diagnoses vary.
- **Disease variability.** Not all patients with mild cognitive impairment will progress to Alzheimer's. There are no set parameters for distinguishing the two groups.
- **Repetitive testing.** Patients frequently repeat the same test and may recall the answers, thereby skewing the results.
- **Unknown population.** Defining a population by the absence of disease is a difficult endeavor. At-risk patients may not see themselves at risk and thus may not come forward to participate.

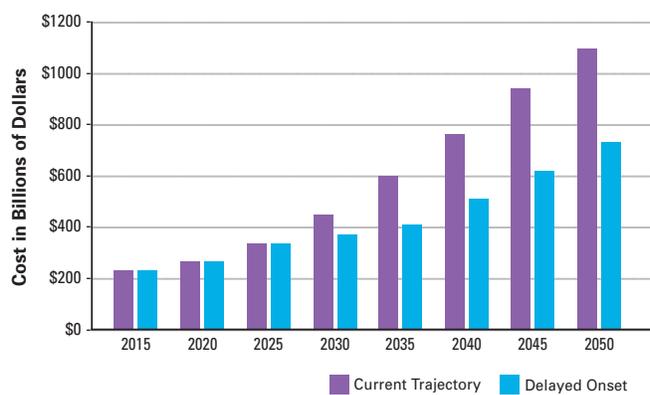
From a psychological perspective, physicians are often reluctant to refer asymptomatic or mildly impaired patients to clinical trials because they fear that current investigational drugs are no different mechanistically than previous Alzheimer's drugs that have failed. They also worry that genetic testing for high-risk individuals may provoke fear and anxiety without any viable options for preventing or treating the disease.

**Patients do not necessarily share physician concerns. A study published in the *New England Journal of Medicine* found that healthy, asymptomatic adults in their 50s did not suffer more anxiety or depression upon finding out they had the APOE4 gene than the individuals who found out they did not have the gene variant. Those who tested positive for APOE4 were slightly more distressed, but they quickly rebounded, the study found. With proper genetic counseling, patients understood and accepted the results of the genetic test.<sup>18</sup>**

However, a growing body of evidence reinforces the benefits of early intervention as a means of potentially slowing pathological processes that lead to neurodegeneration and eventual cognitive decline.<sup>19</sup> New compounds in development are likely to have greater efficacy in modifying the disease course when used before extensive and irreversible damage has occurred.

The reduction in societal burden would be massive, according to the National Center for Biotechnology Information. A hypothetical intervention that delays the onset of Alzheimer's dementia by five years would reduce the number of patients with this symptom by 57 percent and thus reduce the projected Medicare costs of treating AD from \$627 billion to \$344 billion.<sup>20</sup>

### Projected Impact of a Medicine that Delays Alzheimer's Disease Onset by 5 Years, 2015-2050



Source: Alzheimer's Association. "Changing the Trajectory of Alzheimer's Disease: How a Treatment by 2015 Saves Lives and Dollars." May 2015, [http://www.alz.org/documents\\_custom/trajjectory.pdf](http://www.alz.org/documents_custom/trajjectory.pdf)

### The critical role of a study partner

Overcoming obstacles to clinical trial participation requires a much greater degree of sophistication in recruitment strategies and more in-depth screening and retention practices than is typically the case with a less complex condition. Working with an experienced patient recruitment partner can relieve the burden of attending to exhaustive recruitment strategies, which have exponentially increased in number and complexity as Alzheimer's trials have grown longer and more involved. An experienced patient recruitment partner has access to trial-ready patients and/or caregivers; a thorough understanding of patient motivations; keen awareness of the nuances and subtleties of effective messaging to reach the target audiences; proven methodology of screening and qualifying participants; on-the-ground site collaboration and site support; and partnerships with experts and patient groups in the field.

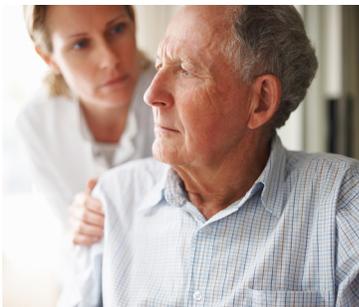
### **Expansive database**

Relevant data and strategic insight are critical, but they won't connect you to actual individuals who can enroll in an Alzheimer's trial. A patient recruitment partner with an expansive database of trial-ready patients provides a ready-made source of potential participants that can be easily tapped via email, phone, mail or digital media without having to rent or purchase an outside database.

Using this proprietary database enables the study partner to conduct surveys in a matter of hours or days, not weeks or months, to obtain valuable feedback on patient motivations, barriers to participation, and attitudes toward Alzheimer's research. The input obtained from patients and caregivers enables the study partner to identify unique subgroups of patients within each therapeutic area. The study partner can then develop and refine high-impact messages that speak directly to the concerns and motivations of each respective subgroup.

### **Patient perceptions**

To better understand the target audiences for Alzheimer's-related clinical trials, Acurian identified and surveyed at-risk patients and family members from its database of households with memory loss or Alzheimer's disease. Responses from 1,886 asymptomatic individuals revealed four distinct patient segments.



**Avoiders who are afraid to assess their risk**



**Unaware individuals who presume they are not at risk in the absence of a family history of Alzheimer's**

**Cautiously aware individuals who are worried about their risks and would consider taking action**



**Active seekers who are looking for ways to reduce their risk or prevent the onset of symptoms**

More than 78 percent of patients said they were interested in learning whether they are at risk for Alzheimer's, although self-reporting does not always correspond to patient behaviors.

The feedback obtained from the survey provides valuable insights that shape Acurian's messaging and recruitment strategies. Ultimately, the goal of a successful Alzheimer's messaging strategy is to shift the mindset of individuals from the first three categories into the seeker mode, where they understand the benefits of early testing and treatment, embrace the opportunity to assess their risk, and are willing to participate in trials that may reduce their risk or alleviate symptoms.



### **The role of caregivers**

Caregivers are one of the most important audiences for clinical trials. This population knows the realities of the disease, and they are motivated to advance research on behalf of their loved ones and their own future risks. In the Acurian survey, nearly 67 percent of caregivers have shared their family member's status with others, indicating they feel it is important to openly discuss the topic. They are interested in genetic testing, and they understand the benefits of early treatment. However, caregivers indicated they are stressed and overburdened, and they have little time for anything other than caregiving, much less a clinical trial. Offering transportation to and from study visits and reimbursement for time and travel could help alleviate their barriers to trial participation.

### **Protocol matching**

Alzheimer's disease progresses along a continuum rather than in distinct stages, making it extraordinarily difficult to match patients to specific protocols. Understanding relevant milestones along the Alzheimer's continuum allows an experienced study partner to build nuanced screeners and train qualified phone support to match patients with the protocols that best fit their symptoms. Acurian's team of 200 protocol-trained call center professionals, located in seven strategically placed call centers, manages 3,000 to 4,000 calls per day.

### **Ground force support**

Knowledge breeds empowerment. Educating the local community provides a mechanism for dispelling myths and breaking down barriers. In-person meetings engender goodwill by demonstrating a level of commitment and accountability to local needs that paper fliers and phone calls cannot achieve. Successful outreach strategies focus on giving, not asking for, information. In return, community members are more likely to volunteer their contact information for future engagements or clinical trials.

Examples of outreach events include meeting with chapters of patient advocacy groups; hosting awareness events at community centers, libraries, churches, synagogues and senior centers; memory screenings at health fairs; and speaking to local civic groups.

### **Data-driven and technology-enabled pre-screening and enrollment**

Screening technologies must be built to handle not only volume, but complex protocol logic, especially as it relates to Alzheimer's-related studies. Measures of mood and memory are notoriously fickle and given to individual interpretation, so the study enrollment partner must have extensive experience in screening vast numbers of people to successfully pinpoint qualified patients.

Acurian globally pre-screens an average of 10,000 study candidates per day for dozens of trials, and has pre-screened up to 50,000 study candidates for its largest trials. Its data capacity is second to none, and the company leverages only 20 percent of its proprietary database and marketing capabilities at any given time. Acurian's combination of technology, data assets and employee headcount is structured to handle up to 700,000 randomized patients per year. To navigate the complexity of Alzheimer's disease, Acurian employs phone- and web-based cognitive testing at the pre-screening level to more precisely segment study candidates into the cognitive ranges required for randomization in a given study protocol.

### Patient-centric tactics

Clinical trials are designed to answer very specific questions that must satisfy medicine's need for clarity and specificity, and regulatory agencies' need for compliance and safety. The patient perspective is typically not part of the clinical trial design. However, this model has created a less-than-ideal scenario for recruiting patients. Minimizing the patient burden will create a more favorable climate for attracting greater numbers of patients to enroll in clinical trials.

- **Reduce bureaucracy:** Work with sponsor to shorten lengthy paperwork and consent forms that might deter physicians from becoming study sites and/or patients from enrolling.
- **Listen and learn:** Understand the attitudes, beliefs and motivations of potential patients through interviews, surveys, patient panels and advisory boards. Closely follow social media to gauge patient and caregiver sentiments about Alzheimer's disease and its impact on the family, and clinical trials. Social media listening and interaction requires daily monitoring and nearly instantaneous responsiveness.
- **Be nimble and responsive:** When strategies fail, quickly shift messaging to a new approach or an untapped population of patients. Social media allows for instant output, input and the ability to rapidly tweak messages accordingly.

### The silver lining: Nowhere to go but up

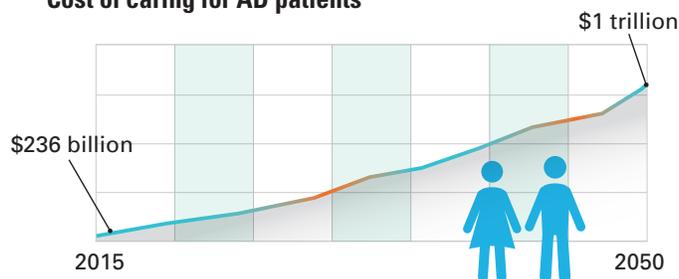
Given today's barren landscape, the playing field for new Alzheimer's drugs is wide open and primed to embrace even small, but measurable, gains in delaying the disease or effectively reducing its symptoms.

The burden is collectively placed on all of us to dramatically change our approach to brain research, and then communicate our successes in ways that the public can embrace and understand. Public perception about Alzheimer's research is understandably negative, and this perception must change before patients decide it is worthwhile to join clinical trials.

Appealing to people in ways that speak to their fears, desires and motivations will move them toward a clearer understanding of the benefits of early intervention.

The biggest winners will be families and society at large, both of which are suffering under the massive weight of mental anguish and financial debt. Alzheimer's currently affects 5.2 million Americans, and that number is expected to triple by 2050 as the population increases. In 2016, the cost of caring for patients with Alzheimer's and other dementias is estimated to reach \$236 billion.<sup>21</sup>

### Cost of caring for AD patients



Despite these numbers, the Alzheimer's community at large has been frustratingly slow to abandon strategies and classes of drugs that have failed to show benefit or efficacy. In the race to flip this paradigm, the first company to succeed with a new drug that delays, treats or halts the ravages of Alzheimer's stands to reap inestimable gains. When this happens, everybody wins.

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- <sup>21</sup> Alzheimer's Association. 2016 Alzheimer's Disease Facts and Figures. <http://www.alz.org/facts/>

**About Acurian**

Acurian, a subsidiary of PPD, is a leading full-service provider of clinical trial patient enrollment and retention solutions for the life sciences industry. The company increases the enrollment performance of investigator sites worldwide by identifying, contacting, prescreening and referring people who live in the local community but are unknown to a research site. As a result, trial sponsors complete enrollment without incurring the unexpected expense of adding sites or time.