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ORIGINAL RESEARCH: REPRINT

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SUBJECT REVIEW

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Carle Research Newsletter
Dear Readers:

Welcome to our latest edition of Carle Selected Papers. We not only have great content for you in this issue but also some exciting things on our horizon.

We have had several requests from readers for a paperless delivery of Carle Selected Papers. While we will always continue to produce hard copies, we do wish to accommodate those interested in receiving their journal via email. If this delivery method appeals to you, contact us at CarleSelectedPapers@carle.com. It is our desire to serve the needs of our readers to the best of our abilities, and we ask that you submit to us any suggestions on how to improve.

This issue highlights the growing population of geriatric patients, the so-called “silver-tsunami,” that is rapidly approaching. As geriatric medicine expands it will bring with it a specific set of patient needs. One major concern when dealing with the elderly is assessing their driving ability. A troubling subject for patients and their families, this also presents particular issues and responsibilities to physicians. Dr. Fola’s article examines effective ways to gauge a patient’s driving skills and help address this delicate subject.

Among the many challenges that face the elderly population, falls are an area of great and grave concern. We are pleased to include an article by Dr. Suma Peter and Paula Swinyer on how to perform an abbreviated fall risk assessment even in a busy office practice.

Two interesting individuals are featured in our “Profiles” section. We are delighted to present a Q and A with both Dr. James Dougherty, Carle’s vice president of Research, and Dr. Kara Fedemeier, a professor of Cognitive Neuroscience at the Beckman Institute.

This edition also features a reprint of an article by Dr. Federmeier on normal aging of the brain. This article first appeared in Language and Linguistics Compass and we are pleased to include it here.

Positive patient outcomes are always the goal for healthcare practitioners and personnel. While treating diabetic patients in the acute setting can be a challenge, Ann Garey presents a study that demonstrates how using a diabetes advanced practice nurse can improve glycemic control. Additionally, teaching patients about upcoming surgeries – what they can expect from their experience and how to physically and mentally prepare for surgery – can vastly improve patient experience and satisfaction. Julie Kennedy examines the latest evidence in orthopedic pre-operative education using a seminar approach. The findings may surprise you.

We have two case reports this edition. Dr. Michael Jakoby presents a patient with factitious hypoglycemia due to peritoneal dialysis with icodextrin dialysate. In the second, Dr. Abraham Kocheril presents a patient with symptomatic heart failure in whom the technique of Cardiac Resynchronization Therapy (CRT) was optimized using gas exchange.

Sadly, we also say goodbye to a longtime colleague of Carle Selected Papers. Jerry DeWitt, the valued reference editor at CSP, is retiring at the end of the year. We thank Jerry not only for his dedication and vast knowledge but also for the amusing and oft-needed wit he brought to this project. We wish him health and happiness in years ahead. He will be sorely missed.

As always if you have an interesting case you would like to present through Carle Selected Papers don’t hesitate to contact our editorial staff. Topic suggestions are especially welcome. I also want to remind you that current and past issues of CSP are posted online at carleconnect.com/publications.aspx. This is a great resource, and we encourage you to use it and to refer new readers.

William Schuh, MD
EXECUTIVE EDITOR
Original Research: REPRINT

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EDWARD W. WLOTKO
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KARA D. FEDERMEIER
Language of the Aging Brain: Event-Related Potential Studies of Comprehension in Older Adults

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Abstract
Normal aging brings increased richness in knowledge and experience as well as declines in cognitive abilities. Event-related brain potential (ERP) studies of language comprehension corroborate findings showing that the structure and organization of semantic knowledge remains relatively stable with age. Highlighting the advantages of the temporal and functional specificity of ERPs, this survey focuses on age-related changes in higher-level processes required for the successful comprehension of meaning representations built from multiple words. Older adults rely on different neural pathways and cognitive processes during normal, everyday comprehension, including a shift away from the predictive use of sentential context, differential recruitment of neural resources, and reduced engagement of controlled processing. Within age groups, however, there are important individual differences that, for example, differentiate a subset of older adults whose processing patterns more closely resemble that of young adults, providing a window into cognitive skills and abilities that may mediate or moderate age-related declines.

1. Introduction
Our cultural adages tell us that with age and experience comes wisdom, and, indeed, empirical data show that healthy older adults often have richer vocabularies and augmented stores of world knowledge (Light 1992). However, aging also brings decline in both physical and psychological abilities: a sore back or more difficult climb up the stairs may be accompanied by decreased ability to remember a phone number or the grocery list, increased tip-of-the-tongue experiences, and a harder time focusing concentration on a particular task. These psychological facets of normal aging are likely to become more consequential as life expectancy continues to increase in the developed world and as medicine offers more solutions to the physical problems of aging. It is clear that research on cognitive aging is an imperative so that intellectual functioning can be correspondingly prolonged.

Language comprehension is a particularly critical skill for normal everyday life, and one that occupies a fairly unique position in cognitive aging research. As opposed to memory, executive function, and most other cognitive phenomena, important aspects of comprehension have been thought to be relatively protected against age-related degradation. Although certain language tasks become harder with age, especially when resources are heavily taxed, older adults report little change in their ability to engage in conversations, read novels or the newspaper, and use language in everyday situations (Light and Burke 1993). Behavioral evidence corroborates these subjective impressions, in that older adults and younger adults often show generally similar performance on comprehension-related tasks (Burke and Shafto 2008). Yet this stability is surprising in light of the myriad age-related cognitive and neural changes that have been documented, many of which are...
required for the rapid, complex processes involved in language (Craik and Salthouse 2008). It seems likely, therefore, that across the lifespan comprehension goals may be successfully met via importantly different configurations of cognitive and neural resources.

In fact, recent evidence – particularly from measures of processing during on-line comprehension, such as electrophysiological brain activity collected as participants read or listen to language – reveals that aging is associated with both quantitative and qualitative changes in the processes used to comprehend language. Work using event-related brain potentials (ERPs), which provide functionally and temporally specific indices of cognitive processing, has shown that the organization of knowledge in what is generally referred to as ‘semantic memory’ does seem to be similar for younger and older adults and that basic aspects of word processing remain stable across the life span. However, there are important age-related – and individual – differences in how that word-related information is then used during on-line language processing. Delineating these processing differences is critical for building an understanding of how the aging brain makes the best use of available resources, skills, and knowledge to afford rapid and successful comprehension, thereby allowing older adults to gain information from the environment and communicate to build and maintain social ties. Our review focuses on ERP findings at the word, sentence, and discourse levels, and in late controlled processes involved in the online construction of message-level meaning from text or speech unfolding in real time. We conclude with a discussion of individual differences that modulate the changes that are seen at the group level.

2. Electrophysiology of Language and the Aging Brain

Language is fast, complex, and hierarchically constituted. Successful translation of the noisy, relatively arbitrary, and often ambiguous language stream into meaning requires equally rapid cognitive processing composed of sub-processes using multiple mechanisms at several interacting levels. Although the study of cognitive aging is a truly multidisciplinary endeavor that involves methodologies, data, and theorizing at levels ranging from genetics and cell biology to sociology, characteristics of ERPs have made this method particularly valuable for the study of language comprehension. ERPs directly reflect (some portion of) neural activity in the brain, as they consist of voltage deflections recorded at the scalp that are generated by the synchronous firing of cortical neurons associated with some type of internal or external stimulus or response – in the case of language, usually words (see Allison et al. 1986; Luck 2005; see also Kutas et al. 2006, 2007 for language-specific discussions of the ERP).

The neural activity is recorded in real time, so that the ERP provides a millisecond-level record of brain activity that is concurrent with cognitive processing, rather than occurring several hundreds of milliseconds downstream (as is true of behavioral measures as well as imaging methods, such as functional magnetic resonance imaging, that measure slower hemodynamic signals). This characteristic also affords the functional specificity of ERP ‘components’ – identifiable features of the waveform that are associated with particular cognitive and neural processes. For example, components in the first several hundred ms after stimulus onset index the analysis of perceptual features in primary and secondary cortical areas. The N400, a component that follows these sensory responses, has been associated with early aspects of meaning processing and is a particularly important measure for studies of language comprehension. The N400 is evoked by any potentially meaningful stimulus and is sensitive to a wide range of manipulations involving meaning (Federmeier and Laszlo 2009), but not to other language factors such as syntax. The amplitude (size) of the N400 reflects how well the eliciting word ‘fits’ with its prior con-
text, and a reduction in N400 amplitude is taken as an indication of ease of semantic processing, akin to a reduction in reaction time in behavioral studies (see Kutas and Federmeier 2000).

The characteristics of ERPs that make them so suitable for studying language also make them particularly useful for studying age-related changes in comprehension (see also King and Kutas 1995). It is clear that aging has differential effects on cognitive subprocesses, and ERPs provide specific indices that allow these effects to be examined independently but in tandem. For example, during a language processing task one can measure general slowing on sensory components, examine patterns of effects on semantic access as indexed by the N400, and determine to what extent older adults recruit later processes associated with explicit evaluation of the stimuli. These separable effects would be conflated with each other and with additional decision or memory-related processes when measured with downstream indices involving reaction times or accuracy scores. Although a wide variety of behavioral tasks (naming, word/nonword decisions, semantic/syntactic judgments, and measures of verbal memory, among others) have been used to make inferences about language comprehension processes, comprehension itself is an inherently internal process without a necessary or even typical behavioral outcome. As ERPs can be recorded without imposition of any additional behavioral response, many studies take the approach of eliminating tasks beyond reading or listening for comprehension to avoid contamination of naturalistic comprehension processes with task-related processes.

Because ERPs directly reflect neural activity, basic neuroanatomical and neurophysiological changes with age (for reviews see Grady 2008; Raz 2009; Davis et al. 2008; a complete discussion of the literature on neurobiological changes with age is beyond the scope of this article) would be expected to manifest as overall group differences, and a number of such changes have been documented. The amplitude of many ERP components, including the N400, becomes smaller with age (see, e.g., Kutas and Iragui 1998), although the functional significance of this difference is not clear. One possibility is that changes in brain morphology cause differences in the configuration of neuron assemblies (such changes may also affect the distribution of a component over the scalp; e.g., Fjell et al. 2005), such that sets of neural generators that were previously geometrically aligned and synchronously firing are no longer so in the aging brain. Another possibility, however, is that the timing of components across trials becomes more variable for older adults, resulting in activity that is ‘smeared’ over time. This highlights an ambiguity in interpreting amplitude changes in ERPs (and in any method that makes use of signal averaging): a smaller mean amplitude can result from a smaller amplitude on every trial with fixed latency, or an equivalent amplitude on every trial with variable latency (see Walhovd et al. 2008 for an approach to differentiating the two).

Advancing age is also associated with delays in the peak latency of components (which are less ambiguous to interpret than overall amplitude or distributional changes). Sensory components are sometimes found to be delayed on the order of 10–50 ms (Anderer et al. 1996; cf. Lindenberger and Baltes 1994), and delays on later components, such as the N400 (Kutas and Iragui 1998) or the P300 (Anderer et al. 1996; Polich 1996), a component associated with working memory, are often of even greater magnitude. However, component delays do not always follow a pattern of sustained or increasing slowing across the cognitive processing stream. For example, N400s to auditory words in normal connected speech have been found to show no age-related latency shifts (Federmeier et al. 2003), despite age-related delays on earlier, sensory components. The temporal sensitivity of ERPs thus allows not only an accurate
assessment of the fairly pervasive timing changes that accompany aging, but the opportunity to examine the relationship in these timing changes across different facets of cognitive processing.

3. Word-level Semantic Processing

As alluded to above, lexical-semantic knowledge and the organization of this information have been shown to be quite stable throughout adulthood. Older adults tend to generate similar word associates and category exemplars as do younger adults that are matched for verbal abilities (Howard 1980; Burke and Peters 1986). Access to this information, although often globally slower in older adults, also seems relatively unaffected by age, as evidenced by preserved behavioral (Verhaeghen and Cerella 2008) as well as electrophysiological priming effects. For example, older adults’ N400 responses, like those of younger adults, are facilitated by lexical associative priming (Federmeier et al. 2003) and category and antonym relationships (Iragui et al. 1996; Federmeier et al. Forthcoming). Findings across methods thus suggest that the strength and organization of connections between words and from words to their meanings remain qualitatively similar with age.

A possible exception, however, comes from work examining the processing of words with multiple meanings. A number of behavioral studies have found evidence that, at least when task demands are minimized, older adults select meanings of ambiguous words in a manner similar to young adults (e.g., Balota and Duchek 1991; Balota et al. 1999). Recent ERP evidence, however, suggests that these similar behavioral patterns may arise from qualitatively different neural processing. Meyer and Federmeier (2007, Forthcoming) examined the contributions of the left and right cerebral hemispheres to the processing of ambiguous words in younger and older adults. To bias processing toward one hemisphere, homographs were presented in the left or right visual half-field (see Banich 2002 for a description of this technique), followed by a centrally presented target word that was either unrelated in meaning or related to either the more frequent (dominant) or less frequent (subordinate) meaning of the homograph. N400 priming patterns revealed that, for younger adults, both meanings were active in the left hemisphere (LH), with the dominant but not subordinate meaning additionally becoming active in the right hemisphere (RH). Older adults, however, showed LH activation of the dominant meaning but RH activation of the subordinate meaning. These results thus suggest an age-related shift of subordinate meaning activation from the LH to the RH, resulting, in older adults, in a division of labor, with each hemisphere focusing on a distinct meaning. Similar age-related increases in bilateral activation patterns have also been noted in the hemodynamic imaging literature for a wide range of cognitive processes (see reviews in Cabeza et al. 2002; Reuter-Lorenz et al. 2000), although their functional significance is still debated. As will be discussed in more detail, for language comprehension in particular, age-related shifts in hemispheric contributions are particularly notable for the processing of message-level meaning.

4. Building a Message-Level Representation

The ability to monitor processing as it unfolds during naturalistic tasks such as reading or listening for comprehension has made ERPs an especially useful tool for studying sentence (and discourse) processing, and it is at this level in particular that important, pervasive age-related differences have been noted. In one study, for example, younger and older adults listened to auditorily presented sentences that were either congruent or grammatical but nonsensical, and could contain a sentence-medial pair of associated words

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or not (Federmeier et al. 2003). Thus, as in Van Petten (1993), effects of lexical association and sentential context could be examined independently (i.e., lexical association without sentential context in incongruous sentences, or sentential context without lexical association) or together (lexical association within congruent contexts) compared to the effects of neither. At the sentence-final word, both groups elicited a smaller N400 for congruous compared to nonsensical sentences, showing that all participants were comprehending the sentences, consistent with their high performance on the concurrent sense-judgment task. However, as in prior work (Woodward et al. 1993; Ford et al. 1996), the N400 effect of congruity was smaller for older adults, although the peak latency of the effect was not significantly different across age groups.

Effects at the critical sentence-medial words (the associated pairs or counterpart unassociated pairs within the two types of sentences) were measured in four 200-ms epochs (0–200, 200–400, 400–600, 600–800 ms) to assess when effects of lexical association and sentential context were apparent in the waveforms. These analyses revealed an early effect of lexical association (0–200 ms) that continued throughout the epoch and did not interact with age group. Sentence-level effects were also apparent by 200 ms for young adults, but were not significant until at least 400 ms for older adults (see also Schwartz et al. 2003). Thus, although younger and older adults responded similarly to lexical association, older adults displayed a qualitatively similar but substantially delayed response to sentential context. Gunter et al. (1992) came to similar conclusions using a slightly younger population, suggesting that declines in sentence-level comprehension begin by at least the fifth or sixth decade of life (see also Kutas and Iragui 1998).

Federmeier and Kutas (2005) further explored the use of message-level information by older adults by examining the impact of sentential constraint. Sentences were either strongly constraining with a predictable ending or were weakly constraining with an unpredictable ending (e.g., ‘She was suddenly called back to New York and had to take a cab to the airport.’ ‘She was glad she had brought a book because there was nothing to read at the airport.’). For both younger and older adults, strongly constrained, predictable endings elicited facilitated N400s compared to unexpected endings. However, this effect was significantly smaller and delayed for older adults as a group, with the age-related difference being driven by the response to the expected completions. In particular, there was no age-related delay on the peak of the N400 to the unexpected endings, and a multiple regression based on a battery of neuropsychological measures predicted the peak latency of the N400 effect, but not the latency of the component elicted by unexpected endings. Thus, the data from this study, using entirely plausible sentences with simple constructions, are consistent with the claim that older adults are not as able as younger adults to efficiently make use of rich sentential context information to facilitate word processing.

A new data set expands upon these findings by completing both strongly and weakly constraining sentence frames with either the most expected ending or an unexpected but plausible ending (Wlotko et al. 2008, Forthcoming). Replicating the prior work, facilitation for the strongly constrained expected endings (compared with both the strongly constrained unexpected endings and the weakly constrained expected endings) was smaller and delayed for older adults. Furthermore, as shown in Figure 1, the effect of expectancy in weakly constraining sentences (weakly constraining expected versus weakly constraining unexpected) was not reliable for older adults (as it is for younger adults; Federmeier et al. 2007). Thus, these findings are consistent with prior claims that the ability to effectively use strong sentential context information is compromised with age, and further reveal that older adults show little facilitation of word processing at all when sentence contexts are weak.

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Overall, these studies show that when semantic information must be combined across words over time during sentence processing, older adults make less effective use of context information, resulting in reduced facilitation of strongly constrained expected words and eliminating facilitation for weakly expected words. Furthermore, facilitation, when it does occur, is substantially delayed. Delays of several hundred milliseconds are of great consequence when processing an input stream that typically comes at a rate of about 3–4 words per second. These changes, therefore, would seem to necessitate a concomitant shift in the neural and cognitive processes used by older adults to build the message-level meaning of a sentence or discourse.

Research on other kinds of processes needed to build a message-level representation has not been as well developed as in the use of semantic information during comprehension. However, King and Kutas (1995) show similar use of syntactic information by younger and older adults (modulated by working memory) and relate these findings to behavioral work (see, e.g., Kemper and Herman 2006). Similarly, Kemmer et al. (2004) observed that older adults showed no difference in the size or timing of the P600 response, an ERP effect sensitive to grammaticality. Thus, there are indications that syntactic processing may change less than semantic processing with age, although further research across a greater variety of syntactic processing contexts is needed.

5. Prediction in Comprehension

One way that sentential context can facilitate word processing is via predictive processing mechanisms, and ERP results attest to the pervasive use of predictive processing by young
adults, resulting in graded facilitation of semantic, lexical, morpho-syntactic, and even phonological and orthographic features of likely upcoming words (Federmeier and Kutas 1999b; Wicha et al. 2004; DeLong et al. 2005; Van Berkum et al. 2005; Federmeier et al. 2007; Laszlo and Federmeier 2009). In young adults, these mechanisms have been associated with LH language processing biases and are postulated to arise through the recruitment, during comprehension, of efficacious top–down pathways also used for language production (Federmeier 2007).

For example, Federmeier and Kutas (1999b) measured ERPs as young adults read for comprehension two-sentence contexts that could be completed by the most expected ending, an anomalous ending from the same semantic category, or an anomalous ending from a different semantic category. N400s were facilitated for the anomalous endings that shared features with the expected ending, and this facilitation was larger in strongly compared to weakly constraining sentence frames – i.e., in the case where the most expected completion was maximally predictable. This pattern shows that as sentence context accrues, semantic features of likely upcoming words become active, facilitating processing for those words, as well as related ones, when encountered. When the sentence endings were lateralized to one visual half-field (Federmeier and Kutas 1999a), only the LH showed this predictive processing pattern. In the RH, instead, expected endings were facilitated related to unexpected endings, but responses to the two types of anomalies did not differ.

The same conditions were examined for younger and older adults who listened to the materials from Federmeier and Kutas (1999a,b) presented as connected speech (Federmeier et al. 2002). Younger adults showed the same pattern for auditory as for visual presentation. In contrast, older adults showed a smaller facilitation for related anomalies, which was restricted to weakly constraining contexts – opposite of the pattern for younger adults. Thus, older adults (like the right hemisphere of younger adults) seem less likely to engage predictive processing mechanisms, or less effective at doing so, such that their processing is more driven by plausibility.

Prediction can provide benefits in comprehension by effectively ‘pre-processing’ information about likely upcoming words, thus saving resources when those words are actually encountered. However, predictions can also be wrong, entailing possible processing consequences. For young adults, Federmeier et al. (2007) found that these consequences manifested as changes in the size of a frontal positivity that followed the N400 (beginning around 600 ms post-stimulus onset), which was enhanced specifically for unexpected items in strongly constraining contexts. Although the functional specificity of this positivity remains to be fully understood, it seems to reflect a type of ‘revision’ needed when a prediction is not fulfilled. Thus, it is sensitive to constraint for unexpected endings (unlike the N400, which seems to reflect instead how well a word fits into its prior context; see also Kutas and Hillyard 1984), as a predictive processing strategy would entail.

However, data from Wlotko et al. (2008, Forthcoming), using the same materials as Federmeier et al. (2007) with older adult participants, show that older adults as a group do not elicit this positivity, as would be expected if the use of predictive mechanisms are not part of their comprehension strategies during sentence comprehension. With sentence processing paradigms, it is difficult to dissociate older adults’ failure to engage predictive processing from the fact that, as already reviewed, they may have a more difficult time building a message-level meaning representation from which to make predictions. Therefore, Federmeier et al. (Forthcoming) examined age-related changes in predictive processing using category label cues (‘A type of insect’) followed, three-seconds later, by typical category targets, non-category incongruent targets, and atypical but congruent category
targets (e.g., ‘ant/gate/hornet’). Younger adults elicited a late frontal positivity for the atypical but congruent category targets – very similar to the positivity from Federmeier et al. (2007) for unexpected but plausible sentence endings. Again, however, older adults as a group did not elicit this effect, showing that even in minimal contexts and with ample time, predictive processing becomes less likely with age.

Older adults thus seem less likely to predict during comprehension, making them less efficient at using sentence context information but also perhaps less affected by the processing consequences of revising incorrect predictions. The source of the decline in the use of predictive processing with age remains unclear. Federmeier (2007) postulated that predictive processing in comprehension arises largely from the LH, supported by the stronger top–down connections in the LH that would be required for efficient language production. Thus, one possible cause of the decline in predictive processing for older adults is the degradation of these feedback connections. Indeed, several data sets show a RH-like pattern for older adults in sentence comprehension studies (Wlotko et al. 2009b; see also Figure 1). Whether structural changes, perhaps in white matter tracts connecting frontal and temporal areas, can provide a locus of changes in comprehension with age is an important area open to investigation.

6. Multiple Meanings and Controlled Processes

Older adults’ failure to recruit top–down predictive processing mechanisms during comprehension is an example of the more general trend for executive/controlled processes, as opposed to automatic processes, to be more affected by age (Hasher and Zacks 1988; West 1996; Foster et al. 1997; Craik and Anderson 1999; Hasher et al. 1999). Some have suggested that reductions in the use of controlled processes can arise from declines in sensory acuity that require more resources to be allocated to lower-level processing, leaving fewer resources available for higher-level operations (e.g., Wingfield, Tun, & McCoy, 2005; cf. Alain et al. 2004).

Within the domain of language, greater age differences have been found when cognitive capacities important for self-regulatory or executive functions are compromised with age (e.g., processing speed and inhibitory efficiency; Kwong See and Ryan 1995; or working memory: Norman et al. 1992; Van der Linden et al. 1999; see Stine-Morrow et al. 2006; for a review). Supporting ERP findings have been obtained from recent studies investigating ambiguity resolution (Lee and Federmeier 2009a) and meaning revision (Meyer and Federmeier Forthcoming), which both show that, with advancing age, top–down control mechanisms tend to become less available to shape meaning activation over time.

In Lee and Federmeier (2009a,b), for example, younger and older adults were asked to read noun/verb (NV), homographs (e.g., ‘lobby’), and matched unambiguous words (e.g., ‘month’) that completed either congruent sentences with both coherent semantic and syntactic contextual information (e.g., ‘You can usually find the registration desk of a hotel in the lobby’) or syntactic prose sentences with grammatical syntactic structure but without coherent semantic information (e.g., ‘You can usually install the math student of a day in the lobby’). Results from younger adults showed that, in comparison with unambiguous words, NV-homographs elicit (i) larger N400 responses in congruent sentences, indexing a semantic mismatch between the context and the automatic activation of the contextually inappropriate sense of the ambiguous word and (ii) a sustained frontal negativity in syntactic prose sentences, reflecting the recruitment of top–down mechanisms to aid semantic selection when semantic constraints are less available (Lee and
Federmeier (2009b). Data from older adults, displayed in Figure 2, showed similar (albeit smaller) N400 effects for congruent sentences, suggesting that automatic semantic activation mechanisms are relatively well maintained. In contrast, the frontal negativity observed for the young in the syntactic prose condition was absent for the older adults, suggesting that the executive mechanisms involved in more difficult circumstances of ambiguity resolution have become less effective.

Thus, when semantic constraints are not available to aid meaning selection, younger adults recruit control processes, likely in frontal lobe regions (Badre et al. 2005; Zempleni et al. 2007), to aid with meaning selection. Older adults as a group, however, fail to do so, suggesting that they are less likely to efficiently and effectively select the meaning of ambiguous words in these circumstances. When semantic constraints are available, older adults, like younger ones, seem able to make use of that information to bias meaning selection, as seen in the N400 reductions observed in the congruent sentences of Lee and Cross homograph (e.g., watch, lobby).
Federmeier (2009a), as well as the patterns observed in the word priming study of Meyer and Federmeier (2007, Forthcoming). In those studies, the lateralized homographs and related or unrelated targets (already described) were preceded by either an unrelated context word or a context word that biased toward a meaning sense of the homograph different from the related target (e.g., ‘river – bank – money’). Although N400 priming was observed in both groups for related targets (bank – money) when the context word was unrelated, when the context word biased meaning selection toward the homograph’s alternate meaning, this N400 facilitation was absent for both groups. In other words, both groups seemed to use the context word to select one meaning of the homograph, such that words related to the other meaning were then treated similarly to wholly unrelated words. These findings are consistent with those of Swaab et al. (1998) and Taler et al. (2009), showing that older adults can use biasing context information to access the correct meaning of ambiguous words and words with metaphorical senses.

Although initial priming of the alternative meaning was blocked by prior meaning selection, young adults’ ERPs (Meyer & Federmeier 2007) revealed that they are able to exploit control process to revise the interpretation at a later time, resulting in priming on the Late Positive Complex (LPC), a potential that follows the N400 and has been linked to explicit memory and semantic revision processes (e.g., Van Petten et al. 1991). Older adults as a group, however, failed to show LPC priming to related targets following a biasing context (Meyer and Federmeier Forthcoming). Thus, when initial meaning selection proves to be incorrect, older adults seem less effective than young adults at recruiting processing mechanisms to afford meaning revision (see also Wright and Newhoff 2002 and Titone et al. 2006). These types of changes in controlled processes may be related to what some have called ‘risky reading’ strategies (Rayner et al. 2006), or increased reliance on ‘good enough’ representations in comprehension (Christianson et al. 2006).

7. Individual Differences in Comprehension

The evidence reviewed here suggests that there can be more than one way to succeed in language comprehension: changes in neural and cognitive resources with age result in older adults relying on different processing pathways to effect comprehension (cf. Stine-Morrow et al. 2008b). Within both younger and older adults – but perhaps especially with age – there is also important individual variability in many of the cognitive abilities brought to bear on comprehension, which have been linked to specific kinds of differences in comprehension strategies. Whether these changes result strictly from differences in neural change with age, or in cognitive preferences or motivations (e.g. Carstensen et al. 2006), or a combination of several factors remains an important area of investigation.

In all studies, older adults have a reduced and delayed N400 effect of sentential context, consistent with their lower reading spans. In young adult populations, reading span (a measure of verbal working memory) is associated with the size of the N400 effect (Van Petten et al. 1997; Wlotko et al. 2009a). One explanation for this pattern is that a reduced working memory size means that sentence context information can be retained over smaller intervals, and, thus, is less likely to bear on the processing of upcoming words. The decline in working memory for older adults is sometimes offered as a cause of changes in comprehension (see King and Kutas 1995 and Burke and Shafto 2008 for discussions), and Federmeier and Kutas (2005) indeed found that reading span (along with verbal fluency) was a reliable predictor of the N400 constraint effect. However, working memory capacity alone can’t explain all the findings, as sometimes young adults low on working memory span still differ from older adults – such as in their tendency to use...
predictive processing mechanisms. A possible reason for this may be that in addition to the storage of contextual information, predictive processes also involve retrieval and generation of information relevant to the context.

Although older adults as a group show a decline in predictive processing, a subset of participants in these studies showed more young-like comprehension patterns. Across studies, the tendency for older adults to manifest predictive processing patterns in their ERP responses has been closely linked to verbal fluency (Federmeier et al. 2002, Forthcoming). Verbal fluency measures the efficacy and speed with which semantic and/or lexical information can be produced in response to a cue. In addition, it also requires many of the top–down processes required in prediction, such as the ability to generate and utilize effective retrieval strategies, monitor the verbal output to avoid repetition, and inhibit task-irrelevant semantic information. Older adults who are able to score well on a verbal fluency task may have less decline in top–down connections and thus be better able to engage predictive mechanisms. Similarly, in Lee and Federmeier (2009a), higher letter fluency was predictive of older adults showing young-like patterns of recruitment of controlled selection mechanisms, as indexed by the frontal negativity.

Finally, in addition to these findings at the sentence level, patterns of ERP effects at the word level have been linked to the ability to inhibit information, as measured by the Hayling test (Burgess and Shallice 1996). When word processing is relatively easy (e.g., retrieving the dominant meaning of a homograph), both younger and higher-functioning older adults – those with better inhibition and executive control – recruit both hemispheres, whereas lower-functioning older adults rely on the LH only. In contrast, when word processing is difficult (e.g., retrieving the subordinate meaning of a homograph), both younger and higher-functioning adults tend to recruit one specialized hemisphere, whereas the lower-functioning older adults then rely on both hemispheres. Thus, at the word processing level, inhibition seems to be important for allowing the selective recruitment of specialized resources that may be distributed across the hemispheres (cf. Banich 1998); other effects of inhibitory capacity have also been linked to sentence-level processing patterns in behavioral work (see Hasher and Zacks 1988; Zacks and Hasher 1997).

Collectively, these data support several types of explanations that have been offered as a basis for cognitive decline in aging (see Light 1988; Burke and Shafio 2008), but further show that there is likely no single cause. Instead, it seems that a combination of at least speed of processing, working memory resources, inhibitory mechanisms, and ability to recruit top–down control processes all contribute to the ability to efficiently access meaning information from words and to effectively make use of sentential context during online comprehension (cf. Kennedy and Raz 2009). The influence of these factors, however, is not global; instead, specific cognitive and neural resources seem to be related to the ability to maintain and update context information over time, use that information to anticipate predictive words, and recruit controlled processes to resolve ambiguity.

8. Conclusion

Aging brings a lifetime of experiences and knowledge that remain largely intact as the brain grows older. The evidence provided by electrophysiological investigations of language comprehension during aging shows that the organization and structure of semantic knowledge is similar across age, but when integrating meaning across words to form message-level representations, older adults show both quantitative and qualitative changes in processing. For example, effects of sentential context are delayed several hundred milliseconds for older adults – a striking amount considering the fast timescale of
comprehension. Yet older adults do build meanings from sentences, so the brain must compensate for the change in timing by adjusting resources and strategies. Some of these adjustments may be seen in the differences in controlled processing or a switch to a less predictive mode of comprehension for older adults. All of these changes are modulated by individual differences, highlighting the importance of understanding what types of abilities, strategies, or brain states may protect against some of the declines in comprehension seen in old age.

Although the research reviewed here provides a window into changes in online comprehension with age, future studies will further illuminate how older adults make use of other kinds of information to build message-level meaning (e.g., syntactic cues, common ground). Further, although findings have been consistent across auditory and visual modalities, this line of work would benefit from being more closely integrated with findings from more naturalistic settings, such as continuous rather than word-by-word reading – for example, as measured by eyetracking – or in situations with richer discourse and social contexts. Finally, enhanced links between cognitive changes and neurobiological ones will bolster understanding of the factors underlying these changes in online processing, be it changes in gray matter, white matter, neurotransmitter distribution, or a combination of these.

As one part of a multidisciplinary approach to investigating cognitive aging, we may hope that research of this kind could illuminate ways to stave off the most serious of the changes in cognitive ability. Other research has shown the importance of social interaction (Parisi et al. 2007; Stine-Morrow et al. 2008a,b) and physical fitness (Kramer and Erickson 2007; Hillman et al. 2008) on brain function. Thus, there are many ways we can ensure our minds and our bodies enable a rich and fulfilling life many decades after the brain begins to ‘age’.

**Short Biographies**

Edward W. Wlotko is currently a Beckman Institute Postdoctoral Fellow at the University of Illinois. His research explores the individual contributions from and the cooperation of the two cerebral hemispheres in language comprehension, and how those contributions change with age. He received his Ph.D. from the University of Illinois at Urbana-Champaign in 2009.

Chia-lin Lee’s research focuses on how different sources of contextual information are processed to shape the interpretation of individual words. Specifically, she is interested in how one-to-many mapping problems involved in lexical ambiguities are resolved in the brain and how relevant cognitive and neural mechanisms change in later adult life. Chia-lin Lee received a BA and an MA in Linguistics from National Taiwan Normal University and an MA in Psychology from the University of Illinois.

Kara Federmeier obtained her Ph.D. in Cognitive Science from the University of California, San Diego. She is currently an Associate Professor in the Department of Psychology at the University of Illinois, Urbana-Champaign and the director of the Cognition and Brain Lab, housed at the Beckman Institute for Advanced Science and Technology. Her NIH-funded research uses event-related potentials to examine brain mechanisms of meaning access and integration, including hemispheric differences in language comprehension, changes in language processing associated with normal aging, and the interplay of language and memory. In 2006, she received the Society for Psychophysiology’s Award for Distinguished Early Career Contributions to Psychophysiology, and in 2010, she received the Cognitive Neuroscience Society’s Young Investigator Award.
Acknowledgment

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Diabetes Advanced Practice Nurse Improves Glycemic Control on a Hospitalist Service

ANN GAREY MSN, FNP-BC,1 MICHAEL JAKOBY, MD/MA2

1Carle Foundation Hospital, 2Southern Illinois University School of Medicine, Springfield, IL

ABSTRACT

Background: Prevalence of diabetes mellitus in the hospital is three-fold higher than the ambulatory setting, and nearly 40% of hospitalized patients in total experience hyperglycemia. There is strong evidence linking poor hospital glycemic control to increased risks of morbidity and mortality and substantial interest in improving hospital diabetes management. Previous studies of nurse-directed hospital diabetes management interventions have documented favorable impacts on length of stay and medication errors, but glycemic control was not reported. We present the results of a retrospective study to determine if management by a diabetes advanced practice nurse (APN) improved glycemic control for diabetes patients admitted to a hospitalist service. Methods: Retrospective chart review of diabetes patients admitted to the hospitalist service at Carle Foundation Hospital, Urbana, IL, in 2011 and managed primarily by the admitting hospitalist (N = 30) or diabetes APN (N = 30) was conducted. Primary endpoint was glycemic control as measured by mean capillary blood glucose (CBG), categorical distribution of CBGs, and proportion of patients with improved glycemic control from initial presentation. Mode of diabetes management was the secondary endpoint. Results: Both patient groups were generally well matched, though HbA1c at admission was higher for patients assigned to the APN (9.1 ± 2.2 % vs 7.8 ± 1.3 %, P = 0.009). Hospital glycemic control was superior for APN managed patients by all metrics. Mean CBG for APN patients was 152 ± 55 mg/dL vs 162 ± 61 mg/dL for hospitalist patients (P = 0.001), and proportion of CBG measurements 70–140 mg/dL was significantly higher (46.9% vs 36.2%, P < 0.001). There was no significant difference in hypoglycemia, defined as CBG < 70 mg/dL, between the two groups (2.4% for APN patients vs 2.0% for hospitalist patients, P = 0.72). Hyperglycemia improved from admission for 83.3% of APN patients compared to 46.7% of hospitalist patients (P = 0.006). All but one (96.7%) of the APN patients were managed with a basal/bolus insulin approach, but only half (50%) of hospitalist patients were managed with standing doses of both basal and prandial insulin (P < 0.001). When ambulatory glycemic control was suboptimal, the APN was much more likely than hospitalists to change the outpatient diabetes treatment regimen (71.4% vs 22.2%, P = 0.036). Conclusion: A diabetes APN trained by a board certified endocrinologist significantly improved diabetes management on a hospitalist service as measured by glycemic control, utilization of basal/bolus insulin, and intensification of treatment at hospital discharge.

INTRODUCTION

Diabetes mellitus is a highly prevalent co-morbidity in the hospital setting. A study of over 2000 consecutive admissions to Georgia Baptist Medical Center found a 26% prevalence of pre-existing diabetes, and an additional 12% of patients were recognized with newly diagnosed hyperglycemia.1 Glycemic control has been demonstrated to have a significant impact on hospital length of stay (LOS) and disposition for patients admitted to the intensive care unit and general medicine service, and hyperglycemia has an adverse impact on outcomes for specific acute illnesses including myocardial infarction, stroke, community acquired pneumonia, and chronic obstructive pulmonary disease exacerbations.24 The high prevalence of diabetes in the hospital and link between blood glucose control and clinical outcomes has generated interest in protocols and clinical services to improve diabetes management. Some medical centers utilize diabetes nurse specialists to facilitate treatment of diabetes.
ist Nurse Service at University Hospital of Wales, UK, providing patient education and management advice to ward medicine teams and nursing staff significantly reduced hospital LOS and patient care costs.\textsuperscript{10} Diabetes Nurse Specialists with both education and medication prescribing privileges at Royal Bournemouth Hospital (UK) and Norfolk and Norwich University Hospital (UK) also reduced LOS, and a Diabetes Specialist Nurse Prescriber at Peterborough and Stamford Hospitals (UK) reduced both LOS and medication errors.\textsuperscript{11-13} However, none of these studies reported glycemic control outcomes, and there are no studies in the peer-reviewed literature evaluating the impact of diabetes advanced practice nurses (APN) working with contemporary hospitalist services in North America. Consequently, we conducted a study to determine if a diabetes APN assigned to a hospitalist service in the US improves diabetes management with primary focus on glycemic control.

**RESEARCH DESIGN AND METHODS**

A retrospective electronic medical records review of patients with diabetes mellitus admitted to the adult hospitalist service at Carle Foundation Hospital, Urbana, IL, June-July 2011 was performed. The study was approved by the Carle Foundation Institutional Review Board. Diabetes was confirmed either by diagnosis prior to hospitalization or measurement of hemoglobin A1c (HbA1c) during hospital admission for patients with capillary blood glucose (CBG) measurements consistently > 140 mg/dL. A total of 60 patients were included in the study; half (N = 30) had diabetes managed by the hospitalist service, and the other half (N = 30) were assigned to an APN trained by a board certified endocrinologist (MJ) in hospital diabetes management. Demographic (age, gender, type of diabetes, tobacco use), clinical (principle diagnosis, diabetes regimens at home, during hospital admission, and at discharge, serum creatinine, lipid panel, length of stay), and glycemic (complete CBG record, HbA1c) data were recorded for each patient’s hospital record without unique identifiers and stored on secured computers accessible only to study investigators.

The primary study endpoint was difference in glycemic control between APN and hospitalist managed patients. Glycemic control was measured by three metrics: 1. Mean CBG during period of diabetes management 2. Categorical distribution of CBGs, and 3. Proportion of patients with improved glycemic control from initial presentation. For APN patients, mean CBG before assignment of care was compared to mean CBG during the period of active diabetes management. For hospitalist patients, admission CBG was compared to mean of all other CBGs for the hospital stay. Secondary endpoint was difference in diabetes management between the APN and hospitalists. The secondary endpoint was measured as utilization of basal/bolus insulin (standing doses of mealtime rapid acting insulin analog and daily basal insulin analog) during the hospital admission and intensification of diabetes treatment at hospital discharge. Intensification of treatment was defined as changing to basal/bolus insulin for home diabetes management when HbA1c was confirmed to be > 7% prior to or during hospital admission.

Data were analyzed with GraphPad Instat version 3.0 (GraphPad Inc., San Diego, CA). All results are means ± standard deviations unless otherwise noted. Student’s t-test with or without Welch’s correction was used to compare means, and Fischer’s exact test was used to compare proportions. P < 0.05 was considered statistically significant.

**RESULTS**

Key patient characteristics are presented in Table 1. Patients were generally well matched for age (as decade of life), gender, type of diabetes, management with insulin before admission to hospital, initial CBG (admission CBG for hospitalist patients, average of CBGs prior to assignment for APN patients), and principle diagnosis. However, glycemic control prior to hospitalization was clearly worse for APN patients as indicated by significantly higher HbA1c (9.1 ± 2.2% vs 7.8 ± 1.3%, P = 0.009).

<table>
<thead>
<tr>
<th>Table 1. Patient characteristics.</th>
<th>APN</th>
<th>Hospitalist</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Age (decade)</td>
<td>5.5 ±1.6</td>
<td>6.3 ±1.3</td>
<td>0.051</td>
</tr>
<tr>
<td>Gender (% F)</td>
<td>43.3</td>
<td>53.3</td>
<td>0.061</td>
</tr>
<tr>
<td>Type 2 diabetes (%)</td>
<td>90</td>
<td>83.3</td>
<td>0.71</td>
</tr>
<tr>
<td>Insulin at home (%)</td>
<td>70</td>
<td>53.3</td>
<td>0.29</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>9.1 ±2.2</td>
<td>7.8 ±1.3</td>
<td>0.009</td>
</tr>
<tr>
<td>Initial CBG (mg/dL)</td>
<td>194 ±71</td>
<td>184 ±94</td>
<td>0.12</td>
</tr>
<tr>
<td>CV or pulmonary admission† (%)</td>
<td>3.3</td>
<td>40</td>
<td>1.0</td>
</tr>
</tbody>
</table>

†- myocardial infarction, angina, heart failure, bypass grafting, stroke, transient ischemic attack, COPD exacerbation, community acquired pneumonia
Hospital glycemic control was superior for patients managed by the APN. Mean CBG for APN patients was 152 ± 55 mg/dL vs 162 ± 61 mg/dL for hospitalist patients (P = 0.001, Table 2). Categorical distribution of CBG measurements was also better for APN patients (Figure 1). Proportion of CBG measurements in the target range of 70–140 mg/dL was significantly higher in the APN group compared to the hospitalist group (46.9% vs 36.2%, P < 0.001) without a significant difference in hypoglycemia, defined as CBG < 70 mg/dL, between the two groups (2.4% for APN patients vs 2.0% for hospitalist patients, P = 0.72). Hyperglycemia improved from time of initial management for 83.3% of APN patients compared to 46.7% of hospitalist patients (P = 0.006, Table 2 and Figure 2).

### Table 2. Glycemic management and control parameters.

<table>
<thead>
<tr>
<th></th>
<th>APN</th>
<th>Hospitalists</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td># of CBGs</td>
<td>934</td>
<td>607</td>
<td></td>
</tr>
<tr>
<td>Basal/bolus insulin (%)</td>
<td>96.7</td>
<td>50</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Mean CBG (mg/dL)</td>
<td>152 ±55</td>
<td>162 ±61</td>
<td>0.001</td>
</tr>
<tr>
<td>Glycemic control improved (%)</td>
<td>83.3</td>
<td>46.7</td>
<td>0.006</td>
</tr>
<tr>
<td>Intensified treatment at discharge† (%)</td>
<td>71.4</td>
<td>22.2</td>
<td>0.036</td>
</tr>
</tbody>
</table>

†-HbA1c > 7% and patient converted to basal/bolus insulin at hospital discharge

APN patients were more likely than hospitalist patients to be managed with standing doses of mealtime and basal insulin in accordance with American Association of Clinical Endocrinologists and American Diabetes Association recommendations for diabetes management on noncritical care hospital services. Results are presented in Table 2. Almost all (96.7%) APN patients were managed with a basal/bolus insulin regimen, with basal insulin held in one case due to hepatic insufficiency. Half (50%) of hospitalist patients were managed with scheduled doses of both basal and prandial insulin (P < 0.001 for comparison to APN patients). The APN was also more likely than hospitalist physicians to convert patients from their home diabetes treatment regimen to outpatient basal/bolus insulin when glycemic control prior to hospital admission was suboptimal as indicated by elevated HbA1c (71.4% vs 22.2%, P = 0.036).
DISCUSSION

Many factors converge to make diabetes management in the hospital highly challenging. Acute illness, surgery, and trauma raise levels of stress hormones (catecholamines, glucagon, cortisol, and growth hormone), proinflammatory cytokines, and mediators of oxidative stress (superoxide anion), leading to increased peripheral resistance to insulin and hepatic glucose output. Treatment with glucocorticoids, beta-blockers, diuretics, and vasopressor agents also increases insulin resistance and exacerbates hyperglycemia. Diabetes is often poorly controlled before hospital admission, making it difficult to determine hospital therapeutic requirements from a patient’s ambulatory treatment regimen. Poor coordination between delivery of food and administration of mealtime insulin also predisposes to poor hospital glycemic control. Finally, diabetes is rarely the primary reason for admission, making it a secondary management issue during most hospital stays.

In this study of patients admitted to an internal medicine hospitalist service, assignment of primary responsibility for diabetes to an APN trained in hospital diabetes management resulted in better glycemic control than when hospitalist physicians managed diabetes themselves. Patients assigned to the APN were generally more challenging as indicated by significantly higher HbA1c at admission and higher, though not statistically significant, initial CBG and rate of home management with insulin. All metrics of glycemic control, including mean CBG, categorical distribution of CBGs, and improvement in glycemic control from initial management, were better for APN managed patients, and there was no difference in hypoglycemia rates between the two patient groups. Patients assigned to the APN were twice as likely as hospitalist patients to be managed with basal/bolus insulin, and multiple studies have demonstrated that the basal/bolus insulin approach is superior to sliding scale insulin based strategies for controlling hyperglycemia in the hospital. The APN also had the experience of working closely with a board certified endocrinologist on a hospital diabetes team for 12 months, and it is possible that her knowledge of insulin pharmacokinetics, strategies for determining initial insulin doses and making daily insulin adjustments, and awareness of the many obstacles to effective glucose control in the hospital is superior to some of the hospitalists. Finally, the APN was able to focus solely on diabetes management, and greater time allocated to task also likely contributed to the results, though the study was not designed to specifically assess differences in time spent on diabetes management.

Patients managed by the APN were much more likely than hospitalist managed patients to be discharged home on insulin when pre-hospital glycemic control was suboptimal. Intensification of diabetes management, defined in this study and the Carle Foundation Hospital diabetes team study as change to basal/bolus insulin and in another study of Partners Healthcare (Harvard Medical School) patients as newly prescribed insulin or oral medications, benefits patients after hospital discharge. In the Carle diabetes team study, compliance with basal/bolus insulin three months after discharge was approximately 80%, and HbA1c improved by 0.9% from baseline. Among Partners Healthcare patients with Type 2 diabetes and baseline HbA1c ≥ 8%, intensification of glucose lowering regimen after hospital discharge resulted in a 1.8% improvement in HbA1c and reduced odds of early hospital readmission, defined as readmission within 30 days of index hospitalization, by nearly 70%. There is growing interest in interventions to reduce early hospital readmission rates as the Centers for Medicare and Medicaid Services (CMS) implements the Hospital Readmissions Reduction Program of the Affordable Care Act.

Though study results are positive, there are important limitations to consider. First, only a relatively small number of patients (60) in a narrow time frame (June-July 2011) were included. The study was retrospective and not designed to determine the factors that may have resulted in better glycemic control for APN managed patients. Finally, the study was powered only to detect differences in glycemic control and diabetes management, and the study was not designed nor large enough to evaluate potential clinical parameters of interest such as hospital LOS, glycemic control after hospital discharge, or early hospital readmission rates.

An APN trained in hospital diabetes management added significant value to the management of diabetes mellitus among patients on an adult hospitalist medicine service. Glycemic control improved as assessed by multiple measures, and APN patients were much more likely than hospitalist patients to be managed with standing doses of mealtime and basal insulin as recommended.
in expert guidelines for hospital diabetes management. The APN was also more likely to intensify ambulatory diabetes regimens when indicated. A larger study including more patients and for longer duration may help determine whether diabetes APNs can also improve hospital LOS, glycemic control after hospital discharge, and hospital readmission rates. Specially trained APNs may be a cost effective intervention for improving hospital diabetes management, particularly at hospitals that do not have inpatient diabetes teams or endocrinology services.

ACKNOWLEDGEMENTS

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Orthopedic Group Education Produces High Patient Satisfaction

JULIE KENNEDY MSN, RN, CMSRN, ONC

ABSTRACT

Changes in financial reimbursement to institutions have caused hospitals to attempt to not only decrease patients’ length of hospital stay but also work to increase patients’ overall satisfaction. Orthopedic surgery is one common reason for admission to the hospital, and orthopedic patients and their families require education in postoperative management upon discharge. This article examines the latest evidence in preoperative orthopedic education and discusses the implementation of a Total Joint seminar on one 40-bed medical-surgical unit at a 325-bed hospital. A multi-disciplinary team consisting of staff nurses, a patient care leader, physical therapy representatives and case managers worked together to create this tutorial to provide instruction to patients and family members. A survey was distributed at the end of each class to assess satisfaction with the course and its teaching methods. Preliminary results showed a high satisfaction rate which may not only improve overall satisfaction with the total joint replacement experience but also improve patient outcomes.

INTRODUCTION

More than 800,000 hip and knee joints were replaced in 2007, which is double the amount of the decade before. These numbers are anticipated to increase with an 88.5 million Americans expected to be age 65 and older by 2050. Therefore, the growing need for innovations in orthopedic care is apparent. Orthopedic patients are discharged from the hospital faster than ever before, and many procedures are transitioning to the outpatient world. The purpose of this article is to explore the current literature on the topic of preoperative education and discuss the Total Joint seminar initiated on a 40-bed medical-surgical unit for the orthopedic population.

How can healthcare professionals best prepare patients to care for themselves once they are home? Implementation of a preoperative course better prepares patients and their families to care for themselves or their loved one once they are discharged from the hospital. Facilities around the country are already providing education to orthopedic patients in a variety of settings. As reimbursement becomes based on outcomes and patient satisfaction, it is even more important to find the most effective, evidence-based educational interventions for orthopedic patients.

METHODS

The patient care leader and a staff nurse from a 40-bed medical-surgical unit at Carle Foundation Hospital conducted a literature search and considered research published from the year 2004 to the present. We performed a search in CINAHL, Cochrane Review, and PubMed using key words group, patient satisfaction, preoperative education and orthopedics. Articles referenced in the initial search have also been included in this literature review. Articles selected provide information pertaining to adult patients that received education for orthopedic surgery or group education. Both experimental and non-experimental articles have been included due to the limited amount of research available.

LITERATURE REVIEW

A Cochrane Review of preoperative education for hip or knee replacement patients compared nine studies with emphasis on outcomes such as postoperative pain, length of hospital stay, compliance with postoperative exercise routine, patient satisfaction, occurrence of postoperative deep vein thrombosis (DVT), range of motion,
preoperative anxiety and postoperative anxiety. Three of the studies cited found a significant improvement in preoperative anxiety in patients who received preoperative education. No significant differences were found for the other outcomes, and no comparison was made between the types of preoperative education received.\(^3\)

*The Journal of Arthroplasty* published a study that examined the effects of a preoperative advice class and educational booklet on 35 patients undergoing total hip arthroplasty. Patients in the group that received the intervention had higher levels of satisfaction and decreased length of stay.\(^4\)

In a non-experimental, descriptive experiment, professors at the University of South Africa surveyed patients for their preoperative education preferences. Respondents preferred oral presentations and showed an interest in receiving more information on necessary preoperative preparation such as shaving, the surgical experience, and audiovisual aids including equipment.\(^5\)

Another article reflected the creation of multidisciplinary patient education intervention providing preoperative education to patients receiving total joint replacement surgery. A task force consisting of a clinical nurse specialist, physical therapist, occupational therapist, administrative manager and care coordinator gathered to build a program that would provide patients with the information needed for a successful surgery. Surveys of the patients indicated that their expectations were met, anxiety was reduced, and that the teaching was effective.\(^6\)

**IMPLEMENTATION**

A multidisciplinary team consisting of staff nurses and the patient care leader from a 40-bed medical-surgical unit at Carle Foundation Hospital, along with management, clinic nurses, the departments of physical and occupational therapy, case management and nursing education began meeting to design our own Total Joint seminar. The goal was to create a class that would thoroughly prepare orthopedic patients for their surgical experience from the time the surgery is scheduled to six to eight weeks postoperatively.

Our Total Joint seminar consists of a PowerPoint taught by a clinic nurse, case manager, occupational or physical therapist, and a staff nurse from this medical-surgical floor. Each member of the team discusses their role and provides information on what the patient can expect. The clinic nurses explain preoperative appointments, npo status, and medications that need to be stopped before surgery. The physical or occupational therapist provides teaching on walker use and other equipment that may be necessary after surgery, as well as hip precautions and postoperative mobility. The case manager discusses insurance benefits and options upon discharge from the hospital. Postoperative pain management possibilities are reviewed by the staff nurse. Information also covered by the staff nurse includes discharge medications, Incentive Spirometer and DVT prophylaxis. Currently, the class is required for all total hip and knee patients and we encourage family members to also attend.

**RESULTS**

Those teaching the class have found that the group setting provides numerous advantages. In the past, patients received their preoperative teaching one-on-one with a nurse in the clinic; however, by teaching five or six patients at a time the clinic staff has been relieved to perform other duties. The seminar has also provided patients an opportunity to talk amongst themselves about their own experiences. Attendees can relate their feelings and learn they are not alone in their fears. Some patients who have had previous joint replacements have shared their stories and helped allay the anxiety of those new to the procedure.

Each patient who attends class is given a booklet on total joint surgery at Carle Foundation Hospital. This booklet has been painstakingly designed to provide clear, readable information to help the patient through their entire surgical experience. The patients are encouraged to bring the booklet with them during their hospital stay so that their care team can refer to certain pages and make notes for that specific patient.

A survey is provided at the end of class to each patient that attends the Total Joint seminar and collected before the patient leaves. A portion of the survey results is presented here. The first classes started in January 2012 and preliminary results are positive. Table 1 summarizes these results.
DISCUSSION

While total joint surgery becomes a more common intervention, it is still a major undertaking for patients and requires weeks of preparation and recovery. Additionally, with a surgical procedure comes fear and anxiety of the unknown and potential risks for poor outcomes. In our current healthcare environment of discharging patients from the hospital at the earliest possible moment, it is of great importance that patients are properly prepared to care for themselves postoperatively.

CONCLUSION

A review of the current literature indicates that preoperative patient education decreases anxiety and may improve outcomes. In order to improve the orthopedic patient experience at Carle Foundation Hospital, we created a Total Joint seminar. Nurses on this medical-surgical floor have noticed that patients who attend the seminar make more informed decisions about their care, and survey results of the patients attending class indicate a positive effect. A new process is being implemented in order to assess patients’ satisfaction after they receive their surgery in order to compare their postoperative satisfaction with the Total Joint seminar. Further research is needed to fully compare educational interventions in the orthopedic population in order to improve outcomes and possibly decrease length of stay.

REFERENCES


Table 1

<table>
<thead>
<tr>
<th></th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>Need More Information (%)</th>
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<tr>
<td>I understand the therapy goals</td>
<td>98.30</td>
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<tr>
<td>before going home.</td>
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<td>I understand what will happen</td>
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<td>in the hospital after the</td>
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<td>conclusion of my surgery.</td>
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<td>I understand when to ask to</td>
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<td>speak with a case manager and/or</td>
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<td>seminar to others?</td>
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N = 177

No formal survey was provided to patients before the implementation of the Total Joint seminar to compare pre-group education satisfaction rates.
Assessing the Acuity of the Elderly Driver:  
A Guide for the Practitioner*

FOLA OLUWEHINMI, MD

1Carle Foundation Hospital

INTRODUCTION

While awareness of the driving health risks posed by persons under the influence of alcohol has been established through publicity efforts of organizations such as Mother’s Against Drunk Drivers (MADD), there are other societal populations that represent just as great a driving hazard. However, due to a lack of focused attention they are frequently overlooked. One such group is senior citizens. As it is estimated that by 2030 people age 65 and older will represent 25% of the driving population this is a problem of increasing concern. As seniors drive fewer miles, less at night and seldom in rush hour traffic, they consequently have the least amount of traffic accidents when compared to other driving groups. However, upon closer inspection they are found to have the highest amount of traffic violations, the highest fatality rate per mile driven due to their inability to withstand the trauma, and, ultimately, nearly the same rate of accidents as young adults just learning to drive.

HEALTH OF THE ELDERLY DRIVER

The main issue with the older driver is not chronological age but physical condition. Although the government has spent significant resources identifying screening tools to help evaluate one’s functional capacity to drive, there is no absolute consensus. Research found that predictors for risk included a history of falls over the previous one to two years, visual, auditory and/or cognitive problems, history of previous car crashes, and the use of medications that may impair response time. Other factors that predispose elders to higher risk include sleep disorders such as obstructive sleep apnea, diabetic or rheumatic complications, and movement disorders. Special attention should be paid to patients with a history of syncope or seizures. Further, when it comes to medications, findings are vague. Research has shown that beta-blockers may reduce performance anxiety and tremor, thereby strengthening vehicle control in some older people. However, medications with effects on the central nervous system, such as sedatives, anxiolytics, antihistamines, anticholinergics and some tricyclic antidepressants, can be harmful alone and worse when combined. Considering that one-third of all benzodiazepine prescriptions are written for people age 60 and older, it is important to re-emphasize that their consumption, alone or combined with alcohol, makes them prone to greater impairment due to the normal physiological effects of aging.

ASSESSING THE SENIOR PATIENT

It is important for the primary practitioner to consider the health of the elderly patient and how that person’s physical condition might impact their ability to operate a moving vehicle. When attempting to evaluate a patient’s ability to drive, begin by questioning how much he/she relies on a car for daily activities, if there have been recent traffic violations, accidents or close calls within the past six months, and if they have gotten lost while driving. Ask if they feel comfortable driving, and if this is an activity they wish to continue. Your review of physical systems should focus on visual problems such as difficulty with glare, problems with peripheral vision or poor vision, problems with audition and mobility issues consistent with neck, shoulder or

*This article originally appeared in Carle Selected Papers vol. 50, no. 1.
wrist problems, limb weakness or issues with their balance. Finally, a mini mental test is always a good idea, as patients with mild to moderate dementia are five times more likely to have a collision. If you find that there are signs of imminent impairment, proceed to assess their social backup and options regarding transportation with family members and/or in the community.

Visual acuity and peripheral vision are evaluated in most states as part of the driver’s license renewal process. For example, Illinois requires residents age 75 and older to take vision and on-the-road tests each year to renew their license. While this may appear inconvenient, research has shown that states with in-person license renewal requirements are associated with a lower driver fatality rate compared to states that do not take this precaution. Begin by assessing whether the patient has 120 degrees of horizontal peripheral vision and at least 20/40 on a Snellen chart. Next, perform a fundoscopy and, if visual acuity is an issue, you may consider a referral for Useful Field of View Test (UFOV), which has shown to be a sensitive predictor of driving safety. Continue with an otoscopy and if there is no cerumen impaction, proceed to a whisper test to see if a referral to an audiologist is needed.

Psychomotor evaluation should include passive and active range of motion of all extremities, and gait assessment with a Get Up and Go Test, which consists of the patient rising from a chair, walking 10 feet, turning around, walking back, and then sitting down within 15 seconds. Drawing two intersecting pentagons and asking the patient to copy them can help assess cognitive function. In order to pass the test, all the sides and angles of the figure should be preserved and the sides should intersect. Medication scrutiny is imperative.

Participation from the patient’s family is also important. Ask if they have concerns. You might suggest they assess the patient’s driving skills by having the patient drive first in an empty parking lot, then on an empty, rural road and finally progressing to a more congested suburban setting, similar to the way parents assess children first learning to drive. If there is disagreement between the two sides, try to serve as mediator. Suggest the use of available Internet resources, such as the Patient Education Forum, Safe Driving for Seniors from the American Geriatrics Society (www.americangeriatrics.org). The American Association of Retired Persons (www.aarp.org) has a program, 55 Alive, which offers eight-hour classes on driving safety for a nominal charge. Regrettably, driving privileges must sometimes be taken away. When this happens the Internet is also an excellent resource to find local transportation options. However, patients suddenly confronted with no longer being able to drive should be closely monitored, as their autonomy and social and mental well-being can be dramatically affected when this right is taken away. Depression is common. Patients and their families should be referred to social services as needed.

**SUMMARY**

Elderly patients should be routinely evaluated by their primary care physician regarding their ability to drive. With the Baby Boomers now approaching senior citizen status this will be a growing societal concern. Being sensitive to this issue and providing needed guidance can help make the transition from driver to passenger less stressful and painful for everyone involved.
Fall Risk Assessment and Prevention in Older and Frail Adults: The Role of Primary Care

PAULA SWINYER, RN, MSN
SUMA PETER, MD

1 Carle Foundation Hospital

ABSTRACT
Older adults are susceptible to progressive decline in health through the wear and tear of intrinsic and extrinsic factors. Frailty occurs frequently in this population, and puts the elderly at risk for falls which can have serious consequences. Awareness of these syndromes is important during routine patient evaluations. It is recognized that primary care providers have limited time during a routine evaluation of the older and frail adult who often present with multiple problems. Recent research and geriatric practice are reviewed and recommendations are made for an abbreviated fall risk assessment and cost and time-effective interventions to decrease fall risk.

INTRODUCTION
Falls and Frailty Defined

Frailty is an increasingly prominent condition as the vulnerable older adult population increases. Theoretically, frailty is defined as a clinically recognizable state of increased vulnerability resulting from aging-associated decline in reserve and function across multiple physiologic systems, such that the ability to cope with everyday or acute stressors is compromised.1 Clinically, the measurement of frailty is difficult, and is still evolving. Most commonly, frailty is linked to certain physiological features such as muscle weakness, bone fragility, very low body mass, susceptibility to falling and trauma, high risk for delirium, vulnerability to infection, blood pressure instability and severely diminished physical capabilities.2 The same multisystem impairments of frailty are shared with a group of geriatric syndromes, defined as those clinical conditions in older persons that do not fit into discrete disease categories and are usually of multifactorial causation.3 The most common of these geriatric syndromes are delirium, pressure ulcers, incontinence, functional decline and falls.

Falls, either with or without injury, pose a serious health problem for older persons. Statistics are variable, but the most common estimate is that falls in the community dwelling occur in one-third of adults over age 65, and in half of those cases the falls are recurrent.4 This rate increases with advanced age. Additionally, falls in the population over age 70 have a 5–10% risk of serious injuries, and of those who fracture there is a 20–30% mortality rate.5 Among the community-dwelling elderly described as frail, men had 3.0 to 3.6 times risk increase and women a 2.4 time risk6,7 for one or more fall than their non-frail counterparts. Since up to 75% of elders who sustain a fracture do not recover their pre-fracture level of function, falls also lead to a decrease in quality of life, hospitalization, admission to extended care facilities and an overall increase in healthcare expenditures.5 This highlights the importance of the primary care provider of the older and frail adult to take the lead in assessment for and early intervention of risk factors to decrease the risk of fall and injury.

Review of Fall Risk

Few falls result from just one cause, but are instead the result of increased susceptibility from intrinsic and extrinsic factors. Intrinsic causes of frailty with fall risk include the normal physiological changes of aging which occur gradually and affect all body systems. These factors are difficult to prevent and treat. Table 1 presents a synopsis of age-related physiological changes that are prominent in creating risk for falls. The most prominent of the physiological changes leading to falls is sarcopenia or loss of muscle mass. Age-related muscle mass loss is well-documented, and appears to be consistent, at a rate of about 1–2% per year past the age of 50 years, occurring in both sedentary and active aging adults.8 In addition poor vitamin D status with a 25 hydroxy vitamin D level less than 10, which results from decreased absorption, is independently associated with an increased risk of falling.9 These physiological changes of aging occur at varying ages and speed of progression, and the effects of the changes can be slowed or accelerated by other issues. Normally occurring intrinsic factors are exaggerated by other patient-specific intrinsic risk factors.
Table 1. Normal Physiological Changes of Aging and Resultant Risk Factors for Falling

<table>
<thead>
<tr>
<th>BODY SYSTEM</th>
<th>NORMAL CHANGES OF AGING</th>
<th>RESULTING RISK FACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARDIOVASCULAR</td>
<td>Decreased baroreceptor sensitivity</td>
<td>Tendency to syncope, orthostatic hypotension</td>
</tr>
<tr>
<td></td>
<td>Cardiac muscle hypertrophy, valve sclerosis</td>
<td>Increasing activity intolerance</td>
</tr>
<tr>
<td>ENDOCRINE</td>
<td>Decrease hormones (estrogen/testosterone)</td>
<td>Decrease bone and muscle mass</td>
</tr>
<tr>
<td></td>
<td>Decrease Vitamin D absorption</td>
<td>Vitamin D deficiency</td>
</tr>
<tr>
<td></td>
<td>Increase bone mineral loss</td>
<td>Decrease bone mass, easily fractured</td>
</tr>
<tr>
<td>MUSCULOSKELETAL</td>
<td>Decreased skeletal mass</td>
<td>Bone loss, easily fractures</td>
</tr>
<tr>
<td></td>
<td>Decreased muscular mass-Sarcopenia</td>
<td>Decreased strength</td>
</tr>
<tr>
<td></td>
<td>Decreased cartilaginous tissues</td>
<td>Tightening of joints, joint inflammation</td>
</tr>
<tr>
<td></td>
<td>Decreased ligament/tendon strength</td>
<td>Limited ROM, joint instability</td>
</tr>
<tr>
<td>NERVOUS</td>
<td>Decreased neurons/neurotransmitters</td>
<td>Impaired muscle strength, DTRs, motor</td>
</tr>
<tr>
<td></td>
<td>Changes in brain dendrites, cells, synapses</td>
<td>skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal slowing of cognitive processing</td>
</tr>
<tr>
<td>PULMONARY</td>
<td>Decreased pulmonary muscle strength</td>
<td>Reduced pulmonary function reserve</td>
</tr>
<tr>
<td></td>
<td>Stiffer chest wall</td>
<td>Dyspnea, decreased exercise tolerance</td>
</tr>
<tr>
<td>SENSORY EYE</td>
<td>Changes in lens and pupils</td>
<td>Decrease visual acuity, distortions</td>
</tr>
<tr>
<td>SENSORY EAR</td>
<td>Middle ear membrane, bone, eardrum changes</td>
<td>Decreasing sense of balance</td>
</tr>
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</table>

Kiel et al evaluated multiple community-based prospective cohort studies of patient-centered risk factors for falls, and the risk factors that appeared in at least two (but usually more) of the studies included: a past history for falls, lower extremity weakness, age, female gender, cognitive impairment, balance problems, psychotropic drug use, orthostatic hypotension, dizziness and anemia. Similar results have been found in other reviews and meta-analyses regarding risk factors. Among these studies leg weakness measured by functional testing or manual muscle examination was the most potent risk factor associated with falls, and increased the odds of falling, on average, by more than four times. This leg weakness is often a result of limited physical activity or prolonged bed rest, together with chronic debilitating medical conditions. The progression of many chronic diseases of aging leads to the problematic risk factors discussed above, via several mechanisms. (Table 2.) Beyond these and other chronic diseases, acute illnesses such as infections, malnutrition and dehydration can quickly affect an older person’s homeostasis and cause falls. Medications can also be detrimental by causing falls. Woolcott et al performed a meta-analysis of 22 studies evaluating the fall risk from many classes of medications. Most central nervous system medications were associated with falls in the elderly and included sedatives and hypnotics, antidepressants and benzodiazepines. Environmental risks can also precipitate falls, including flooring, stairs, room arrangements, seating, and other home safety hazards. A person's toileting habits including frequency/urgency, delay of toileting, equipment and assistance in the bathroom and use of incontinence-wear will especially impact fall risk. Footwear is a small, but important, issue in fall risk. Multiple studies done regarding footwear during falls have shown the culprits as non-supportive shoes with slippery bottoms or going barefooted. Modifying these and other extrinsic risk factors can significantly decrease fall risk.

Assessment for Fall Risk

Assessment of fall risk by the primary care provider in the outpatient setting should be performed based on information currently available regarding frequency, risk factors and causation of falls, including the discussion above. Assessment during the annual examination should be focused on frailty or fall history. Given the various aspects of the geriatric examination, recommendation for evaluation for fall risk is abbreviated to the basics. Many of these are components are done during a routine H&P and others can be easily incorporated. Central to this examination is asking the patient if he or she has had a fall since their last examination. The recommended musculoskeletal evaluations listed in Table 3 have been shown effective in evaluating postural stability and strength.

Table 2. Chronic Illnesses Which Commonly Cause Fall Risk to Increase

<table>
<thead>
<tr>
<th>DISEASE</th>
<th>MECHANISMS THAT INCREASE FALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVA history</td>
<td>Leg weakness, balance and gait deficits</td>
</tr>
<tr>
<td>Parkinson's disease</td>
<td>Balance, gait, cognitive impairment</td>
</tr>
<tr>
<td>Arthritis</td>
<td>Weakness, decline in mobility</td>
</tr>
<tr>
<td>Chronic pain</td>
<td>Multiple possible causations</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Especially executive function and speed of process loss</td>
</tr>
<tr>
<td>Cognitive impairment</td>
<td>Weakness</td>
</tr>
<tr>
<td>Protein malnutrition</td>
<td>Medication adjustment, education on slow position changes</td>
</tr>
</tbody>
</table>

In addition to normal physiological and disease-specific causes, other well-documented extrinsic factors are additive to fall risk. Medications can also be detrimental by...
Assessment of patients with a history of falls, or following a fall must be expanded to determine the cause of fall and risk of future falls. Important aspects of the actual fall assessment include activity when the fall occurred, sensations (ie, dizziness) prior to the fall, location and time of the fall and any loss of consciousness. This information about a previous fall is important in helping the patient to identify their triggers for fall risk. The findings during a fall assessment will also guide advanced evaluations and diagnostics which are not routinely ordered, but may be helpful to pinpoint causation, especially in recurrent falls (ie, advanced neurological examination, podiatry evaluation, urinalysis, holter monitoring, spine x-rays or CT scans).

Interventions to Reduce Fall Risk

Multiple interventions to reduce fall risk have been studied. Some studies targeted single risk factors while others addressed multiple risk factors. Overall, evidence suggests that interventions specifically aimed at risk factors and impairments identified during a patient assessment are much more effective than a standard package, and the American Geriatrics Society reported that a comprehensive review of literature shows insufficient evidence for multifactorial intervention programs to prevent falls in all geriatric populations. Table 4 reviews interventions and modifications that can be recommended for specific risk factors, based on research-based recommendations. More aggressive interventions are required for patients who have had one or more falls in the past. Overall, maintaining health, routine activity and exercise, good nutrition and hydration, and supplementation with vitamin D are low-level, low-risk, cost effective interventions for fall-risk prevention.

<table>
<thead>
<tr>
<th>H&amp;P COMPONENT</th>
<th>KEY ASSESSMENTS FOR FALL RISK</th>
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</thead>
<tbody>
<tr>
<td>MEDICAL HISTORY</td>
<td>Focus on progression of chronic illnesses known to increase fall risk</td>
</tr>
<tr>
<td>MEDICATION REVIEW</td>
<td>Evaluation for polypharmacy Close review of CNS agents known to increase fall risk</td>
</tr>
<tr>
<td>REVIEW OF SYSTEMS</td>
<td>Determination of recent history of fall(s) or near fall(s) Presence of dizziness, syncope or balance problems Presence of increasing weakness, especially of legs Evaluation of the use of alcohol</td>
</tr>
<tr>
<td>PHYSICAL EXAMINATION</td>
<td>Examination of orthostatic BP, especially if dizzy or on cardiac medications Evaluation for cognitive changes, especially executive functioning/ speed of processing A focused neurologic examination (including peripheral neuropathy) Musculoskeletal function Strength and mobility of lower extremities Tinetti Get up and Go test Assessment of balance in a narrow stance</td>
</tr>
<tr>
<td>DIAGNOSTICS</td>
<td>25 hydroxy vitamin D Vitamin B12 Hemoglobin/Hematocrit Renal function</td>
</tr>
</tbody>
</table>

*S isn’t clear. Further clarification may be needed.

CONCLUSION

Falls among the older adult in the outpatient setting are common. They increase morbidity and mortality, can significantly affect quality of life and decrease an elder’s ability to be independent. Primary care providers are well positioned to have a positive impact on fall prevention in the elderly. Fall causation presents a complicated picture, produced by an interaction of normal changes of aging, risk factors caused by disease and other extrinsic factors. By far, the best prevention of frailty as well as fall risk is lifestyle modification and treatment of disease. Beyond that, assessment of individual risk factors by the primary care provider, and appropriate recommendation to modify those risk factors to reduce falls, is imperative.
REFERENCES


Table 4. Recommendations for Intervention to Reduce Falls by Risk Factors

<table>
<thead>
<tr>
<th>RISK FACTOR</th>
<th>RECOMMENDED INTERVENTIONS TO REDUCE FALLS</th>
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<tr>
<td>Environmental risk</td>
<td>Occupational therapy for home safety risk evaluation</td>
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<tr>
<td>Sarcopenia</td>
<td>Strength training exercise program</td>
</tr>
<tr>
<td>Vitamin D deficiency</td>
<td>Supplementation of Vitamin D level to &gt;30-50, at least 800 Units daily</td>
</tr>
<tr>
<td>Vitamin B12 deficiency</td>
<td>Supplementation of Vitamin B12</td>
</tr>
<tr>
<td>Chronic pain</td>
<td>Analgesic treatment of pain, therapy</td>
</tr>
<tr>
<td>Unstable gait, decreased ROM, poor balance</td>
<td>Therapy program and ongoing exercises to address specific issues</td>
</tr>
<tr>
<td></td>
<td>Assistive devices (walker, safe cane)</td>
</tr>
<tr>
<td>Unsafe footwear</td>
<td>Low--heels with thin, hard sole and treads worn indoors and outdoors.14</td>
</tr>
<tr>
<td>Postural hypotension, dizziness</td>
<td>Medication adjustment, education on slow position changes, compression stockings</td>
</tr>
<tr>
<td>CNS drug effects</td>
<td>Reduction of CNS agents</td>
</tr>
<tr>
<td>Urinary urgency, frequency, incontinence</td>
<td>Toileting program</td>
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<td>Frequent alcohol use</td>
<td>Changes to bathroom facilities</td>
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<tr>
<td>Visual deficits</td>
<td>Correction of vision as possible and low vision modifications</td>
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<tr>
<td>High fall risk</td>
<td>Call alarm systems</td>
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<table>
<thead>
<tr>
<th>SUBJECT REVIEW</th>
<th>Fall Risk Assessment and Prevention in Older and Frail Adults: The Role of Primary Care</th>
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</table>

FALL RISK ASSESSMENT

Table 4. Recommendations for Intervention to Reduce Falls by Risk Factors
Case Reports

p.37  Factitious Hyperglycemia and Subsequent Iatrogenic Hypoglycemia in a Hospitalized Peritoneal Dialysis Patient Managed with Icodextrin Dialysate

CHAITANYA MAMILAPALLI
EDWARD RICO
MICHAEL JAKOBY

p.41  CRT Optimization Utilizing Gas Exchange: A Case Report

TRIVENI ABBURI
ABRAHAM G. KOCHERIL
Factitious Hyperglycemia and Subsequent Iatrogenic Hypoglycemia in a Hospitalized Peritoneal Dialysis Patient Managed with Icodextrin Dialysate

1CHAITANYA MAMILLAPALLI, 2EDWARD RICO, 2MICHAEL JAKOBY

1Faculty member and 2Chief, Division of Endocrinology, SIU School of Medicine, Springfield, IL; 3Endocrinologist, Union Associated Physicians, Terre Haute, IN

ABSTRACT
Icodextrin is a colloid osmotic agent used in some peritoneal dialysates. It is absorbed into the systemic circulation and hydrolyzed to maltose, a disaccharide that causes factitiously elevated capillary blood glucose (CBG) measurements by point-of-care (POC) meters utilizing glucose dehydrogenase pyrroloquinolinequinoine (GDH-PQQ) and glucose-dye-oxidoreductase (GDO) based reactions to detect glucose. We report a recent case of icodextrin-related factitious hyperglycemia leading to iatrogenic hypoglycemia, brain injury, and death.

INTRODUCTION
Seven percent of end stage renal disease (ESRD) patients in the United States are managed with peritoneal dialysis (PD). Glucose is the osmotic agent in most peritoneal dialysates, though absorption of glucose across the peritoneal membrane results in loss of osmotic gradient over long dwell times and exacerbates hyperglycemia in patients with diabetes mellitus. Nearly 20% of PD patients may experience permanent loss of peritoneal ultrafiltration capacity and require transition to hemodialysis.2

The limitations of glucose as an osmotic agent have prompted investigation into alternatives. Icodextrin (Extraneal™, Figure 1) is a solution of starch-derived, water soluble glucose polymers that acts as a colloid-osmotic agent. Compared to glucose dialysates, icodextrin dialysates result in more efficient and sustained ultrafiltration and are less injurious to the peritoneal membrane. However, approximately 25% of icodextrin polymers are absorbed through the peritoneal lymphatic system and enter the systemic circulation where they are metabolized by alpha-amylase activity into oligosaccharides, mainly the disaccharide maltose.4 Due to lack of serum maltase activity, circulating maltose levels may reach 100–120 mg/dL and be falsely detected as glucose by some glucose meters, leading to significant over estimates of capillary blood glucose (CBG).4 We report a recent case of icodextrin-related factitious hyperglycemia leading to iatrogenic hypoglycemia, metabolic encephalopathy, and death.

Figure 1. Chemical structure of icodextrin. The polymer is an osmotically active derivative of starch linked by glucosidic (1-4) bonds with molecular weight ranging from 13,000-19,000 Daltons

CASE
A 57-year-old ESRD patient was admitted to hospital for mitral valve replacement and septal myomectomy. The patient had no history of diabetes mellitus, and she was neurologically intact before surgery. After surgery, her home PD regimen with 7.5% icodextrin dialysate was restarted. An order set for post-operative CBG monitoring and sliding scale insulin was also activated, with supplemental insulin ordered for CBG values over 130 mg/dL. A Roche glucose meter utilizing a glucose dehydrogenase pyrroloquinolinequinoine (GDH-PQQ) based...
reaction to detect CBG yielded results consistently 120–180 mg/dL and occasionally over 200 mg/dL, triggering administration of multiple doses of regular insulin beginning the evening of post operative day (POD) 1. (Table 1) Low laboratory measured glucose (44 mg/dL) and altered mental status were first documented the morning of POD 2, though no treatment for hypoglycemia was initiated because bedside CBG was 119 mg/dL. Multiple laboratory measured glucose values < 50 mg/dL were recorded while bedside CBG was more than 100 mg/dL. Endocrinology was consulted on POD 5, insulin orders were stopped, and blood glucose monitoring was changed to the central hospital laboratory. However, magnetic resonance imaging (MRI) of the brain showed diffuse injury consistent with metabolic encephalopathy, and the patient’s family withdrew supportive care on POD 10 because the patient remained in a persistent vegetative state.

**DISCUSSION**

Many glucose meters available for hospital and home use give spuriously elevated CBG readings when PD patients use icodextrin dialysate. Meters utilizing GDH-PQQ and glucose-dye-oxidoreductase (GDO) methods are susceptible, including the Freestyle meters manufactured by Abbott Diabetes Care and ACCU-CHEK line of meters manufactured by Roche Diagnostics. Others, such as One Touch meters from Life Scan and Breeze 2 and Contour from Bayer Healthcare, use test strip methods.

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>CBG (mg/dL)</th>
<th>Lab glucose (mg/dL)</th>
<th>R† (Units)</th>
<th>Clinical events</th>
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</thead>
<tbody>
<tr>
<td>POD 1</td>
<td>1632</td>
<td>151</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>2206</td>
<td>185</td>
<td></td>
<td>4</td>
<td></td>
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<td>POD 2</td>
<td>0530</td>
<td>44</td>
<td></td>
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<tr>
<td></td>
<td>1044</td>
<td>119</td>
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<td>AMS‡ first noted</td>
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<td></td>
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†-regular insulin; ‡-altered mental status; ¥-intravenous fluids with 5% dextrose
ods that are unaffected by the presence of maltose. This is demonstrated by the comparison of bedside glucose measurements obtained on POD 5 using the hospital Roche meter and a Bayer Contour meter provided by the Southern Illinois University (SIU) diabetes center (Table 2); the Roche meter consistently yielded measurements more than two-fold higher than the gold standard central laboratory measurement, while measurements with the Bayer meter were unaffected by maltose interference. A comparison of point-of-care (POC) glucose meters and test strip methods is presented in Table 3. GDH-PQQ strips are not glucose specific and react with other sugars including maltose, galactose, and xylose.

Table 2. Simultaneous glucose measurements (mg/dL) from hospital laboratory, hospital POC glucose meter, and meter from outpatient diabetes center on POD 5

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Table 3. Major POC glucose meters and test strip methodologies for measuring CBG.

The FDA and glucose meter manufacturers have published guidelines to prevent adverse events from spurious hyperglycemia due to detection of interfering sugars by POC glucose meters. Specific recommendations include: 1. Central laboratory blood glucose measurements are always recognized as gold standard results, 2. Patients undergoing PD with icodextrin dialysate are always clearly identified, 3. POC glucose testing for icodextrin patients is only performed with glucose meters utilizing glucose oxidase or glucose hexokinase strips, 4. All medical and paramedical personnel are educated regarding potential interferences with POC glucose measurements.
testing, and 5. Glucose meters subject to potential interferences from sugars such as maltose be clearly labeled. In our patient’s case, personnel involved in the patient’s care were unaware that icodextrin can cause erroneously high bedside CBG measurements, the chart was not clearly labeled, and central laboratory blood glucose measurements were not recognized as definitive results. Hypoglycemia not only went unrecognized but was exacerbated by inappropriate administration of supplemental insulin.

Over 25,000 ESRD patients in the United States are managed with PD, and a growing number are using icodextrin solutions as dialysate. Sufficient icodextrin is absorbed across the peritoneum to significantly elevate plasma maltose levels, and this can spuriously and significantly elevate CBG measurements obtained by POC glucose meters using GDH-PQQ or GDO strips, delaying recognition of true hypoglycemia or predisposing to interventions that can result in iatrogenic hypoglycemia, neurological injury, and death. Other therapeutic agents, including intravenous immunoglobulin (IVIG), abatacept for rheumatoid arthritis, and tositumomab for non-Hodgkin’s lymphoma, contain maltose. Healthcare providers across multiple specialties and levels of training need to be aware that maltose elevates CBG in selected glucose meter systems to protect patients from potential harm.

Presented as poster P3-743 at the Endocrine Society 93rd Annual Meeting, Boston, MA, June 4-7, 2011

REFERENCES


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CRT Optimization utilizing Gas Exchange: A Case Report

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1University of Illinois College of Medicine at Urbana-Champaign

INTRODUCTION

Cardiac Resynchronization Therapy (CRT) is an important treatment for patients with symptomatic heart failure (New York Heart Association [NYHA] class II to IV), severe LV systolic dysfunction (left ventricular ejection fraction (LVEF) ≤35 percent) and intraventricular conduction delay (QRS ≥120 ms). The rationale for CRT is that ventricular dyssynchrony can further impair the pump function of a failing ventricle. Resynchronization has been shown to improve LV pump performance and reverse the deleterious process of ventricular remodeling. However, LV lead implantation can be challenging and a significant minority of those patients with successful implantation will be non-responders. Optimization of CRT programming is often considered when the clinical response to CRT is inadequate.

CASE REPORT

A 77-year-old Caucasian male from another state presented for further care of ischemic cardiomyopathy and ambulatory class IV heart failure symptoms. His past medical history included pacemaker placement for complete heart block, triple vessel bypass surgery for coronary artery disease, chronic obstructive pulmonary disease and hypertension. An attempt was made to upgrade the pacemaker to a CRT defibrillator (CRT-D) for treatment of his low LVEF (less than 35%), heart failure symptoms and wide QRS complexes due to right ventricular pacing. In that operation, the left ventricular lead could not be placed through the coronary sinus due to reported significant intravascular fibrosis, which limited the movement of the tip. The CRT-D pulse generator was therefore implanted without the LV lead. When he was referred for an epicardial LV lead implantation by a cardiac surgeon to complete the CRT system, he sought a second opinion. He was then referred to our center for further management. On examination, lungs were clear, heart examination was remarkable for a soft S3 and extremities for mild pedal edema. EKG showed a right ventricular pacing rhythm.

After discussing the options, the patient requested another attempt at placing a transvenous LV lead. In the electrophysiology laboratory, a new LV lead was successfully implanted through coronary sinus into a lateral branch vein. On pacing through this lead, immediate...
shortening of QRS duration was noted. The CRT system was completed by attaching the new LV lead to the existing CRT defibrillator pulse generator.

He improved significantly following this CRT upgrade into a NYHA class III heart failure status. However he continued to have some limitation due to residual exertional dyspnea. There were no signs of heart failure decompensation on follow-up examination.

CRT reprogramming using gas exchange was undertaken, using the Shape HF cardiopulmonary exercise system (Minneapolis, MN), to address his remaining dyspnea. Based on the Shape HF findings, ventriculo-ventricular (V-V) timing was optimized by programming LV pacing earlier than RV by 20 milliseconds. The test also detected poor chronotropic (heart rate increase with exercise) response, which was addressed by adjusting the device’s rate response thresholds. He reported improvement in his dyspnea. The patient clinically improved to and remained at a NYHA class II status at one year follow-up evaluation. Interrogation and testing of his CRT-D at this visit showed appropriate biventricular pacing and stable thresholds.

**DISCUSSION**

As per the ACC/AHA guidelines updated in 2008, class I indications for CRT are LVEF ≤ 35%, sinus rhythm, LBBB with a QRS duration ≥ 150 ms, and NYHA class II, III, or ambulatory IV symptoms. Class IIa recommendations include:

1. LVEF ≤ 35%, sinus rhythm, LBBB with a QRS duration 120 to 149 ms, and NYHA class II, III, or ambulatory IV symptoms.

2. LVEF ≤ 35%, sinus rhythm, a non-LBBB pattern with a QRS duration ≥ 150 ms, and NYHA class III/ambulatory class IV symptoms.

3. Atrial fibrillation and LVEF ≤ 35% if a) the patient requires ventricular pacing or otherwise meets CRT criteria and b) AV nodal ablation or pharmacologic rate control will allow near 100% ventricular pacing with CRT.

4. LVEF ≤ 35% and are undergoing new or replacement device placement with anticipated requirement for significant (40%) ventricular pacing.

In multicenter trials, 40% of patients receiving CRT do not have significant clinical improvement, and are considered non-responders. It is not clear if they simply do not show benefit with CRT or if it is due to inadequate programming. The optimization of CRT programming involves a variety of techniques. The most commonly used techniques are echocardiography based. They often result in a time-consuming process, requiring high cost and labor intensity. Consequently, CRT is often not optimized in clinical practice.

Here we utilized gas exchange for CRT optimization. The lungs lie hemodynamically in series with the heart, share a common surface area, and are influenced by acute changes in left heart pressure and intrathoracic pressures. Changes in ventilation and gas exchange are dynamic as they reflect changes in cardiac function. The important links between respiratory function and cardiac disease severity and in combination with heart rate response to exercise provide a basis for functional classification of patients with chronic heart failure and for functional optimization of CRT. Atrio-ventricular (AV) and VV timing can be adjusted dynamically, using gas exchange during exercise, and frequent optimization is associated with improved long-term clinical response in CRT-pacemaker patients.

Rather than optimizing the CRT programming at rest, the Shape HF method allows for assessment of the effects of AV and VV timing changes while the patient is walking at a comfortable pace (usually 1 mile per hour). This dynamic optimization could improve the overall clinical response to CRT. In addition, optimization to improve ventilatory parameters could improve dyspnea, more than optimization to improve stroke volume (as with echocardiography). It is important to recognize that this cardiopulmonary exercise test is not a stress test, and that gas exchange information is collected at submaximal exercise, making it a feasible method for the geriatric heart failure population.
CONCLUSION

CRT could be a potent intervention for symptomatic patients with systolic heart failure and conduction abnormalities, especially left bundle branch block. Challenges to achieving an effective clinical response include placing the LV lead in an ideal location and optimizing device programming. After failure to deploy the LV lead initially at another center, this patient was initially referred to cardiovascular surgery for epicardial LV lead placement. Although minimally invasive, this approach could be difficult for the geriatric heart failure population. Fortunately, we were able to navigate the cardiac veins in a repeat percutaneous procedure, to position the LV lead in a desirable location. After implanting the necessary hardware, CRT optimization was undertaken using cardiopulmonary exercise testing. Device reprogramming using gas exchange information led to a further clinical improvement in our patient. CRT optimization using gas exchange is a newer technique and may help a significant number of non-responders when other issues such as adequate LV lead location have been accomplished.

REFERENCES


Profiles

p.45  Kara D. Federmeier, PhD
p.48  James Dougherty, MD
Kara D. Federmeier PhD, Associate Professor Department of Psychology and the Neuroscience Program at the University of Illinois and the Beckman Institute Cognitive Neuroscience group

1. PLEASE DESCRIBE THE TYPE OF RESEARCH YOU PERFORM AND YOUR FIELDS OF SPECIALTY.

I am fascinated by how the brain can so quickly and effortlessly connect a word (or picture or face) to the associated memories and knowledge that give that item its meaning. My lab studies the neural bases of language comprehension, with a focus on word and sentence-level meaning, as well as verbal memory. We are particularly interested in how the two hemispheres of the brain comprehend language, both individually and interactively, and in how verbal processing changes over the course of normal aging. We do this by noninvasively measuring brain electrical activity, as well as by monitoring people's eye movements while they read. Both of these are methods that allow us to track language processing over time.

2. HOW DID YOU FIRST BECOME INTERESTED IN THIS FIELD?

My interest in the brain began while I was still in high school. One of my younger brothers bravely battled against (and eventually died of) a brain tumor. It therefore was clear to me at a young age that neuroscience was an important area and that we still had a lot to learn about the brain and, in particular, about how processes like language, which are so important to our lives, arise from the brain.

3. WHERE DID YOU OBTAIN YOUR RESEARCH TRAINING?

My first experiences with research were at the University of Illinois, where I did my undergraduate degree in biology. There are a lot of great things about public research universities, but the opportunity for undergraduate students to be involved in cutting edge research is one of the best aspects of the kind of education you can get at a place like the U of I. My undergraduate research experience, primarily in Bill Greenough's lab, looking at the neural bases of motor learning, and in Marie Banich's lab, looking at hemispheric differences in spatial processing, solidified my desire to do research at the interface of brain and cognition. I then did my graduate degree in Cognitive Science at the University of California, San Diego. My primary advisor there was Dr. Marta Kutas, who was the first person to use electrophysiological measures to study language. I couldn't have asked for a better advisor or a richer program in which to begin my career.

4. DO YOU WORK SOLITARILY OR AS PART OF A TEAM? DO YOU COLLABORATE WITH OTHER SPECIALTIES, DISCIPLINES AND OTHER RESEARCHERS FROM OTHER ORGANIZATIONS?

My lab is at the Beckman Institute, which brings together faculty from a variety of departments and areas. It is appealing to be in this institute and was an important part of the reason I wanted to come to the University of Illinois. I believe that some of the best science arises when people with different expertise, different back-
grounds, and different views come together to work toward a shared goal.

5. WHAT ARE THE PLUSES AND MINUSES TO WORKING IN THIS ENVIRONMENT? (MEANING ALONE OR AS PART OF A TEAM)

Interaction with people studying a diverse set of topics and using a variety of methods keeps you from becoming too settled into the jargon and assumptions of an individual discipline or approach. You learn to examine topics from multiple angles, to assume that you do not know enough (and never will), and to honestly assess the worth of your work from a larger perspective. However, I think it is also important to have depth – to be an expert in your area. By being part of a more traditional department (Psychology) but also being at the Beckman Institute, I get the best of both types of environments.

6. WHAT IS THE MOST COMPPELLING ASPECT OF YOUR WORK?

I honestly love almost every aspect of my job. I like lecturing, writing, reading, thinking, experimenting. The part I enjoy most is playing with ideas: figuring out what data mean, how to design an experiment to get at a question, how to fit new information in with old. The part that is most inspiring is the moment in which you are the first to see some data – to learn something that has never been known before.

7. WHAT IS THE MOST DISAPPOINTING FEATURE?

While I love the work that I do, a disappointing feature is the fact that there is no real downtime. There are always things on the to-do list, always people who need things from you, and no time that you really feel is completely yours or completely free from work demands. Also, there is always more to learn and it is hard to stay on top of it all.

10. WHAT INFLUENCE HAVE YOUR RESEARCH FINDINGS HAD ON HEALTHCARE IN GENERAL?

Most of my research is basic science; the aim is not to solve a particular problem but to build general knowledge about how the brain works. It is important for science to be able to take the long view. Ultimately, we expect that a better understanding of how language arises from brain processes could play a role in a lot of health related areas, especially with respect to language disorders.

In the last few years, I have also begun to be involved in some more applied research. In one project, with Carle, we are looking for brain changes that might allow earlier diagnosis of Alzheimer’s disease.

11. WHAT IMPACT HAVE YOUR RESEARCH FINDINGS HAD OR HAVE POTENTIAL TO HAVE ON HEALTHCARE PRACTICES IN ILLINOIS?

Sometimes, advances in diagnosis involve technology that is not going to be readily available outside of large medical centers (usually in big cities). However, we are working towards methods of diagnosis that involve protocols and equipment available (or potentially available) even in small clinics. I would like to be a part of medical advances that can impact the lives of people that live in small or medium sized towns, like those in which I grew up and now make my home.

12. WHAT ARE THE GOALS YOU WISH TO ACCOMPLISH?

I want to continue to train good students, to advocate for methodological excellence, and to ask and answer interesting questions. Since the questions that I have worked on, about how meaning information is represented and processed in the brain, really lie at the heart of an understanding of human cognition, it is hard for me to imagine that a more interesting topic could come along. But I do see myself as now being in a position to be able to take on some new kinds of projects and to expand my research into new areas.

13. WHAT KEEPS YOU MOTIVATED?

Having family support from my husband, my parents (who live nearby), and my children makes a big difference in allowing me the time and energy to get through the sometimes grueling and always stressful (though also rewarding and stimulating) parts of having a faculty position. Mostly, I just really love the work – almost all aspects of it – which makes it not only possible, but actually enjoyable to put in the long hours and deal with the setbacks that are inevitable along the way. The driving force for me has always been the questions, the experiments, the data that beg to be understood . . . and the rest has followed from that. My students are also an important source of motivation. Helping other people develop their curiosity into a productive line of research
and, ultimately, a successful career is one of the most rewarding aspects of my job.

14. WHAT IS THE SINGLE MOST IMPORTANT DISCOVERY YOU PERSONALLY HAVE MADE?

One of the challenging, and humbling, aspects of basic research is that it is hard to know which of your discoveries will end up being important in the long run. I believe I am best known for my work showing that both hemispheres of the brain can comprehend language (not just the left hemisphere, which has been more closely linked to language because of the aphasias that are associated with left hemisphere strokes), but that they use different processes to extract meaning from language. The left hemisphere is good at predicting – guessing, almost – what word might be coming up next. The right hemisphere, however, is better at creating mental images from language. An interesting implication of this is that, although we tend to think we are comprehending “the” meaning of a word or sentence, different parts of our brain actually understand the same word or the same sentence differently – at the same time!

15. HAVE YOU HAD ANY RESEARCH FAILURES/SETBACKS AND HOW DID THAT IMPACT YOUR WORK?

Typically, a “failure” is just an experimental outcome that we cannot currently understand. Each failure is a reminder that there is still a lot we don’t know, and most “failures” are informative if one is persistent and determined enough to think deeply about them. If all our experiments worked the way we thought they would, there wouldn’t be any need to do the experiments. It is when nature throws us a curveball that we really learn something.

16. HISTORICALLY, WHAT IS THE SINGLE MOST IMPORTANT DISCOVERY EVER MADE IN YOUR FIELD? HOW? WHERE? BY WHOM?

In 1928, Hans Berger showed that it was possible to noninvasively record the brain’s electrical activity using sensors (electrodes) placed on the scalp. George Dawson, in 1947, was then one of the first to be able to extract from the ongoing electroencephalogram (EEG) the brain responses linked to a particular event in the environment – creating the event-related potential (ERP). The development of this technique offered us the ability to actually “watch” the brain as it perceives, remembers, communicates, and plans actions in the world. This technique has fundamen- tally changed our understanding of cognition – and continues to do so.

17. HOW IS CARLE AND/OR THE U OF I ASSISTING YOU IN YOUR RESEARCH? (RESOURCES, PERSONNEL, ETC.)

Carle physicians and the Carle research team are helping us link up with patients, who generously contribute their time to research projects. When the U of I and Carle come together, we have the opportunity to translate new discoveries and devices coming from basic research into medical practice.
James Dougherty, MD, Vice President Research and Graduate Medical Education

1. PLEASE DESCRIBE THE TYPE OF RESEARCH YOU PERFORM.
I provide supervision and direction for Carle's research activities as VP for Research and GME. I do not practice clinically. My training is in Emergency Medicine.

2. HOW DID YOU FIRST BECOME INTERESTED IN THIS FIELD?
I have always enjoyed the challenge of answering questions. As a chemistry major in college, solving questions was a way of life. It has simply continued through medical school and my medical career. All physicians are scientists, whether they know it or not.

3. WHERE DID YOU ATTAIN YOUR RESEARCH TRAINING?
Undergrad at Eastern Illinois University, then University of Illinois College of Medicine in Chicago.

4. DO YOU WORK SOLITARILY OR AS PART OF A TEAM?
My preference is to work as part of a team, but I’ve done both.

5. WHAT ARE THE PLUSES AND MINUSES TO WORKING IN THIS ENVIRONMENT? (MEANING ALONE OR AS PART OF A TEAM)
Team-based research has several advantages such as many eyes examining the research phases, diversity of input. Working alone is fine for less ambitious projects.

6. WHAT IS THE MOST COMPPELLING ASPECT OF YOUR WORK?
I’ve been involved with research as a core component of my professional life for over 30 years. The most compelling aspect of my work is being able to impart my sense of enthusiasm for research and how its integration with clinical care and medical education creates the best environment to take care of patients.

7. WHAT IS THE MOST DISAPPOINTING FEATURE?
Being an emergency physician, I really enjoyed designing EMS related research and organizing a research team to investigate it. Trying to design a sustainable model to do this was not in the cards when I first started.
8. WHAT ARE THE GOALS YOU WISH TO ACCOMPLISH?
See Carle succeed and advance using both research and medical education as strong “enablers” of that success.

9. WHAT KEEPS YOU MOTIVATED?
Watching teaching occur where none has happened before or watching a new researcher finally grasp the significance of blinding the study, the “aha” moment.

10. WHAT IS THE SINGLE MOST IMPORTANT DISCOVERY YOU PERSONALLY HAVE MADE?
To be successful in research, you have to be narrow, not wide, deep not shallow. Having patience and a sense of humor doesn’t hurt either.

11. HISTORICALLY, WHAT IS THE SINGLE MOST IMPORTANT DISCOVERY EVER MADE IN YOUR FIELD? HOW? WHERE? BY WHOM?
My field is Emergency Medicine and I believe the determination of relative effectiveness (or not) in various treatment algorithms for cardiac arrhythmias is the most important finding.

12. HOW IS CARLE AND/OR THE U OF I ASSISTING YOU IN YOUR RESEARCH? (RESOURCES, PERSONNEL, ETC.)
My role is to help research collaborations occur between Carle physicians and UIUC researchers. Carle has a significant investment of resources, both people and financial to make this happen.
Research at Carle

p.51  Study Listing
p.62  Carle Research Newsletter
# Research at Carle

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| Carle 12116 | OPEN | Anemia at Hospital Admission and the Subsequent Development of Acute Kidney Injury during That Hospital Stay | Chart Review |
| Carle 12118 | OPEN | Reviewing the Treatment Modalities for Submassive Pulmonary Embolism | Chart Review |
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| Carle 12147 | OPEN | Intimate Partner Violence Education: The Impact of Nursing on Patient Outcomes | Survey |
| Carle 12149 | OPEN | Evaluation of Staff Nurses’™ Attitudes Toward Pressure Ulcer Prevention: A Quantitative Study | Survey |
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<td>2008</td>
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<td>A Humanitarian Device Exemption Treatment Protocol of TheraSphere for Treatment of Unresectable Hepatocellular Carcinoma</td>
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<td>9021</td>
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<td>Using Non-Invasive Brain Imaging to Investigate Functional Changes in the Auditory and Language Processing in Adult Cochlear Implant Patients</td>
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The 2013 Carle Research Institute Awards Excellence in Research

Excellence in Research and Friend of Research

The Research Institute’s Unit Partnership Council has begun a new initiative to recognize the exemplary work of Carle and University of Illinois physicians, professors and staff. During August many individuals were nominated for the Excellence in Research award and Friend of Research awards. These individuals have shown their dedication to the success of the Research Institute as well as to the success of the studies and the teams with which they work. Listed below are the 2013 awardees. Excellence in Research is for any principal investigator, co-investigator or sub-investigator that exemplifies expertise, professionalism, results, and collaboration in their research. Friends of Research are individuals who exemplify excellence in service and collaboration with researchers as well as patients.

Awards will be given at the Research Mixer in The Forum immediately following Foundation Day, Thursday, November 7, 2013 from 5 to 6:30 p.m.

Excellence in Research Award Recipients

Aron Barbey, PhD  
Dr. Barbey is assistant professor in the Department of Speech and Hearing Science at the University of Illinois. Dr. Anna Keck of the Carle’s Research Institute nominated him for his work on their collaborative study “Nutrient Biomarker Patterns, Cognitive Function, and MRI Measures of Brain Aging,” where they analyze the relationship between nutrient biomarkers and psychometric and imaging indices of brain health in non-demented elders. Dr. Barbey along with his multidisciplinary team is exceeding enrollment expectations per their grant timeline.

Brian Wheatley, MD  
Dr. Wheatley is a vascular surgeon at Carle Foundation Hospital and an assistant clinical professor at the University of Illinois. Research study coordinator Tiffany McGeehon nominated Dr. Wheatley for his work on the CryoVein LimbSave study, which is a multicenter, prospective clinical trial that is evaluating below-the-knee bypass in patients with critical limb ischemia using CryoVein’s cryopreserved saphenous vein allograft. Dr. Wheatley was able to complete 83 percent of his required enrollment before any other site began enrolling, and as result, Carle was designated as a site to collect photographic data. Carle will also become a competitive enrollment site once 100 percent enrollment has been obtained.
The 2013 Carle Research Institute Awards:
Excellence in Research and Friend of Research (cont.)

Friends of Research Award Recipients

Meagan O’Brien, MS
Meagan is an ophthalmic assistant in Carle Opthalmology. She was nominated by Dr. Michael Tsipursky, MD, Ophthalmologist at Carle, for her work on a project involving novel applications of photodynamic therapy in combination with anti-VEGF injections for resistant macular degeneration.

Colleen Luce, RN
Colleen is a nurse in Orthopedics. Research study coordinator Kevin Osborne nominated her for her work on a collaborative study with Dr. Stewart, PhD, University of Illinois. To date, she has consented almost all of the nearly 700 subjects in that study.

Jenna Bates
Jenna is a surgery scheduling specialist for Head and Neck Surgery at Carle. Research study coordinator Barbara Hall nominated Jenna for her efforts in providing patient population information in order for the Research Institute to consent subjects and obtain tissue for collaborative studies with the University of Illinois.

Travis Blunier, MS
Travis is the Lab Cytology Pathology manager at Carle. Dixie Heath, director of Research Operations, and tissue-data management specialist Bre Stillwell nominated Travis for his exemplary work in helping to facilitate tissue collection and lab processing for numerous research projects. Travis is vital to the success of the Tissue Procurement Services team and to the entire Research Institute.

R. Bruce Wellman, MD,
Dr. Wellman, chief executive officer, Carle Physician Group, was nominated by Dr. James Dougherty for providing steady and supportive leadership to all Carle-based research in his role as chief medical officer. Additionally, he serves as the institutional official, a position of significant responsibility in the research compliance world.

Matt Wheeler, PhD
Dr. Wheeler is a professor at the University of Illinois Department of Animal Sciences. He is passionate about Carle and the University of Illinois and has been a huge advocate for collaborative work. He is helping develop research areas at Carle in sports medicine, oral maxillofacial surgery and neurosurgery. Dr. Wheeler was nominated by Jerrad Zimmerman, MD, program director of the Carle Sports Medicine Fellowship Program.
Registration of clinical trials: Who should register and why

The website ClinicalTrials.gov is a registry and results database that provides easy access to information about clinical studies to prospective study participants, healthcare professionals, researchers and other members of the public. The federal requirement to register a clinical trial applies to studies that are not only federally sponsored or industry sponsored, but to investigator initiated trials as well. Typically, registration is the responsibility of the sponsor of the trial, but, in some cases, the sponsor may designate the principal investigator to be responsible for the registration.

U.S. law requires that all “applicable clinical trials” initiated after 9/27/07 or ongoing as of 12/26/07 must register at ClinicalTrials.gov. Applicable clinical studies are investigational studies that use a drug, biologic or device as an intervention and would include the following:

- Controlled, clinical investigations (other than Phase I) of a drug or biologic subject to Food and Drug Administration (FDA) regulations,
- Device trials that are controlled trials with health outcomes of devices subject to FDA regulation (other than small feasibility studies), and
- Pediatric postmarket surveillance required by the FDA.

The consequence of not registering an applicable clinical trial may result in civil monetary penalties up to $10,000/day, and, for federally funded studies, the withholding or recovery of grant funds.

A clinical investigation can still be considered an “applicable clinical trial” even if the study intervention does not require an Investigational New Drug or Investigational Device Exemption. Examples of studies that do not have to be registered include the following:

- Phase 1 drug trials or studies in which investigational drugs are used as research tools,
- Observational research, or
- Studies that do not use drugs, biologics or devices such as behavioral interventions.

However, both the FDA and National Institutes of Health (NIH) encourage the registration of all trials and not just those that are required to register.

In addition, the International Committee of Medical Journal Editors (ICMJE) requires prospective registration of all interventional clinical trials in a public registry in order to be considered for publication in journals that adhere to ICMJE standards. The ICMJE defines a clinical trial as “any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes.” Note that this definition of clinical trial is broader than the definition of an applicable clinical trial and would include not only drugs and devices, but surgical procedures, behavioral treatments, dietary interventions and process-of-care treatments. Purely observational studies are not required to be registered. ICMJE accepts registration not only at ClinicalTrials.gov, but at several other trial registries as well. For more information, go to the ICMJE website.

Cancer Research Update: Learning Network to improve access to clinical trials through education and collaboration

In an effort to increase accrual (patients participating in clinical trials), particularly among racial minorities and the patient population over age 65, Carle Cancer Research has applied for and been granted the opportunity to participate in the National Cancer Clinical Trials Collaborative Learning Network with the Education Network to Advance Cancer Clinical Trials (ENACCT). This Learning Network seeks to improve access to cancer clinical trials through education and collaboration with communities, healthcare providers and researchers. Through a series of eight webinars with accompanying required homework and two on-site visits with ENACCT representatives, a team of clinical researchers, oncologists, and both the Mills Breast Cancer Institute coordinator and Radiation Oncology manager will work for four months to identify practical, patient-centered approaches to increase accrual overall as well as the specific populations mentioned above. Webinars, consultation visits and self-assessments will be used as tools to develop a clinical trial recruitment and accrual process map and action plan that aids in the identification of weak links in the current processes. Understanding gaps in the current screening processes, securing physician buy-in, gleaning community support for research, enhancing communication within the Carle Cancer Center and to the community regarding new research options, and identifying inefficiencies and weaknesses through participation in the Learning Network will fortify the goals of the organization to maintain and grow its research opportunities. In alignment with the research-driven culture of Carle, the Cancer Research believes participation in this Learning Network will directly translate to broader and better options for cancer patients in our communities.
Publications

The following recent publications highlight Carle researchers in bold:


Carle IRB - New Research Studies

Safety and Efficacy of the Cochlear™ Nucleus® CI422 Cochlear Implant in Adults
PI: Michael Novak, MD, Otolaryngology, Carle

A Registry of Caris Life Sciences® Molecular Intelligence Service™ (Biomarker Assessment Results) Intended for Correlation with Cancer Clinical Outcomes
PI: David Graham, MD, Oncology, Carle

Efficacy of Oxygen Systems in Pediatric Bronchiolitis
PI: Taylor Yardley, BSN, Pediatrics, Carle

Assuring Quality of Pediatric Assessment Frequency
PI: Ann Eckhardt, PhD, RN, House Officer, Carle

Assessing the Effectiveness of Advance Care Planning in Health Care Providers
PI: Jean Holley, MD, Nephrology, Carle

Investigating Causes of Feeding Intolerance/Problems and Necrotizing Enterocolitis in Premature Infants in the NICU Setting
PI: Kelly Tappenden, PhD, Food Science and Human Nutrition, University of Illinois

Subungual Squamous Cell Carcinoma Presenting as Chronic Paronychia: Report of 3 Cases and Review of the Literature
PI: Ike Uzoaru, MD, Pathology, Carle

Reviewing the Treatment Modalities for Sub-massive Pulmonary Embolism
PI: Scott Santeler, MD, Heart and Vascular Institute Procedure Center, Carle

Fatigue Countermeasures Program for Nurses
PI: Robin Grubbs, RN, Quality, Carle

Decrease falls by educating nurses to utilize hourly rounding
PI: Cricket Engelbrecht, RN, BSN, Emergency, Carle

Treatment related changes in cognition and brain function in hypothyroidism
PI: Arthur Kramer, PhD, Beckman Institute, University of Illinois

Lab-on-a-chip for point-of-care HIV/AIDS diagnostics
PI: Rashid Bashir, PhD, Bioengineering, University of Illinois

Physician Consultations: An Observation of Consultations Between Doctors in an ED Setting
PI: John Lammers, PhD, Communication, University of Illinois

How Did We Do?

See something you liked or have a suggestion for future issue? We’d like to hear from you. Send your comments and/or suggestions to research@carle.com.