Contents

From the Editors 5

Christina Schirtzinger 7
Comparison of Bird Species Composition Near Forest Edges

Caleb Septer 25
Sleep and Neurodegeneration: Relationships and Gaps in Knowledge Between

Audreya Williams and Ashley Ozebek 38
The Use of the Critical-Care Pain Observation Tool in Nonverbal, and Cognitively Impaired Patients

Megan Paolini 43
The Role of the Microbiome on Human Health and Wellness

Megan Paolini 45
Biotechnology and Genetics

Megan Paolini 47
The Controversy Surrounding Vaccines

About the Authors 49
From the Editors

This third issue of *The BRAIN: A Journal of Undergraduate Writing* is the first of our four STEM issues, beginning with Science. As stressed in the first issue, the premise of the journal lies in the fact that every semester, undergraduate students write papers for a wide variety of classes, papers that, once written, have nowhere to go except, maybe, the trashcan. We think the trashcan should not be the final resting place of these essays. A journal of undergraduate writing could become a place where papers, once relegated to trashcans or recycling bins, could go, and gain a more permanent existence.

Because we limited the scope of the journal’s content, we received fewer submissions than we had hoped for, but the variety of genres, as in the second issue, was quite varied, ranging from smaller paper assignments to more formal scientific research articles. This third issue highlights the best of what we received from writers writing about science.

The issue begins with Christina Schirtzinger’s paper focusing on bird species composition in forests. From there, we move to Caleb Septer’s paper that has as its focus the relationship between sleep and some neurodegenerative diseases. Ashley Ozebek and Audreya Williams’ paper looks at and synthesizes research on a particular pain assessment tool. The journal ends with a series of smaller papers by Megan Paolini; they focus on human-oriented scientific research.

As usual, we were amazed at the work writers do to create these successful pieces of writing that show a range of critical and creative capital, through research and synthesis of that research. This issue of the journal showcases the kind of critical creativity that research can produce in a variety of courses.

As always, we are pleased that these undergraduates were willing to put their work out in the public sphere.
Comparison of Bird Species Composition Near Forest Edges
Christina Schirzinger

Latitude: 39.00426137323804
Longitude: -81.8396472930908

List of Figures
1. Count of birds by diet in each site
2. Count of birds by foraging type in each site
3. Wide view of open field edge with forest edge
4. Topographic map of forest, marked with each site

List of Tables
1. Names of bird species with code names for foraging diet and residency listed for reference
2. Bird species richness, similarity, diversity, and evenness

Abstract
Mixed-species bird flocks are common in non-breeding seasons and help protect year-round residents against predation and with food gathering. Selection of habitat and season among mixed-species flocks in temperate zones are well-studied variables, but changing composition of species amongst habitat type in the same vicinity has room for more observation. Flocks were observed by forest edge and open field edge habitats near Groundhog Creek in Meigs County, Ohio, in the non-breeding season. Observations were taken of species composition in the two habitat types to understand structural differences between habitats. I investigated to test for differences between forest edges and open field edges in: 1) composition, 2) diversity, and 3) foraging and diet types of birds. My hypothesis was to see significant differences in all categories investigated. Results showed a significant difference between species abundance in each habitat type. No difference in species richness was observed, but both had high diversity ($D(s) = .91 \& .93$). Shannon-Weaver also showed a higher diversity in open field edges ($H' = 2.86$) than forest edges ($H' = 2.53$). A higher count of birds was observed near open field edges compared to forest edges. Further studies could look at measurable differences of flock location relative to forests edges when near open field edges.

Keywords: mixed species bird flock, diversity, composition, forest edge, open field edges, richness, similarity
Introduction

Mixed-species groups can be observed in schools of fish (Bastos, 2008), herds (Fitzgibbon, 1990), primates (Stensland et al., 2003), and birds (Colorado, 2015; Klaver, 2012; Greenberg, 2001; Hutto, 1994; Eguchi et al., 1993). Cohesive movements of groups are unique and well-studied in bird communities. Birds have examples of mixed-species flocks, particularly in forested and coastal areas (Develey et al., 2000; Croxell, 1976; Ming et al., 2005). During non-breeding seasons, a majority of non-migratory bird species will participate in mixed-species flocks. Mixed-species flocks move cohesively: they work together to keep watch for predators and to search for food. Many examples exist of incredible diversity, composition, and structure of mixed-species flocks (Colorado, 2015; Krebs, 1973; Eguchi et al., 1993).

In western Mexico, composition and social organization of flocks in a tropical deciduous forest were determined by a foraging range of one or more leader species, also known as nuclear species (Hutto, 1994). Considerable evidence pertains to flocks being structured around species interactions. Competitive interaction based on co-occurrence and guild proportionality models of bird species in the Andes showed positive correlations between the two models (Colorado, 2015). In southeastern Brazil, species richness, size, and structure were determined by forest fragment size (Maldonado-Coelho, 2001).

Mixed-species flocks occur due to two main factors: foraging (for food) and predation. To assist with effective foraging, flocks tend to include birds with specialized feeding, such as insectivores, herbivores, and omnivores. Flocks rely on nuclear species to guide them to the best foraging sites. In temperate regions, these are normally tufted titmice (*Baeolophus bicolor*) or Carolina chickadees (*Poecile carolinensis*); these two birds are efficient at finding foraging sites. Other nuclear species, like antbirds, are quite noisy and provide cues to locate swarms of insects (Greenberg, 2001). These species don’t necessarily want other species around them but tolerate other species for benefits of anti-predation and foraging.

When food sources were made superabundant artificially, species that would normally contribute in mixed-species flocks, like woodpeckers and chickadees, no longer participated, showing the importance of food for flock cohesion (Berner et al., 1985). Cohesion was also
represented with observations of nuclear species modifying their location and height of foraging with other nuclear species present (Krebs, 1973). Flocks in Madagascar would also forage at different heights due to composition and abundance of insectivorous species (Eguchi et al., 1993).

Flock cooperation also helps prevent predation. Primary mechanisms of anti-predation are increased vigilance and use of alarm calls of certain species. The need for increased vigilance creates tradeoffs with thermoregulation and predation. Flocks by an open field tend to stay in the forest rather than in sunlight, even in 30-degree weather, due to higher risk of predation (Carr et al., 2014). The temperature can also predict species presence and composition. In Connecticut, a flock was found to be determined by the temperature and productivity of the region, but temperature was the best indicator of species present in winter (Craig, 2012). As for vocalizations, nuclear species have well-developed conspicuous vocalizations to send information effectively and efficiently to other flock members (Suhonen, 1993).

There are many ways to differentiate a flock of birds from an aggregate of birds. Flocking birds have specific species composition, territory lines, and foraging behavior. Clustering objectively has linked birds to landscapes, and maps of clusters showed strong regional patterns associated with distinctive habitat assemblages (Fuller et al., 2005). Birds can move in and out of flocks, making it harder to distinguish differences between flocking and non-flocking birds. Aggregates are brought together for a resource, but do not maintain cohesion in groups (Greenberg, 2001). When studying effects of forest fragmentation, forest edges become territory boundaries, helping to distinguish flock sizes and composition, but boundaries would change only when forests would grow back (Develey, 2001).

The major costs of living in a flock are adjusting foraging and territory sites to join flocks. These costs are a result of exploitative competition, which was described in the example of woodpeckers and chickadees as less likely to be in a flock when food was readily available (Berner et al., 1985). Costs go both ways as all are affected by an increased chance of being seen by a predator, exploiting location due to noisiness, and losing opportunity for food from the number of organisms present (Craig et al., 2014).
Flocks form out of complex systems based on home ranges, nuclear species present, and factors like predation and food availability. Questions arose about the complexity existing at forest edges. Higher diversity at forest edges was present rather than inside the forest during fall migration due to migrants using edges as stopover habitats. In the southeastern region of Ohio, chickadees and titmice will more often than not be dominant species in the fall season (Rodewald, 2002).

I examined a three-fold hypothesis based on this more general one: composition differs between forest edge and open-field edge habitats. To break down this more general hypothesis into its related component parts, I investigated species communities on forest edges compared to open-field edge sites, in terms of each site: 1) composition and diversity; 2) species richness and abundance; and 3) foraging and diet types of birds. Data was collected at nine different sites among two habitats: five forest edge sites and four open-field sites. I investigated the hypothesis for significant differences in: 1) composition; 2) diversity; and 3) foraging and diet types of birds between forest edges and open-field edges.

**Methods**

The study was conducted on private property along Groundhog Creek in Meigs County, Ohio. Two study areas were chosen on the western side of a hill, where both open-field edge and forest edge habitats could be observed in a close vicinity (Figure 3). Nine sample sites were established: five forest edge sites and four open-field edge sites (Figure 4). Sites were spaced approximately 50 meters apart, with the exception of site 7 (only reached by walking around the creek edge and onto the road). I assumed birds would not travel between sites with approximately 50 meters between (Reynolds et al., 1980). Trees located approximately 20 meters apart were used to regulate site size.

Data was collected on foot around 8:30 in the morning for five consecutive days. Forest edge sites (sites 2-5) were sampled the first three days, and open-field edge sites (1, 7-9) were sampled for the last two days. Observations were taken within each site limits, approximately 10 meters from each site to keep from disturbing birds. Binoculars and the *Peterson Field Guide to Birds of Eastern and Central North America* (2010) were used to observe details of each species.
noted weather, site number, time, count of birds, species of birds, comments of behavior of birds such as visible perching, foraging, or flying birds, and any observed disturbance at each site. I also recorded any sounds that came from each site. Observations were made at each site for 10 minutes.

Each forest edge site had differing vegetation in order to capture diversity accurately. Some had mature dead trees, small and large live oaks (Quercus sp.), thorn bushes (Rosa sp.), maples (Acer sp.), Populus sp., and other deciduous trees. Canopy cover ranged 0-60%, with varying ground cover of bushes, vines, and leaf litter. Birds in the open field edges were considered to be a part of a mixed-species bird flock due to foraging and flocking behaviors such as being chased by or chasing other birds located on the same branch or bush, or singing to guard territory. Forest edge birds were not considered to be in a flock due to dispersal and non-flocking behavior.

Observations were copied into Excel and tested for diversity, similarity, and evenness between forest edges and open field edges. When testing for diversity, Shannon-Weaver’s (H’) equation was used:

\[
H = \sum_{i=1}^{s} - (P_i \times \ln P_i)
\]

Another method for species diversity, Simpson’s equation, also was used:

\[
\int_{0}^{x} f(x) \, dx = \int_{0}^{x+2h} f(x) \, dx
\]

To test for similarity, Jaccard’s equation was used:

\[
J(X,Y) = \frac{|X \cap Y|}{|X \cup Y|}
\]

For evenness, Pielou’s equation was used:

\[
J' = \frac{H'}{\ln(S)}
\]

Each species was given codes to determine location, residency, diet, and foraging type. Sums of species were taken at each site, and the total of each bird count was given to get an accurate reading of abundancy. Linear models were used for each diet and foraging type by forest or field location.
Results

A total of 26 species were present, when all sites were included. 19.2% of the species were winter residents, 69.2% were year-round residents, and 11.6% were summer residents. Each species was categorized by diet types: insectivorous, omnivorous, carnivorous, and herbivorous. The statistical breakdown for each diet type was: 34% insectivorous, 46% omnivorous, 3% carnivorous, and 17% herbivorous. Each species was also categorized by foraging type, and the correlating statistical breakdown was as follows: 42.3% probing, 7% caching, 11% hawking, 26.9% gleaning, and 7% scratching (Table 1). Species consistently present between the two sites were tufted titmouse (*Baeolophus bicolor*), Carolina chickadee (*Poecile carolinesis*), Carolina wren (*Thryothorus ludovicianus*), yellow-rumped warblers (*Setophaga coronata*), and song sparrows (*Melospiza melodia*).

For the first part of the hypothesis, which consisted of examining differences between habitat types in composition and diversity, a t-test showed a significant difference in composition, based on the number of species present (p<.0001). All 26 species were present at open-field edge habitat sites, while only 15 species were present in forest edge habitat sites. Simpson’s index showed high diversity for both forest edge (D(s)=.91045, SE=.0067, t=.181, Table 2) and open field edge (D(s)=.92698, SE=.0017), with slightly differing evenness (forest=.073, field=.041). Shannon-Weaver also showed the same results for high diversity, with open-field edge sites being more diverse (H‘=2.86, SE=.0003, t= -6.184, Table 2) than forest sites (H‘=2.53, SE=.0026). Forest edge sites showed more evenness (.9343) than field edge sites (.8791). This occurrence proved the hypothesis correct with a difference in diversity, but with differing outcomes of evenness.

For the last part of the hypothesis, which consisted of showing differences between habitat types in foraging and diet, I performed a linear model for each variable separately, using the total count of birds in each site with diet type and foraging type. Count of birds between each habitat type was significantly different (p<.0001, t= 1.214, df=53). Herbivore, omnivore, and carnivore counts were significant between each site (herbivore p=.027, omnivore p=.030, Figure 2). Insectivores were near significant (p=.059, Figure 2). No evidence for significant difference of counts occurred with any foraging type between the two
habitat types (gleaning p = .104, hawking p = .213, probing p = .336, scratching p = .321, Figure 2).

Discussion

I investigated three related hypotheses: species communities on forest edges when compared to open field edge sites would differ in 1) composition and diversity; 2) species richness and abundance; and 3) foraging and diet types of birds. I concluded that open field edge sites were slightly more diverse than forest edge sites, especially with the presence of a mixed-species bird flock (Table 2). I also concluded that these findings are due to the presence of a mixed-species bird flock (Berner et al 1985, Carr et al 2014, Colorado 2015, Rodriguez 2001).

The first hypothesis was supported, with evidence for differing compositions among species present at each location. This evidence is consistent with other studies that have also investigated composition of birds in differing habitats (Fuller 2005, Craig 2012, Rodriguez 2001, Rodewald 2002). Evenness, which can help to explain diversity and composition, at both habitat types seemed to differ very slightly (Table 2). Mixed flocks’ evenness has been shown to increase as summer transitions to winter, which may explain greater evenness for open field edge sites with the flock versus forest edges without a flock (Craig 2012). With these studies in mind, studying correlations with composition and evenness would be beneficial in observing transitions from summer to winter for temperate flocks.

The second part of the hypothesis predicted a difference in diversity between the two habitat types. Because diversity entails richness and abundance, these factors should be considered for conservation of habitat for birds, whether they are in a mixed flock or not. Previous studies showed richness was affected by habitat size, specifically forest fragmenting (Maldonado-Coelho 2001). Greater land-use and anthropogenic disturbances could deter the nuclear species from using that territory (Goodale 2015, Mammides 2015). Therefore, unique conservation for the leader species will benefit the cascading effects on species that follow the nuclear species normally and keep a higher diversity.

The last part of the hypothesis predicted differences in foraging and diet type between forest edges and field edges. Evidence for different
diet types was present while foraging behaviors were not significant, which made the prediction partially correct. Research has previously shown flocking birds will adjust their foraging behavior to be the most efficient with capturing prey, which may or may not create diversity in foraging type (Krebs 1973). Varying diet is more beneficial for a flock as it decreases the need for competition within the flock, as well as being most efficient when foraging in a specific area (Colorado 2015). Birds will have more effective foraging, while reducing needs for competition, as that is energetically expensive (Eguchi 1993, Suhonen 1993). In using less energy on competition, these birds have more energy for foraging as well as keeping watch for predators.

Investigating mechanisms that influence species diversity and composition can also help to understand conservation of multiple birds, not just one species. Behaviors can be interpreted in two ways to understand structural organization and composition of mixed flocks. The first way is to be vigilant of species interactions, such as titmice or chickadees, as they tend to be nuclear species; this vigilance will help us better understand the role of other birds. Because of ‘follower’ species’ dependency on nuclear species for foraging sites, participation of certain species is restricted to the territory of nuclear species and could show a positive correlation with leader species.

The second way is to consider indirect effects of species present that do not take part in flocking. When the territory of non-flocking birds overlaps with flocking birds’ foraging sites, there is a need for mutual habitat use. Mutual habitat dependency requires knowledge of habitat parameters of which two or more species can be co-dependent on and should be a future investigation with flocks near non-flocking birds.

References


Figure 1.
Figure 2.
<table>
<thead>
<tr>
<th>Letter</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Winter resident</td>
</tr>
<tr>
<td>S</td>
<td>Summer Resident</td>
</tr>
<tr>
<td>P</td>
<td>Permanent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foraging/ diet Letter Code</th>
<th>Caching</th>
<th>Hawking</th>
<th>Gleaning</th>
<th>Probing</th>
<th>Scratching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insectivore</td>
<td>IC</td>
<td>IH</td>
<td>IG</td>
<td>IP</td>
<td>IS</td>
</tr>
<tr>
<td>Carnivore</td>
<td>CC</td>
<td>CH</td>
<td>CG</td>
<td>CP</td>
<td>CS</td>
</tr>
<tr>
<td>Omnivore</td>
<td>OC</td>
<td>OH</td>
<td>OG</td>
<td>OP</td>
<td>OS</td>
</tr>
<tr>
<td>Herbivore</td>
<td>HC</td>
<td>HH</td>
<td>HG</td>
<td>HP</td>
<td>HS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
<th>Foraging/Diet Letter Code</th>
<th>Residence</th>
<th>Foraging/Diet Type</th>
<th>Location</th>
<th>Field Count</th>
<th>Total Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red-breasted Nuthatch</td>
<td>Sitta canadensis</td>
<td>RB NU W IC BO TH</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1.
<p>| Golden-crowned Kinglet | Regulus satrapa | GC | KI | W | IH | BOTH | 1 | 4 | 5 |
| Tufted Titmouse | Baeolophus bicolor | TU | TI | P | OG | BOTH | 3 | 24 | 27 |
| Northern Cardinal | Cardinalis cardinalis | NO | CA | P | HG | FIELD | 0 | 14 | 14 |
| Hairy Woodpecker | Picoides vilosus | HA | WO | P | IP | FIELD | 0 | 3 | 3 |
| Yellow-bellied Sapsucker | Sphyrapicus varius | YB | SA | W | IG | FIELD | 0 | 1 | 1 |
| Eastern Towhee | Pipilo erythrophthalmus | EA | TO | P | OG | BOTH | 1 | 4 | 5 |
| Carolina Wren | Thryothorus ludovicianus | CA | RW | P | IP | BOTH | 3 | 13 | 16 |
| Gray Catbird | Dumetella carolinensis | GR | CA | S | OP | BOTH | 2 | 2 | 4 |
| Northern Flicker | Colaptes auratus | NO | FL | P | OP | BOTH | 4 | 8 | 12 |
| American Crow | Corvus brachyrhynchos | AM | CR | P | OS | BOTH | 7 | 12 | 19 |
| Blue Jay | Cyanocitta cristata | BLJ | A | P | OC | BOTH | 6 | 6 | 12 |</p>
<table>
<thead>
<tr>
<th>Species</th>
<th>Call</th>
<th>Notes</th>
<th>Date 1</th>
<th>Date 2</th>
<th>Date 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>House Finch</td>
<td>Haemorhous mexicanus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Song Sparrow</td>
<td>Melospiza meoldia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow - Rumped Warbler</td>
<td>Setophaga coronata</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Robin</td>
<td>Turdus migratorius</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Sparrow</td>
<td>Spizella pusilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pileated Woodpecker</td>
<td>Dryocopus pileatus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-throated Sparrow</td>
<td>Zonotrichia albicollis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carolina Chickadee</td>
<td>Poecile carolinesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern Mockingbird</td>
<td>Mimochlora polyglottos</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ovenbird</td>
<td>Seiurus aurocapilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Great Blue Heron</td>
<td>Ardea herodias</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Call</th>
<th>Notes</th>
<th>Date 1</th>
<th>Date 2</th>
<th>Date 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>House Finch</td>
<td>Haemorhous mexicanus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Song Sparrow</td>
<td>Melospiza meoldia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow - Rumped Warbler</td>
<td>Setophaga coronata</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Robin</td>
<td>Turdus migratorius</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Sparrow</td>
<td>Spizella pusilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pileated Woodpecker</td>
<td>Dryocopus pileatus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-throated Sparrow</td>
<td>Zonotrichia albicollis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carolina Chickadee</td>
<td>Poecile carolinesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern Mockingbird</td>
<td>Mimochlora polyglottos</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ovenbird</td>
<td>Seiurus aurocapilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Great Blue Heron</td>
<td>Ardea herodias</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barn Swallow</td>
<td>Hirundo rustica</td>
<td>BA</td>
<td>RS</td>
<td>S</td>
<td>IH</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------</td>
<td>----</td>
<td>----</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td>Red-winged Blackbird</td>
<td>Agelaius phoeniceus</td>
<td>RW</td>
<td>BL</td>
<td>P</td>
<td>OH</td>
</tr>
<tr>
<td>Wild Turkey</td>
<td>Meleagris gallopavo</td>
<td>WIT</td>
<td>U</td>
<td>P</td>
<td>OP</td>
</tr>
</tbody>
</table>

**Table 2.**

<table>
<thead>
<tr>
<th></th>
<th>Simpson's Index D(s)</th>
<th>SE</th>
<th>t</th>
<th>Evenness</th>
<th>Shannon-Weaver H'</th>
<th>df</th>
<th>Evenness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FOREST</strong></td>
<td>0.9104</td>
<td>0.006</td>
<td>-0.18</td>
<td>0.073</td>
<td>2.530</td>
<td>60.7</td>
<td>0.934</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>65</td>
<td>22</td>
<td>21</td>
<td>88</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td><strong>FIELD</strong></td>
<td>0.9269</td>
<td>0.001</td>
<td>0.041</td>
<td>2.864</td>
<td>0.879</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>65</td>
<td>49</td>
<td>1</td>
<td></td>
<td>07</td>
<td></td>
</tr>
</tbody>
</table>

**Percent Similarity (Jaccard)**

61.70 %
Sleep and Neurodegeneration: Relationships and Gaps in Knowledge Between Sleep and Neurodegeneration
Caleb Septer

Abstract

Various relationships amongst neurodegenerative diseases (NDDs) and sleep disorders in patients affect their quality of life in many ways. Alzheimer’s disease (AD) is related to a number of different biomarkers that invade the brains of its victims. Orexin proteins, tau proteins, and amyloid-beta biomarkers have been linked to sleep disturbances in AD patients. Huntington’s disease is another NDD that may also be influenced by the sleep patterns of its patients. To show a relationship between neurodegeneration and sleep, this paper compares an NDD test group and control group without NDDs. The comparisons among these groups considers the following: Total sleep time (TST), sleep latency (SL), sleep efficiency (SE), rapid eye movement (REM) sleep, and melatonin amount.

Introduction

It is no secret that sleep is one of the most important activities not only for one’s physical health, but also for one’s mental health. Sleep can impact various realms of cognitive function in the human brain, including attention and memory (Kang, 2016). With the world’s population aging, neurodegenerative diseases (NDDs) are among the top health concerns of the 21st century (Pillai, 2017). In many patients with a neurodegenerative disease, sleep disturbances are common; these disturbances can impair the quality of life for patients and their caregivers. There have been clinical sleep disorders associated with NDDs that comprise all sleep categories including insomnia, hyperinsomnia, and circadian rhythm disorders. These disorders could be related to the degeneration of the brain stem and hypothalamus (Trotti, 2016).

Neurodegenerative diseases are incurable and debilitating, resulting in the progressive death of nerve cells. These dying nerve cells can cause problems in movement or mental functioning. Two of the most
common or known neurodegenerative diseases are Alzheimer’s disease (AD) and Huntington’s disease (HD). Alzheimer’s disease, or senile dementia, is a common disease that destroys memory and other important mental functions. Huntington’s disease or Huntington’s chorea is a rare inherited condition in which nerve cells in the brain break down over time. When looking at these two neurodegenerative diseases, there is a clear relationship between them and the amount of sleep the patients get. Furthermore, there is evidence that sleep disorders could also possibly play a role in the development of these NDDs. It is evident that there is a gap in knowledge between sleep and NDDs that needs to be further understood. To help understand this gap in knowledge, research tests are presented below to show the impact these NDDs have on sleep.

**Alzheimer’s Disease**

The hypothalamus is one of the older and smaller parts of the human brain, containing neural circuits that deal with basic life functions. Some of these functions consist of energy metabolism, electrolyte balance, thermoregulation, sex drive, and the sleep-wake cycle. More specifically, the hypothalamus has a critical role in the control of the sleep-wake rhythm. The hypothalamic region of the brain is obstructed by the pathology of AD. Alzheimer’s disease is clinically described as memory loss and decline in cognition, but sleep impairment and daytime sleepiness also represent symptoms of AD pathogenesis (Liguori, 2017).

AD is also marked as the deposition of extracellular plaques of amyloid-beta peptides and intracellular neurofibrillary tangles of abnormally hyperphosphorylated tau proteins. Amyloid-beta proteins are aggregates that become folded into a certain shape, allowing many of the proteins to stick together (Ju, 2017). They then can form plaques around nerve cells or neurons. Tau proteins stabilize microtubules in neurons and when these tau proteins become mutated (hyperphosphorylated) they become tangled and can’t function properly (Liguori, 2017).

Sleep impairment has also been recently associated with orexin peptides in AD patients. Orexin neuropeptides or hypocretins are produced in the lateral hypothalamus and are involved in sleep
regulation and attention (Pillai, 2017). In humans, degeneration of orexin neurons is associated with narcolepsy. Thus, orexin neuropeptides play a critical role in the sleep-wake regulation in the hypothalamus. All three of these biomarkers (amyloid-beta, tau, and orexin) are well recognized as biomarkers of AD diagnosis and are studied by Liguori (2017) and a team of scientists.

To measure these biomarkers, the team used a positron emission tomography (PET) of the hypothalamic region of the brain. In their study, they evaluated the possible correlation with sleep impairment and cerebrospinal fluid (CSF) biomarker changes. To make this correlation, they examined sleep measured by a polysomnography (PSG), AD biomarkers, and hypothalamic uptake in a population of AD patients compared to non-AD control groups. The team selected 18 AD patients and 18 control groups that closely represented the same age as the AD patients to conduct their experiment on. The testers underwent two consecutive PSG studies to evaluate nocturnal sleep. The first night of sleep was considered an adaption period and was not tested.

The second PSG monitoring was considered for sleep analysis. The following standard factors were computed: sleep onset latency (SL), total sleep time (TST), sleep efficiency (SE) and REM sleep. REM sleep or rapid eye movement sleep is a state of sleep in which the body is paralyzed but brain activity is still firing. This is an important stage of sleep because one’s brain acts somewhat awake, with cerebral neurons firing with the same overall intensity as in wakefulness. A first CSF sample of 4 ml was obtained for total cell count. Another 4 ml sample was taken with an atraumatic needle within 1-2 hours after morning awakening to measure orexin, tau and amyloid-beta levels. The CSF and PSG data was studied using Statistica 10.0 software. Their data is presented below in Figures 1 and 2.

Figure 1 (Liguori, 2017)

<table>
<thead>
<tr>
<th></th>
<th>AD (n=18) mean</th>
<th>Controls (n=18) mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>71.56</td>
<td>74.11</td>
</tr>
<tr>
<td>Sex</td>
<td>10F 8M</td>
<td>11F 7M</td>
</tr>
<tr>
<td>Disease duration</td>
<td>2.42</td>
<td>NA</td>
</tr>
</tbody>
</table>
As expected, we can see from the graph that the AD patients expressed an overall higher mean of orexin levels compared to the controls. A higher level of orexin neuropeptides indicates that the AD patients expressed higher attention; this could lead to making it very difficult to fall asleep. In addition, AD patients showed a higher CSF tau/amyloid-beat ratio with respect to the controls. When their team compared the hypothalamic uptake from the PET scan to the tau/amyloid-beta ratio they found a negative correlation.

Furthermore, they found no correlation in the controls. The hypothalamus is, therefore, altered by AD pathology and is associated with both sleep impairment and a higher tau/amyloid-beta ratio (Liguori, 2017). The biomarkers in the AD patients show alteration compared to those patients in the control group.

When looking at the AD patients sleep statistics compared to the controls, there are still no surprises. The AD patients showed a shorter TST (351.56) compared to the controls (375.14). They also conveyed a lower overall sleep efficiency (SE) percentage compared to the controls by almost a ten percent difference. The sleep latency category also indicated sleep disturbances in AD patients. Sleep latency is the length of time that it takes to accomplish the transition from full wakefulness to sleep. Lastly, AD patients had an overall lower REM percentage of
sleep than the controls. The AD patients showed sleep disturbances in every category studied in this experiment (Liguori, 2017).

Sleep disturbances have also shown a relationship for AD pathogenesis and mild cognitive impairment (MCI). Additionally, poor sleep quality has been linked to an increased risk of metabolic and cardiovascular diseases, which are independent risk factors of AD. AD progression alters the entire course of AD, including preclinical dementia, MCI and advanced AD. Current research has suggested the relationship between sleep disturbances and Alzheimer’s disease pathogenesis is bidirectional. All things considered, sleep disturbances and AD pathogenesis are caught in a vicious cycle by which sleep disturbances leads to increased AD pathogenesis, which in turn intensifies sleep disturbances (Kang, 2016).
Figure 3 (Kang, 2016)

Figure 3 shows the bidirectional relationship of sleep and AD pathogenesis from the beginning stages of normal sleep disturbances leading up to MCI or AD. The first stage of sleep disturbance in normal aging shows decreased clearance of amyloid-beta, increased synaptic activity and increased changes of the response in molecular level. There are several studies that show how sleep disturbance could precipitate the accumulation of amyloid-beta. Sleep trouble can prevent the clearance of amyloid-beta in the brain. With synaptic activity increased in the brain, falling asleep could be almost impossible.
Activation of synapses also influences the homeostasis of amyloid-beta and tau proteins, both of which combine and accumulate during AD pathogenesis. Increased changes in response in the molecular level could play a role in the progression of AD but are also part of the normal aging process. The second stage of the graph shows how the above stage could progress into preclinical dementia. It also shows how preclinical dementia increases amyloid-beta plaques and tau neurofibrillary tangles (Kang, 2016).

Amyloid-beta accumulation has been known to result in an imbalance between production and clearance (Pillai, 2017). With clearance of amyloid-beta being suppressed, the brain begins to form amyloid plaques. These amyloids are aggregates of proteins that become folded into a certain shape that allows many of them to stick together. They then can form plaques around nerve cells or neurons. The tau proteins that stabilize microtubules in neurons can become mutated and tangled (neurofibrillary tangling) causing them to not function properly.

The third stage similarly shows how preclinical dementia could progress into MCI or AD. It also shows how increased changes of neurotransmitters and changes in the brain region lead to these diseases (Kang, 2016). Increased changes in neurotransmitters impact sleep by disrupting its regulation of normal feedback between neuronal subsystems leading to a buildup (Pillai, 2017). As discussed earlier, AD can alter different parts of the brain like the hypothalamus for example. There as also been evidence of AD pathology impacting the pineal region of the brain. This dysfunction of the pineal gland provokes the decrease of melatonin levels (Kang, 2016).

Melatonin is an organic substance that is synthesized in the penal gland during the nighttime. It helps regulate internal circadian rhythms and therefore control biological activities including body temperature, cortisol secretion and the sleep-wake cycle. The lack of a stable circadian rhythm in AD patients could be due to their reduction in melatonin levels. Endogenous melatonin levels do decrease normally with age but this decrease is even more pronounced in patients with AD. With the obvious positive responses of melatonin on sleep, it has been contemplated that melatonin might be beneficial for not only sleep in AD patients but also cognitive improvement.
Research done to test these probable impacts from melatonin on patients with AD and other dementia syndromes have been disappointing. The research found that melatonin not only didn’t help the patients sleep better but also had negative effects on mood. These random human clinical trials have shown little to no benefit on measured sleep. The American Academy of Sleep Medicine (AASM) recommended against the use of melatonin for irregular sleep disorders in patients with dementia, given the negative results in previous trials (Trotti, 2016).

Huntington’s Disease

Huntington’s disease, unlike AD, is an autosomal disorder caused by trinucleotide expansion within the Huntington gene (Musiek, 2015). HD is mainly organized in the striatum part of the brain, but recent studies have shown that there is also significant neurodegeneration in the hypothalamus. As stated earlier, the hypothalamus plays a critical role in the brain’s sleep-wake cycle. Even more specifically, the circadian pacemaker of the suprachiasmatic nuclei (SCN) is a key regulator of sleep-wake cycles (Morton, 2004). SCN is located in the hypothalamus directly above optic chiasm and is responsible for circadian rhythms, and receives input from the retina and synchronizes oscillations in peripheral organs to the light-dark cycle (Musiek, 2015).

One important region of the SCN that could be impacted by the NDD contains orexinergic neurons. With neurodegeneration in the SCN region of the brain, sleep can be extremely impacted in patients with HD. Sleep reduction efficiency in HD is characterized by frequent nocturnal awakening. HD patients show a significant increase in the number of movements during nocturnal “bedtime.” Studies have shown that HD patients show disrupted night-day activity patterns that could be impacting their sleep (Morton, 2004).

These movement irregularities are frequently supplemented by delusions, hallucinations and mental depression (Wiegand, 1990). In patients with HD, up to 87.8% report sleep problems. They variably show difficulties maintaining sleep and reduced duration of slow wave and REM sleep. With percentages like 87.8%, Arnulf (2008) and a team
of medical doctors decided to conduct an experiment between patients with HD and selected controls. They selected 25 patients with HD that were all interviewed and examined by a neurologist from the HD referring centers. In addition, there were 25 selected age and sex matched controls from a series of subjects. The patients and controls sleep was monitored from “lights off” to 6:30 A.M. the next morning (all patients woke up spontaneously before that time).

Sleep monitoring included electroencephalography. Electroencephalography is an electrophysiological monitoring method to record electrical activity of the brain. The team was interested in testing the patients and controls for total sleep time (TST), sleep efficiency (SE), sleep latency (SL) and rapid eye movement (REM) sleep. The variables were based off of means of 5 measured tests. The variables in this experiment are the same variables tested in the experiment on AD patients. Statistical analysis used analysis of variance for comparison of continuous variables between groups. Frequencies were compared using chi-squared tests (Arnulf, 2008).

<table>
<thead>
<tr>
<th>Sleep Measures</th>
<th>HD patients (n=25)</th>
<th>Controls (n=25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TST (min)</td>
<td>366</td>
<td>405</td>
</tr>
<tr>
<td>SE (%)</td>
<td>77</td>
<td>86</td>
</tr>
<tr>
<td>SL (min)</td>
<td>164</td>
<td>107</td>
</tr>
<tr>
<td>REM (%)</td>
<td>14</td>
<td>19</td>
</tr>
</tbody>
</table>

Figure 4 (cont.)

<table>
<thead>
<tr>
<th>Patients</th>
<th>HD patients</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)</td>
<td>48.3</td>
<td>48.2</td>
</tr>
<tr>
<td>Insomnia</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>REM sleep behavior disorder</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Excessive daytime sleepiness</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>
When looking at HD patients compared to the controls, it is obvious that HD has an impact on the sleep of the patients. The mean total sleep time (TST) of HD patients (366) was lower than the tested controls (405). This means that HD patients weren’t getting as much total sleep as a normal control was. The sleep efficiency percentage of HD patients (77) was also lower than the controls by almost 10 percentage points (86). Sleep efficiency is the ratio of the total time spent asleep (total sleep time) in a night compared to the total amount of time spent in bed. The sleep latency time (min) was higher in HD patients when compared to the controls. This means it takes a longer average time for HD patients to fall asleep than a tested control patient. Lastly, the percentage of rapid eye movement (REM) sleep was lower in HD patients than controls. In every aspect, sleep was disturbed in HD patients compared to the controls (Arnulf, 2008).

Continuing to look at figure 4, HD patients also showed higher frequencies of insomnia, REM sleep behavior disorder (RBD) and excessive daytime sleepiness. Insomnia is categorized as persistent problems falling and staying asleep. The HD patients showed higher insomnia rates (16) compared to the controls (4). In a person with RBD, the paralysis that normally occurs during REM sleep is nonexistent, allowing the person to "act out" their dreams. RBD is characterized by the acting out of these dreams that are vivid, intense, and violent (Chiaro, 2017). As stated earlier, REM sleep is a very critical time of sleep, so any disruption during this time could drastically impact the patients overall sleep. The HD patients displayed 2 more RBD experiences than the controls. Excessive daytime sleepiness was also higher in HD patients compared to the controls.

There are many similarities between sleep and patients with AD and HD. The similarities are especially evident in the four sleep categories that were tested. First of all, the patients with the NDDs showed that sleep was disturbed in every category when compared to the controls. When comparing TST from figure 2 (AD patients) and figure 4 (HD patients), HD patients (366) got more total sleep time than AD patients (351). The difference between the two is not substantial though. The same goes when comparing sleep efficiency between the two NDD groups. One big difference worth noting is SL in AD patients was significantly different when compared to HD patients. The two studies
were independent from another therefore that could have an impact on the difference. Any distinction that immense is always worth noting.

**Conclusion**

There is no question how vital sleep is for the human brain. As portrayed in the above information, any type of disturbance can lead to corrupted sleep. For people with NDDs or unaffected people, corrupted sleep can cause mood swings, personality changes and depressive thoughts (Zhao, 2017). Researching more about sleep and its connection to NDDs is a subject that needs to be tapped into more. It also has a considerable amount of conclusions that have not been concluded. The gaps in the field could help patients with NDDs and also help prevent early onset pathogenesis of these diseases.

Liguori (2017) provides prodigious information concerning the topic. The research shows the significance of the degradation of the hypothalamus in AD pathogenesis. It additionally adds the importance of AD biomarkers and the role they play in the sleep-wake cycle. These biomarkers are documented in an experiment on AD patients compared to selected controls. Here sleep is also compared to the controls in the following variables: total sleep time, sleep efficiency, sleep latency and rapid eye movement sleep.

Kang (2016) also provides great incite on a different perspective on this gap in knowledge. The research shows the pathogenesis of AD and the risk factors of poor sleep quality. More importantly, Kang (2016) shows the reader how the pathogenesis of AD and sleep disturbances is a bidirectional relationship. More blatantly, this means that sleep is not only disturbed when a patient has AD but it also means that sleep disturbances can lead to preclinical AD and even AD. This presents another gap in knowledge as to how often sleep disturbances can cause NDDs and how relevant it is to the pathogenesis of the disease.

When looking at Trotti (2016) and the impacts of melatonin on AD patients, the research showed that melatonin had no positive correlation. In fact, melatonin actually caused mood swings and had a negative impact on AD patients. This begs the question as to what could help these patients sleep. Additionally, if NDDs have a bidirectional relationship to sleep, are there aspects that are causing this initial disturbance? With all the technology in today’s world, it
would not be far-fetched to hypothesize that disturbances in sleep could be a direct result to staying up on one’s phone. Social media has made a huge impact on today’s generations and could be a reason why the future of this generation has higher NDDs. A reliance on social media and therefore staying up later could have a direct correlation on future NDDs. The diseases could mature at faster rates and also have higher diagnosis rates.

References


The Use of the Critical-Care Pain Observation Tool in Nonverbal, and Cognitively Impaired Patients
Audreya Williams
Ashley Ozebek

Introduction

Pain has been introduced as the fifth vital sign, but is often not adequately treated. Managing pain is a complex process, but it becomes more complicated with critically ill patients. There is no universally accepted pain assessment tool used in intensive care units (Linde, 2013). Pain is often misinterpreted because patients are unable to self-report due to sedation drugs and mechanical ventilators. The origins associated with discomfort come from respiratory therapy, placement of a nasogastric tube, venous and arterial catheters, and fundamental patient care such as repositioning and hygiene. Therefore, it is essential to have an accurate and dependable method to assess pain in unconscious and nonverbal patients to cultivate treatment (Severgini, 2016). The Critical-Care Pain Observation Tool (CPOT) is a recently developed behavioral pain assessment scale that more effectively assesses patient pain when they are incapable of reporting it themselves. This scale is considered to be the most valid and reliable method for assessing pain in critically ill and nonverbal patients.

PICO Question

In critical care patients, the question is: is the use of the CPOT compared with other pain assessment scales more accurate in interpreting pain to improve patient outcomes? After examining the healthcare policy regarding pain management, changing the current practice was not needed at the time because the actions listed are all currently widely accepted. However, adding to the policy would allow it to be more versatile for all patients.

Methods

The recommended addition to the policy was sought and found using Google Scholar to locate and filter through articles. We used Ohio University’s library resource ALICE and searched key words, such as “pain management,” “assessment tool,” and “critical care.” ALICE was
also utilized for articles found on Google Scholar that could not be read without purchase.

**Analysis**

A cardiothoracic intensive care unit in Rhode Island Hospital currently uses the five–item scale called Faces, Legs, Activity, Crying, and Consolability (FLACC) as a pain assessment tool. FLACC has been verified in children younger than age seven along with nonverbal patients. Nurses have been examining the application of the crying and consolability signs in adults because they are typically not consistent indicators, especially in mechanically ventilated patients who are unable to exhibit these behaviors. The CPOT is a newer observation tool to calculate pain in nonverbal intensive care patients. This tool is based off of a four-item indicator: facial expression, body movements, muscle tension, and compliance with the ventilator or vocalization for patients who are not mechanically ventilated. The CPOT includes an assessment of both upper and lower extremities, whereas the FLACC scale assesses the lower extremities only (Linde, 2014).

Baptist Hospital in Louisville, Kentucky, examined the reliability and validity of CPOT in a general population of critically ill adult patients. They assessed patients’ pain using three different pain scales: CPOT, the Pain Intensity Numeric Rating Scale (NRS), and the FLACC scale. Seventy-five patients were observed at three different periods to examine their performance at low, moderate, and high levels of pain during turning, and assessed again during a central line dressing change, a non-painful procedure.

After nurses completed the CPOT and FLACC scales, patients were asked to use NRS to subjectively rate their pain. There were higher scores on the CPOT scale during turning than at rest or with the dressing change, which correlated with what the patients reported their numerical pain score was during both procedures. This study showed that the CPOT is an acceptable pain assessment tool, as well as showing that it was more appropriate for use with adults than the FLACC scale (Buttes, 2014).

Storsveen & Hall-Lord’s (2017) recent study assessed the validity of the CPOT in a Norwegian intensive care unit on mechanically-ventilated patients only. Nurses who had sound knowledge in both English and
Norwegian, as well as thorough training in the CPOT, assessed patients’ pain levels during repositioning. Two critical care nurses assessed each patient at rest, during repositioning, and post-positioning. The results showed a significant difference in mean score between resting and turning within facial expressions, ventilator compliance, and muscle tension. This result shows that the CPOT measures existing pain in patients (Storsveen & Hall-Lord, 2017).

In Gelinas, et al’s (2014) recent study of nurses’ evaluations of twelve-month post-implementation of the CPOT in Quebec, Canada, results revealed that 87 percent of the nurses were satisfied with its use. All 60 trained nurses were asked to complete an evaluation questionnaire within a two-week period. Each inquiry was sent through internal mail in the hospital setting and included a return envelope. There was a 63 percent return rate with the majority rating the CPOT as quick to use, simple to understand, and easy to complete.

Results from the questionnaire showed that 10 nurses felt their patients’ pain was relieved, and the pain relief helped those nurses to justify the medication they were giving. Five nurses stated they felt that the CPOT was a rapid, objective, precise, and uniform assessment for pain. Over 75 percent of the nurses stated that this tool increased their effective communication of pain assessments with other nurses. In addition, 26 nurses acknowledged that the CPOT influenced their practice (Gelinas et al, 2014). The findings that Gelinas, et al. (2014) reported in their study were consistent with other research studies previously analyzed.

Consistency of Evidence

The recommendations by researchers are consistent among systematic reviews and evidence-based practice guidelines. All of the peer-reviewed articles and research studies showed that CPOT is valid and reliable tool when either used alone or in conjunction with other pain assessment tools. Studies showed that a majority of the nurses who used this scale approved of it and stated that it is easy to use. Patients will benefit from the implementation of the CPOT in critical care units because they will be appropriately medicated based on their identified pain levels when they are incapable of reporting their discomfort level. Pain is subjective and when patients cannot report this pain, a large portion of treatment falls into the practitioner’s hands. This
responsibility can be stressful and cause insufficient treatment from over or underestimation of medication. Utilizing the CPOT will take the load off of the practitioner and provide the best patient outcome.

**Recommendations**

The health systems’ pain policy includes the Adult 0-10, the Wong-Baker Faces Pain Scale 0-10, and the FLACC scale for pain assessment tools. Adding the CPOT to the list of available assessment tools would cover all types of patients seen throughout a hospital. The ICU would have a more reliable way to assess patient pain, while medical surgical floors and the emergency department would have another assessment tool for patients who are uncommunicative. This tool would help nurses advocate for patients experiencing pain when physicians are reluctant to prescribe analgesics due to the opioid epidemic.

Physiological signs, such as tachycardia, elevated blood pressure, tachypnea, and lowered oxygen saturation readings, are taken into consideration during a pain assessment. In some instances, these physiological signs are not always reliable indicators of pain. These are symptoms that can be controlled with medications or related to other pathophysiological origins. Specifically, these are things that the intensive care unit attempts to control with medications and ventilator settings. Using the CPOT will help nurses evaluate a patient’s true level of pain as based on other indicators expressed by the patient. Research has shown that the CPOT is still as effective when used in combination with other pain assessment tools and can be considered another option for nurses to use.

**Discussion**

The recommendation to add the CPOT to health systems pain management policy is based on evidence-based practice for best patient outcomes. This evidence-based practice will allow another pain assessment tool to be added to the policy to better assess patient pain when they are unable to report it themselves, such as intensive care patients and nonverbal patients. Allowing this scale as an additional assessment will enable nurses to validate their patients’ pain management and communicate their findings to the health care provider.
References


The Role of the Microbiome on Human Health and Wellness
Megan Paolini

The three articles read were Probiotics Can Prevent Sepsis in Infant, Study Shows, Is a Messed-up Microbiome Linked to Obesity? New Study Casts No Doubt, and When Gut Bacteria Change Brain Function. The main microbiological concept to be explained is the role of the microbiome on human health and wellness. The microbiome are all the microbes in an environment.

The article called Probiotics Can Prevent Sepsis in Infants, Study Shows is about a special mixture of good bacteria in the body that can reduce incidence of sepsis. Sepsis is when the immune system stops fighting germs and begins to turn on itself. It’s a current public health concern, that is believed to be helped by using a special probiotic, Lactobacillus plantarum. Probiotics are live bacteria and yeasts that are good for a person’s health. Due to the success of this finding, the next step Dr. Panigrahi hopes to take is to bring infant mortality rates down in India, which has one of the highest infant mortality rates in the world. First, the study must be replicated in a different country in different circumstances.

The next article, Is a Messed-up Microbiome Linked to Obesity? New Study Casts Doubt explains the difficulty of finding a clear common characteristic of microbiomes in the digestive systems of a person with a healthy weight when compared to an obese person. The complexity of these findings means that there is much more to learn about the relationship of the gut microbiome and human health, but the controversy is that no one can determine a ‘healthy microbiome.’ However, it can’t hurt to eat the right nutrients to try and balance a person’s microbes.

The third article, When Gut Bacteria Change Brain Function describes the idea that microbes can produce effects as far away as the human brain. This article investigates how the microbiome stimulates how people feel and think, diving into detail about the roles these effects play in autism, anxiety, depression, and other disorders. The only controversy with this experiment was using mice to try and link the
microbiome to anxiety. These articles address immune system responses, obesity, and neurological health, as well as components of health and wellness that can be positively met with the right microbiome. The connection of microbiomes in humans and their health is very strong.

If researchers continue to try to understand how the microbiome interacts with their hosts, then we can create new tools that will further examine how to change the microbiome in humans as a diagnostic strategy. Understanding what ‘environments’ are already in a body and how those environments interact with probiotics or nutrients will push research in the right direction for human health. These articles demonstrate how far microbes can affect the body, and that the gut microbiome of a healthy weight individual wasn’t any better than one of a heavy weight individual. That shows just how complex these microbe communities are, and how difficult it is to find the right connection for health.

From the perspective of public health, a possible breakthrough with this research could reduce infant mortality in India, as microbiomes in the gut connected with human health. The role of the microbiome on human health and wellness is a complex interaction that needs further research to continue to benefit the health of individuals and communities.
Biotechnology and Genetics
Megan Paolini

The three articles read were Genetically Modified Approaches to Fighting Malaria Succeed in New Test, Farmers say GMO Corn No Longer Resistant to Pests, and First Genetically Engineered Salmon Sold in Canada. The main microbiological concept to be explained is biotechnology associated with genetic engineering. Biotechnology is the science of using living systems to benefit human kind. Genetic engineering is the direct alteration of an organism’s genetics to achieve desirable traits.

The first article, Genetically Modified Approaches to Fighting Malaria Succeed in New Test, is about using genetic modification as a new tool to fight malaria. Malaria is caused by a parasite that lives in the mosquito’s gut and infects humans when the mosquito bites. There were two studies done to support the modification. The first study was focused on whether mosquitos that have been genetically modified would be more resistant to the malaria-causing parasite and then would become weak and unable to breed. That study found that one type of genetically modified mosquito bred well and became attractive to normal mosquitos. The research caused a mosquito population to become 90% genetically modified within one generation. The second study used the genetic modification of bacteria found inside mosquitos to fight malaria. The researchers genetically modified a type of bacteria, one that kills off the malaria-causing parasite before it can develop properly. The next step for both tests is to test outside of the lab, simulating nature.

The article called Farmers Say GMO Corn No Longer Resistant to Pests is about genetically-modified corn seeds no longer protecting Brazilian farmers and their corn crops from tropical bugs. The problem is that there are barely any non-GMO seeds available, and seed companies are blaming Brazilian farmers for creating the pest problem. The scientific question that researchers have been asking is if conventional seeds will prevent bugs from mutating and developing resistance to GMO seeds.
The last article, *First Genetically Engineered Salmon Sold in Canada*, is about the first time a GMO food has been sold for food on the open market. This salmon is engineered to grow faster, making it reach its market in about half the time it normally does. This situation has caused controversy between activists and the larger market. The larger market sees the GMO food as sustainable and good for the economy. The activists see the environmental risks that may come with the support of the salmon on the open market. The idea that genetic engineering can be successful in achieving desirable traits is supported in these articles. Desirable traits can be used to fight infection, resist pest killing crops, or take food to the market in half the time.

The next issue concerning genetic engineering probably will be the interaction with the genetically modified organisms and the other organisms in that environment. In my opinion, genetically modified technology is the most beneficial in fighting disease. Using this technology in food will cause the most controversy, while the engineering approach to fighting malaria is amazing. The genetically modified organism affects the breeding of insects and how that is linked to fighting a disease. There are many different ways we can effectively use this biotechnology.
The Controversy Regarding Vaccines
Megan Paolini

The three articles read were Rise in Mumps Outbreaks Prompts U.S Panel to Endorse 3rd Vaccine Dose, Polio Paralyzes 17 Children in Syria, W.H.O. Says, and Mom Gets Jail Over Refusal to Vaccinate Son. The main microbiological concept to be discussed among these articles is the controversy caused by vaccines. A vaccination is a form of artificial immunity. A vaccine works by artificially stimulating the adaptive immune response in the body. It stimulates this response by exposing the immune system to an artificial antigen in the vaccine that triggers memory cell production. This mimics the primary response that would happen if the immune system was exposed to that disease.

The first article, Rise in Mump Outbreaks Prompts U.S Panel to Endorse 3rd Vaccine Dose, was about the controversy of recommending a third dose of the vaccine for mumps. This third dose of vaccine is supported because people in areas that had high rates of immunization experienced mumps outbreaks. Currently, the CDC recommends that children receive two doses of the vaccine. This dosage looks sufficient to control mumps in the general population; however, the evidence presented has suggested that the immunity is waning over time, prompting recent outbreaks. The question is whether the U. S. panel should endorse the recommendation. There needs to be more scientific evidence on the protection and adverse effects with a third dose of the vaccine.

The second article, Polio Paralyzes 17 Children in Syria, W.H.O. Says, describes how Syria has experienced a second outbreak of the polio virus. This outbreak was caused from the polio vaccine itself. The vaccine is secreted in the waste of vaccinated children, and over time can mutate into an infectious strain that may affect the unvaccinated children. Although it is believed that vaccine-derived outbreaks are just a sign of poor vaccination and poor sanitation in the community, this one situation could cause controversy over the effectiveness of other vaccines.
In the third article, *Mom Gets Jail Over Refusal to Vaccinate Son* was about a mother from Michigan who is now in jail “standing up for what she believes in,” which is not choosing to vaccinate her 9-year-old son. This notion about vaccines is a common controversy surrounding vaccines today. Some people believe that vaccines cause disease, despite the scientific evidence that suggests that this particular notion is false. The debate with this situation is if the mother deserved jail time for standing up for what she truly believes. The controversy of vaccinations and their effects on individual and community health ties these articles together. Vaccinations are proven effective, yet outbreaks in a community are not entirely preventable. Some may not think it is necessary to get a vaccine for their children.

There should be no controversy for getting a vaccine. Understanding the science behind how vaccines work is not only fascinating but proves that no one can be harmed by getting a vaccine. A vaccine simply exposes someone’s body to an artificial antigen, which, in return, protects that body in a natural way. The immune system is tricked into learning how to destroy the disease if there was a real exposure or threat. There is no harm in other doses of a vaccine either. The adverse effects such as fever symptoms are due to the initial response the body will go through. Increased outbreaks in a community are due to transmission routes that happen within the environment, and these can be improved with preventable measures. The next stage of this issue is to focus on tracing new outbreaks in areas with high rates of immunization back to the cause of the outbreak. After that, the next step is researchers working with public health professionals on creating effective, preventative methods for high risk areas.
About the Authors

Ashley Ozebek is a junior attending Ohio University-Chillicothe. She is studying for a Bachelor of Science in Nursing and is a member of Sigma Theta Tau. She is employed at Nationwide Children’s Hospital as a patient care assistant. She aspires to care for critically ill patients. She wrote this paper as a group project for NRSE 2250 Nursing Research & Evidence Based Practice. Dr. Camille Leadingham.

Megan Paolini is a junior-level Community and Public Health student. She will graduate in May 2019. The course she wrote her papers for was Bios 2210, Microbes and Humans. It was Microbiology in the interest of human health. Her papers resulted from a writing assignment developed by Stephanie Miller, her Microbiology professor. The assignment was to construct a thesis utilizing several articles Miller provided. The first step was finding how all the articles were related to one another. It was a unique opportunity to apply scientific knowledge that we learned in the classroom to real world examples. Megan’s analysis of this assignment is summed up in this statement: “I never thought I would have the opportunity to write in a biology course, but I loved the challenge.”

Caleb Septer is a junior studying Biological Sciences at Ohio University. Caleb hopes to become a physician assistant in the future and spends most of his time finding a happy medium between friends and studying. When he’s not studying, Caleb enjoys listening to music and playing his guitar. Writing has always been another passion of Caleb’s and he enjoys proofreading his friend's papers often. Caleb would like to thank Mr. Cummins for an enjoyable last composition class (English 3090J—Writing in the Sciences) at Ohio University.

Christina Schirtzinger wrote this paper as a project for her Field Ecology course, taught by Kelly Williams.

Audreya Williams is a junior attending Ohio University-Chillicothe. She is studying for a Bachelor of Science in Nursing and is a member of Sigma Theta Tau. She is employed at Nationwide Children’s Hospital as a patient care assistant. She aspires to care for critically ill patients. She wrote this paper as a group project for NRSE 2250 Nursing Research & Evidence Based Practice. Her professor was Dr. Camille Leadingham.