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**Survey and Biology of Butterflies
in the Athens Lake Region**

Tonya Payne

Biology 498, 499

Mentor: Dr. Roger Sheppard

Committee: Dr. Ron Canterbury

Dr. Tonya McKinley

Abstract

This research dealt with collecting butterflies and skippers and observing their behavior throughout the spring of 2002 until the fall of 2002. Surveying the butterfly populations in Athens Lake, West Virginia updated the records for Mercer County. The butterflies were captured and preserved for species identification. Photographs were taken and behaviors were recorded. Twenty-five different species of butterflies were collected with 11 new species recorded for Mercer County. Of these, the Monarch was also observed although much later than expected. The plant specimens that the butterflies feed and perch on were also collected and identified. This information was compared to past research to gain a clearer picture of the types of butterflies and skippers in Mercer County, the time of year present, and their behavior and primary food plants. With only a few exceptions, most of the data corresponded to previous literature.

Introduction

Butterflies and moths are insects from the order Lepidoptera. The characteristics that distinguish lepidopteron from others within the enormous class Insecta are the scaled wings and the coiled proboscis. The scaled wings of Lepidopterons allow for camouflaging or as a warning to predators, courtship, and for regulating body heat (Malikul & Opler, 1998). The other unique characteristic of butterflies and moths is the feeding tube, called a proboscis, which is designed to coil upward close to the body allowing the insect to carry this body structure safely to a variable amount of flower nectar, wet soil, fruit juices, sap flows, carrion, or dung (Malikul & Opler, 1998).

In order to distinguish between butterflies and moths, some scrutinizing during examination of antennae shape, body design, and temporal flying patterns (Borror et. al, 1976). Unlike the variable types of antennae moths have, the antennae of a butterfly will be long and slender with enlarged knobs that result in a sort of clubbed shape apparatus (Borror et. al, 1976). Moths have a furry, robust body structure, whereas butterflies are more slender and delicate (Borror et. al, 1976). One more important distinction between butterflies and moths lies in the time of day that each insect is active. Most moths will be active at night and butterflies active during the day (Borror et. al, 1976). There are a few exceptions to this rule.

Butterflies and moths also differ from skippers even though skippers are sometimes grouped with butterflies. Again the antennae must be carefully examined. Where the butterfly's antennae end in knobs, the skipper's antennae will end in an extension called the apiculus (Malikul & Opler, 1998). A Skipper's body is also robust and the head is large when compared to the body, as opposed to the butterfly and moth. Additionally, the most important characteristic

of a skipper is its distinct flight pattern. The flight of the skipper will be fast up and down, jerky motions roughly resembling that of skipping (Borror et. al, 1976).

Butterflies utilize many species of angiosperms for feeding, using their coiled proboscis. This allows them to occupy every continent except Antarctica. There are thousands of species with many different shapes, sizes, and colors all over the world. Locally, are swallowtails, sulphurs, metalmarks, brush-footeds, and skippers. Species accounts of butterflies have been published for this state. Those in West Virginia can be found in Thomas J. Allen's The Butterflies of West Virginia and Their Caterpillars.

Statewide records from West Virginia show that seven different species of the family Papilionidae have been identified and four of these occur in Mercer County (Allen, 1997). Two prime examples are the Pipevine Swallowtail and the Eastern Tiger Swallowtail. The Pipevine Swallowtail is found on flowers in gardens, meadows, or even at roadsides (Pyle et. al, 1981). While visiting flowers, Papilionidae continue to flap their wings in a probable effort to avoid tilting the flower due to their weight (Scott, 1986). When not feeding and searching for host plants the Pipevine Swallowtail female will produce larvae that feed on toxic plants (Malikul & Opler, 1998). The toxins help in reducing the swallowtail predation rate. Some butterflies will mimic the colors of the Pipevine Swallowtail because of this characteristic. However, mimics of the Pipevine Swallowtail are only observed where the Pipevine is abundant (Opler & Krizek, 1984). One mimic of the Pipevine Swallowtail is the female Eastern Tiger. The female has developed dimorphism with classic Batesian mimicry. Although normal yellow females are believed to be preferred by males, this mimicry has allowed lower bird predation rates (Opler & Krizek, 1984).

The family Pieridae, or the Whites and Sulphurs, have an interesting familial feature. Many species have ultraviolet light pattern on their wings allowing them to recognize members of the opposite sex (Scott, 1986). Five species of Whites are listed in Thomas J. Allen's book as being found in the state, but no records for any of these exist in Mercer County. This is unusual because one of the most common butterflies in West Virginia, the cabbage butterfly, is from this family and probably occurs in Mercer County (Allen, 1997). Native to Europe and imported to America, the cabbage butterfly has spread due to their co-evolution with a major plant family the crucifers (Feltwell, 1986). This is probably one reason for its vast range and the fact that this species can be seen from early spring till late fall. Male and female cabbage butterflies differ by the number of black spots on the forewings, with the males having only one and the females having two (Malikul & Opler, 1998).

There are six different species of Sulphurs recorded for the state with four of those included in Mercer County (Allen, 1997). One interesting species of sulphur is the Clouded Sulphur or sometimes known as the Common Sulphur, which has a great range extending across West Virginia and over most of the United States (Holland, 1931). These butterflies can be observed constantly throughout the summer in open fields and clover meadows (Pyle et. al, 1981). Another close species is the Orange Sulphur, which has similar flight periods. Since both look indistinguishable while flying, a method of separating the two species can be achieved by examining the width of their distinct borders. Female Clouded Sulphurs will have a thinner border as opposed to the Orange Sulphur (Allen, 1997). Some of these females will have an albino form with the yellow areas of their wing replaced by white (Borror et. al, 1976). However, both species will occasionally interbreed when abundant making classification difficult due to hybrid phenotypes (Pyle et. al, 1981).

Harvesters, Hairstreaks, Coppers, and Blues are commonly called the gossamer-winged butterflies (Allen, 1997). The reason for this is that many of the butterflies in this family have vibrant colors with eyespots and tails that, when combined, look like the head of another butterfly.

The harvester is also found in Mercer County yet this species is widespread from Nova Scotia to South Carolina to Mississippi (Holland, 1931). Harvesters can usually be located near aphid colonies feeding off of the aphid honeydew or bird droppings. Ironically, the adults never visit flowers (Malikul & Opler, 1998).

There are no records for coppers, hairstreaks, and blues in Mercer County even though West Virginia has three species of coppers, 17 Hairstreaks, and five Blues recorded (Allen, 1997). The American Copper is a common species and can usually be found in disturbed habitats and fields (Opler & Krizek, 1984).

Around 17 hairstreaks are found in West Virginia. However, Mercer County lacks records for any of those listings (Allen, 1997). One species of hairstreak that could be located in Mercer County is the Red-banded Hairstreak. Red-banded Hairstreaks can be found in open areas such as overgrown fields and edges (Malikul & Opler, 1998). This species of butterfly is found in the southern portion of the state in nearby counties such as McDowell (Allen, 1997). Red-banded Hairstreaks receive their name from the red band that is located across the underside of the wings and the three hairline tails protruding from the hind wing (Borrer et. al, 1976).

The Eastern Tailed-Blues are found throughout the state only lacking records in a few counties with Mercer being one of them (Allen, 1997). The Eastern Tailed-Blue can be observed in open fields, roadsides, and forest paths (Holland, 1931). Another species of blue, the Appalachian Azure prefers the woody habitat because this is where their larval host plant, the

Black Cohosh occurs (Smith, 1998). Significantly, this is the only larval host plant for the Appalachian Azure (Malikul & Opler, 1998).

Only one species of Metalmark is listed for West Virginia including Mercer County (Allen, 1997). The Northern Metalmark, found throughout the Appalachian Mountains, is not easily located and is considered rare which may be due to its habitat preference (Borror et. al, 1976).

There are many different species of Brushfooted butterflies that are recorded for both West Virginia and Mercer County. Around 39 species are believed to inhabit West Virginia with 14 known species in Mercer County (Allen, 1997). One representative of a brush-footed butterfly found in Mercer County is the common Red-spotted Purple. Another mimic of the unpalatable Pipevine Swallowtail, the Red-spotted Purple will sometimes hybridize with White Admiral (Malikul & Opler, 1998). The Red-spotted Purple males can be found near dirt roads imbibing moisture from puddles and nearby wood growth searching for the females (Allen, 1997).

The Little Wood Satyr can be located in woody, brush-type area. This butterfly is colored brown with eyespots, one eyespot for male and two for female. The best time to observe or collect these as specimens is during their flight peaks, which occur during late May and early June and then late June into the middle of July (Allen, 1997).

Even though many Brush-footed butterflies are commonly recognized, out of all of the brush-footed butterflies, the Monarch is probably the most well known. These are the famous migrants from central Mexico. The Monarch visits and reproduces in West Virginia, although not listed for Mercer County, beginning in May and reproduces again with the second brood coming out in June and July (Allen, 1997). These distant travelers can usually be seen anywhere there is milkweed and sometimes remain in West Virginia till August. During the fall, the

Monarch will begin migration toward Mexico or California for over wintering areas (Malcom & Myron 1993).

Over 45 Skippers are also listed in West Virginia with four different types recorded in Mercer County (Allen, 1997). Probably one of the most common and largest is the Silver-spotted Skipper (Borror et. al, 1976). This butterfly has a flight that is sharp and fast making it very difficult to get near. The easily observed Silver-spotted Skipper gets its name from the bright white spot on the underside of its wings. Another similar skipper, the Golden-banded Skipper, lacks this attention-grabbing white spot. Unfortunately, this skipper occurs less often throughout its habitat, and has been recorded in only three counties in central West Virginia (Allen, 1997).

The idea of listing so many different families and species is to become familiar with the variety and complexity of just a few of the numbers of butterflies that might be observed at the Athens Lake Region. In order to determine some of the potential diversification, a study of the area is needed. This study will deal with collecting butterflies from the spring of 2002 throughout the fall of 2002. With many of these records, other researchers will be able to conduct more detailed studies of certain interesting butterflies. The study of Athens Lake also updates records on the species of butterflies in Mercer County. This can permit action that would allow for an important species to be conserved, such as the Monarch, by taking steps to protect the habitat. Other important aspects of this project include the fact that butterflies are important indicators of environmental status. Butterflies can help indicate the presence of high quality habitat. These insects are useful in understanding habitat quality on a much smaller scale because of their recognition of the better sections of habitat. Any disturbance to butterfly numbers could indicate negative effects of human intrusion on nature (New, 1991). With a declining ecosystem, certain plants and those insects that feed on or even pollinate these plants, like butterflies, will

begin to disappear. With a lack of pollination, angiosperms and their mutualistic partners will disappear. This study could help identify an important area of the environment where intervention is needed not only for butterflies but for humans as well.

Methods

The materials used in this study included a butterfly net, killing jar, and ethyl acetate. These things were used for capturing and preserving the insect. A mounting block, mounting pins, push pins, pinning boards, collecting box, and index cards were used for pinning the insect in an acceptable, presentable manner. A camera with a macro lens was used to record butterflies and skippers in the field. A pair of 8x42 Orion binoculars was also used to identify specimens at a distance that could not be approached. Use of a plant press, shovel, and clippers allowed for plant specimens to be extracted from the field and preserved.

A methodical approach used to study the butterflies of Athens Lake was traveling to the lake around 1-2 days a week beginning in May and ending in the fall when no more butterflies were observed. Butterfly specimens were collected with a butterfly net and placed in a killing jar. The specimens were only collected at Athens Lake in Mercer County. The designated area for collecting at the lake was the public property owned by the town of Athens.

The specimens collected each day were pinned within two hours after initial collection. Insects were pinned with a mounting pin that was inserted through the thorax at a predetermined height using a mounting block. The specimens were then placed on spreading boards with their wings separated and held in place using strips of index card held with pushpins. These butterflies were allowed to dry for approximately one week then removed and stored in a collecting box. The specimens were then labeled using names, dates, areas of collection, and collectors in the standard practice.

The behavior of butterflies was observed with and without the binoculars and recorded during each visit. Any collection data and other noticeable events were also recorded into notebooks. Noticeable events could include the absence of a particular butterfly or an overabundance of another. Also recorded in this notebook were the areas within the lake region that the butterfly was captured or observed along with the date and general weather conditions. Any species of butterfly that was first identified through the binoculars was recorded and then attempts were made to collect and preserve the specimen.

Plant specimens were collected and pressed; these included flowers visited by each butterfly species. Plants were uprooted using the shovel or cut using the clippers. All possible dirt was removed from the roots. The plant was arranged between newspapers and blotting paper to represent, when dry, both sides of leaves and flower. The plant press was then placed near a ventilated area and allowed to dry for approximately two weeks. At a later time period, plants were removed and identified using plant keys, and cataloged for later reference with the butterfly.

A camera, equipped with a macro lens, was used for short-range photographs on the butterflies and skippers as they were noted in their environment. Mainly side profiles or open-wing profiles picture were taken and the flash was used unconditionally because of low light levels and a high probability of under exposure. The film used was Kodak 64 Kodachrome. The f-stop was varied between 8, 11, and 16. A record of which f-stop was used for each picture was recorded.

After collection was completed in the fall a compilation of data commenced. With the main objective of this study being to examine species accounts, only one specimen of a species was required for the insect to be listed as an inhabitant of Mercer County. New records were

determined by comparisons with species distributions listed in Allen's book on The Butterflies of West Virginia and Their Caterpillars. In order to understand these insects and their lifestyles, butterflies were identified with plants in which they had interactions and habitat location and type. Along with the habitat and behavior, any food plants were also recorded in order to add to the information already known. The time of year that the butterflies and skippers were observed was also recorded. This information was then be compared to any previous research to gain a clearer picture of the types of butterflies and skippers in Mercer County, the time of year present, and their behavior and primary food plants.

Results

Five different families of butterflies were collected from Athens Lake with 25 separate species. The families represented at the lake through the survey were Pieridae, Lycaenidae, Papilionidae, Nymphalidae, and Hesperidae. The Cabbage White, Clouded Sulphur and Orange Sulphur were collected for the family Pieridae (Table 1). The Lycaenidae family was recorded due to the Eastern-tailed blue and the Spring Azure (Table 2). The Eastern Tiger Swallowtail, Pipevine Swallowtail, Spicebush Swallowtail, and the Black Swallowtail captured were from the Papilionidae family (Table 3). Nymphalidae specimens were the Gray Comma, Great Spangled Fritillary, Little Wood Satyr, Meadow Fritillary, Monarch, Red-spotted Purple, Silvery Checkerspot, American Snout, and the Pearl Crescent (Table 4). The European Skipper, Least Skipper, Mottled Duskywing, Sachem, and the Zabulon Skipper captured were from the family Hesperidae (Table 5). Tables, as mentioned above, were created for easier classification with the listings of the common name for the butterfly, the species name and subfamily, and whether or not the butterfly was previously found in Mercer County before the survey began.

Eleven species from these five families of butterflies are new records for Mercer County. From the family Lycaenidae, the Eastern-tailed blue and the Spring Azure are new records. For the family Pieridae, the Cabbage White updates the records. The Meadow Fritillary, Pearl Crescent, and Monarch are now recorded in Mercer County from the family Nymphalidae. The Black Swallowtail is a new record for the family Papilionidae and the family Hesperidae is updated by the Least Skipper, European Skipper, Sachem, and Zabulon Skipper.

The butterflies collected at Athens Lake tend to have been collected in or near four major habitats. These were the sunny road, the shady roads, the open fields, and the transitional zones. The sunny road was an area where many of the milkweeds and near-ground flowers grew. The road was also composed of grass and sandy areas with occasional moisture spots. This is the location where many Monarchs and Cabbage butterflies tended to be found. Also growing near the road was Thistle. This plant attracted many Swallowtails and Fritillaries to the sunny spots along the road. Other sunny road inhabitants included the Pipevine Swallowtail, Silvery Checkerspot, and Orange Sulphurs.

The open fields were alongside the sunny road. This part of the lake had somewhat taller flowers including the Milkweed, Thistle, and Iron Weed. The Appalachian Azure and Spring Azure were found throughout the field with the Crown Vetch that grew lower to the ground. Other field dwellers were the Clouded Sulphur and Orange Sulphur. The Crown Vetch seemed to be their main food source. Many of the skippers were also observed gathering in the fields. Many specimens of butterflies were found in several different types of habitats. The Least Skipper was not only observed in the open field but also in a transitional zone.

The transitional zones were noted in areas where the taller brush and field met, where the lake and open field adjoined, or even where the fields bordered the roads. The American Snout

was captured along the transitional zone of the reservoir and brushy habitat. Many of the Swallowtails and Fritillaries were discovered in these areas due to the feeding plants and behavior of these butterflies.

The last zone noted was the shady road. These were two areas in which tree foliage covered significant portions of the landscape. Here only a few weeds and small undergrowth lived. Moreover, the butterflies found in this area were not seen feeding on any of the plants or tree sap but mainly imbibing moisture from the sandy areas along the road. An example of this is the Gray Comma and the Swallowtail.

There were butterflies in which habitat preference was not a major factor. The Monarch could be found anywhere that milkweed grew. The Swallowtails and Great-Spangled Fritillaries could be observed in any habitat with thistles. The Cabbage White was also seen in almost any area containing flowers or even weeds. This particular butterfly seemed to have no particular habitat preference.

Occasionally a butterfly was collected that was only observed once in one certain habitat and not located again. This was what occurred with the Little Wood Satyr, which was only noted once in a brushy habitat and not seen again for the length of the survey. Observations on the Black Swallowtail were also incomplete since this butterfly was caught before any behavior was recorded. One other specimen preserved from this project with difficulties was the Zabulon Skipper. This particular skipper was collected along with many other skippers during the day and the observer failed to detect any differences in the field and therefore failed to separate the habitats for the different species.

Table 1. Species of butterflies captured at Athens Lake from the family Pieridae in 2002.

Common Name	SubFamily	Mercer County	Species Name
Cabbage White	Pierinae	No	<i>Pieris rapae</i>
Clouded Sulphur	Coliadinae	Yes	<i>Colias philodice philodice</i>
Orange Sulphur	Coliadinae	Yes	<i>Colias eurytheme</i>

Table 2. Species of butterflies captured at Athens Lake from the family Lycaenidae in 2002.

Common Name	SubFamily	Mercer County	Species Name
Eastern-Tailed blue	Polyommatainae	No	<i>Everes comyntas comyntas</i>
Spring Azure	Polyommatainae	No	<i>Celastrina ladon ladon</i>
Appalachian Azure	Polyommatainae	No	<i>Celastrina neglectamajor</i>

Table 3. Species of butterflies captured at Athens Lake from the family Papilionidae in 2002.

Common Name	SubFamily	Mercer County	Species Name
Eastern Tiger Swallowtail	Papilioninae	Yes	<i>Papilio glaucus</i>
Pipevine Swallowtail	Papilioninae	Yes	<i>Battus philenor</i>
Black Swallowtail	Papilioninae	No	<i>Papilio polyxenes asterius</i>
Spicebush Swallowtail	Papilioninae	Yes	<i>Papilio troilus troilus</i>

Table 4. Species of butterflies captured at Athens Lake from the family Nymphalidae in 2002.

Common Name	SubFamily	Mercer County	Species Name
Gray Comma	Nymphalinae	Yes	<i>Polygonia progne</i>
Great Spangled Fritillary	Heliconiinae	Yes	<i>Speyeria cybele cybele</i>
Little Wood Satyr	Satyrinae	Yes	<i>Megisto cymela</i>
Meadow Fritillary	Heliconiinae	No	<i>Boloria bellona bellona</i>
Monarch	Danainae	No	<i>Danaus plexippus</i>
Red-spotted Purple	Limenitidinae	Yes	<i>Limenitis arthemus astyanax</i>
Silvery Checkerspot	Nymphalinae	Yes	<i>Chlosyne nycteis nycteis</i>
American Snout	Libytheinae	Yes	<i>Libytheana carinenta bachmanii</i>
Pearl Crescent	Nymphalinae	No	<i>Phyciodes tharos</i>

Table 5. Species of butterflies captured at Athens Lake from the family Hesperidae in 2002.

Common Name	SubFamily	Mercer County	Species Name
European Skipper	Hesperiinae	No	<i>Thymelicus lineola</i>
Least Skipper	Hesperiinae	No	<i>Ancyloxypha numitor</i>
Mottled Duskywing	Pyrginae	Yes	<i>Erynnis martialis</i>
Sachem	Hesperiinae	No	<i>Atalopedes campestris huron</i>
Silver-spotted Skipper	Pyrginae	Yes	<i>Epargyreus clarus</i>
Zabulon Skipper	Hesperiinae	No	<i>Poanes zabulon</i>

Discussion

There were several main ideas about butterflies that were examined during this survey. One is the preference of butterflies to specific food plants and therefore certain habitats. A butterfly's choice of habitat could also be due to other factors such as amount of shade or sunlight.

Most of the butterflies collected in this study were in the same or similar habitats as described in the literature (Allen, 1997; Opler & Krizek, 1984; Pyle, 1981). All of the blues from the family Lycaenidae were found in open fields. Both the Spring Azure and the Appalachian Azure are contrary to Allen's (1997) description of their habitat. Both butterflies are assumed to be found in woodlands and wet meadows. Other conflicting data between this experiment and Allen's book existed in the habitat description of the Mottled Duskywing from the family Hesperidae. This skipper was listed for wooded uplands and edges, yet in this study it was found along the roadsides adjacent to the fields. One last disagreement between this research and Allen was the location of the Silvery Checkerspot from the family Nymphalidae. This butterfly was found in very, sunny areas with low grass unlike the moist habitat described by Allen. Some reasons for these differences were probably due to the existence of many microhabitats. Also, many of the main habitats were linked closely and there would be an occasional change in habitat due to some bush or tree or open, sunny area. A wandering butterfly could have easily been captured out of its normal habitat while searching for a site to perch or nest, feed, or locate females.

While collecting and observing behavior of these butterflies, special attention was dedicated to the arrival of the Monarch. Unfortunately, it was reported by the media this past January that a winter storm in Mexico left thousands of Monarchs frozen. This and the logging

taking place in the Monarch over-wintering sites have contributed declines in the Monarch population (Anonymous, 2002). This migratory species is normally expected to arrive at Athens Lake during May, June, and at the latest July. However, the Monarch was not sighted until mid-August. When the Monarch was finally observed, the weather at Athens Lake was beginning to turn dry. Before long the flowers wilted and the Monarch had no food plants. This is a possible reason for the later disappearance of this butterfly. Within the span of about two weeks, the Monarch had arrived at and departed Athens Lake. The most plausible reason was the weather, although, other factors should be noted. By the time the Monarch was observed at the research site, it was late in the season. The migration could have begun and the instincts for the butterflies to advance south were affecting the length of their visit. There were also still large numbers of Swallowtails still inhabiting the area causing competition for the Monarch.

By the end of the study, over 25 different species of butterflies were collected at Athens Lake with 11 as new records. Of these 11 records, five families were represented. Many previous records from Allen were not located at Athens Lake. Possible reasons include weather as previously mentioned. Not only were the Monarchs affected by the dry conditions and withering plants but also other butterflies were left with a lack of food plants. For example, the Blues population decreased when the Crown Vetch disappeared.

Moreover, toward the end of the collecting period construction was taking place on the roads where some of the butterflies were being collected. Not only did collection stop in these areas, but also many of the food plants that the butterflies were feeding on were removed and grass was replaced in that particular habitat. Over half of the upper field was destroyed where large amounts of Swallowtails and Sulphurs fed on the nectar of the flowers.

Another fault to this project was that the researcher did not begin collecting until later May and due to weather conditions had to end in early September. Many butterflies can only be viewed in during certain times in the season, such as the Mourning Cloak (Opler & Krizek, 1984).

Athens Lake does not support all types of habitat that butterfly food plants thrive in and therefore lacks in species of butterflies that would habituate these areas. Therefore future directions for this research would be to further survey Athens Lake to find more species that might have been overlooked or to do an in-depth study at the lake on a particular butterfly species. Other options include surveying other areas in Mercer County in order to locate more habitats and butterflies. Surrounding counties could also be studied in order to gain a better perspective on butterfly populations and habitat differences within a portion of West Virginia.

However, the diversity of Athens Lake was a good representative of the southern portion of the state. The multiple habitats here allowed for a variety and diversity of butterflies to occupy a small area. As the results have shown, at least 25 different species of butterflies and skippers are located at the lake. This made for an interesting observation of butterfly habitat and behavior on a local scale while updating records and providing a baseline study for future researchers.

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Running head: HANDEDNESS AND REACTION TIME

The Effect of Handedness on Visual Reaction Time

Roland L. Peckham

Concord College

Abstract

Research suggests that left-handed (LH) people suffer more accidents than right-handed (RH) people. The most widely held explanation is that this phenomenon is due to cultural bias in today's world which is designed for RH people. However, considering new research that suggests LH may be a product of brain trauma, reaction time (RT) was studied as a possible correlation. The subjects were 55 public school students, both male and female, ages 11 to 19 years. All participants were tested for hand preference by questionnaire, and then RT was tested by the Cedrus SuperLab software on a Macintosh classic computer. No significant differences were found between the LH and RH groups. The results suggest that visual reaction time may not be a valid explanation for the higher rate of accidents of LH individuals.

Handedness, or the quality of having a hand preference for performing tasks, has been a topic of discussion at least as far back as 1486, and even at that time it was thought to be a learned trait (Harris, 1990). John Watson (1930) noted that from birth we are conditioned to use our right hand, and that left handedness (LH) was merely a lack of training that could easily be changed if a child was young enough, even though no specific age was given. Later research, however, pointed to a genetic influence. It has been shown that left-handed people comprise about 10% to 15% of the general human population (Segalowitz, 1983). However, if both parents are LH, then the chance of a child being LH increases to about 47%. Interestingly enough, if only one parent is LH, it is the sex of the parent that matters. If a child has a LH mother, the chances of that child being LH is 31%, whereas if the father is LH, the chances are only 22% (Coren, 1992). Data such as these deter one from making the assumption that handedness is a function of one allele, such as eye color, and this explanation becomes harder to accept when twin studies are considered. The incidence of same handedness in twins is significantly higher than that of other siblings, regardless whether the children in question are dizygotic or monozygotic (Herron, 1980). Furthermore, in a compilation of previous data collected on twins, it has been shown that same handedness occurs more often in dizygotic (84%) than it does in monozygotic (72.6%) twins (Newman, 1937). It seems that perhaps the strength to which a person is handed may be inherited (Coren, 1992).

Some more recent studies with handedness point to perinatal variables such as birth trauma (Baken, 1990), or very low birth weight (Powls, 1996) in determining handedness. Head trauma soon after birth may also be a factor (Coren, 1992) in hand

preference.

Other correlations with LH influence include allergies (Smith, 1987), mental retardation, epilepsy (Andegalowitz, 1983), bipolar disorder, schizophrenia, anxiety, and autism. Studies also reveal that LH people are up to three times more likely to be clinically depressed (Sackheim, 1983). Overall IQ within LH people is normal (Corballis and Beale, 1976).

The percentage of the population that is LH decreases steadily over the life span to less than one percent of 80 year olds (Coren, 1992). One proposed theory was that all the older LH people had been taught to be right handed, thus skewing the data. This idea has not been widely accepted, due in part to research done by Coren, (1992) that shows that the percentage of LH Americans has remained relatively stable over the last 70 years, despite the fact that left handedness has been gaining acceptance in school settings. Other research has found that when questions regarding writing are removed from handedness questionnaires, the older age trend is still found (Ellis, Ellis, Marshall, Windridge, and Jones, 1998). The reason for this decline seems to be that LH people simply die younger. In a study done by Coren (1992), the average lifespan of LH females was 5 years less than the RH controls, and LH males died 8 years earlier than the RH controls.

One reason for the shorter life span may be the new reports of handedness being a risk factor in injuries (Wright, William, Currie, and Beattie 1996), and an explanation for these findings may be that LH people are living in a RH society. Coren (1992) cites and illustrates eight specific instances of devices that are so awkward for LH people that they have the potential to become dangerous.

Reaction time may also be a factor in the shorter life expectancy of LH people. Reaction time has been paired with accident rates to see if a correlation exists (Emery, 1996; Reilly, Zedeck, & Tenopyr, 1979; Goldberg & Parthasarathy, 1989; Lord, Ward, Williams, & Strudwick, 1995), and often a significant correlation was found (Bavarik, 1968; Mihal & Barrett, 1976; Van der Flier & Schoonman, 1998; Lord, Clark, & Webster, 1991; Helgren, Gillberg, Gillberg & Enerskog, 1993). Studies done by Gabbard, Hart, and Gentry (1995) have found that RH children have better general motor proficiency than LH children. The only study located that dealt directly with handedness and reaction times found a considerable difference of 12 milliseconds between LH and RH groups, but was not found to be statistically significant; probably due to the small number of subjects (McConville, 1960). Since there have been correlations found between RT and accident rates, a hypothesis was formed that there may be a significant difference between the reaction times of LH and RH people, namely that LH people may have a slower RT than their RH counterparts. Because previous research in this area dealt with adolescents, the experimenter chose to continue with these same ages for this study.

Method

Participants

The participants used were 55 summer school students, ages 11 yrs. to 19 yrs. (Mean age = 14.55 yrs., std. Dev. = 1.77). There were 44 RH students (31 male, 12 female) and 11 LH students (8 male, 4 female).

Apparatus

A questionnaire was developed to determine the handedness of each participant. The questions relating to handedness were found to be reliable and valid in a previous study by Porac and Coren (1981). Other questions related to gender and age (see Figure 1).

Visual reaction time was determined by use of a program developed on Cedrus's SuperLab version 1.68 on a Macintosh Classic personal computer.

Procedure

Participants were meeting their respective classes, and the experimenter went into each room. The experimenter then gave a brief introduction to the class as to who the experimenter was and what the experimenter was going to do. Questionnaires were distributed to all participants, with time allowed for completion. Questions about the questionnaire were fielded at that time. After all the participants were finished, they were taken one at a time into the back of the room for RT measurement. The program developed for this experiment consisted of an uppercase "F" that was almost a full screen size, and was presented on the screen 26 times with a random number of milliseconds separating each trial.

The first time the stimulus was presented no measure was taken, and the participant was given the instructions. All participants were told that when the figure that they saw before them, an "F", appeared on the screen, they were to hit the space bar on the standard keyboard before them. A black piece of paper the same size as the space bar was taped directly in front of the space bar, and all participants were instructed to keep

their striking finger(s) on the black strip of paper that was fixed in front of the space bar, so as to minimize the differences between subjects on distance traveled between the starting point and response point. Each participant used their hand of preference as identified by the questionnaire. Participants were told that a press on the space bar would start the trials. After all the trials were run, each participant was thanked individually for their participation. At the conclusion of each class of students, the class as a whole was thanked for their cooperation and help.

Results

The participants were measured on 25 trials, but only the last five trials were used in the statistical analysis, so as to control for learning and practice effects or other confounds. Because five measures were taken per participant, a repeated measure analysis of variance (ANOVA) was used. An alpha level of .05 was used, and the results proved not to be statistically significant, $F(1, 55) = 1.922, p = .171$. There were also no confounding trends, $F(1, 55) = .310, p = .580$. Table 1 includes these measures.

Discussion

These results are consistent with the previous work done by McConville (1960), namely that the hypothesis that LH people would have a slower simple visual RT was not supported by the data found in this study. A major problem that arose with this study was the small number of participants used ($n = 55$). Any future studies executed in this area should include a larger number of participants, and perhaps participants from different geographic locations.

This evidence may seem to support the possibility that the reason for the reported higher incidence of accident rates among LH people may stem from the obvious cultural bias in machinery. However, simple visual reaction time may not be the best way to test for differences between LH and RH groups. A battery of complex RT tests consisting of multiple stimuli (visual, tactile, auditory, etc.) would seem to be more applicable to instances found in "real world" accident scenarios.

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Table 1

Analysis of Variance for Reaction Time

<u>Within-Subjects Contrasts</u>			
<u>Source</u>	<u>df</u>	<u>F</u>	<u>Sig. Level</u>
RT	1	.782	.381
RT * Handedness	1	.310	.580

<u>Between-Subjects Effects</u>			
<u>Source</u>	<u>df</u>	<u>F</u>	<u>Sig. Level</u>
Handedness	1	1.922	.171

Figure Caption

Figure 1. Sample of questionnaire used in this study.

Order Number _____

Please answer all questions carefully.

1. How old are you? (Please answer in years.) _____
2. Are you male or female? _____
3. Which hand do you write with? _____
4. Which hand do you throw with when you want to hit something? _____
5. Which hand do you draw with? _____
6. Which hand do you hold your toothbrush with? _____

**THE TWO VIRGINIAS:
The Differences That Divided**

**N. Pauline Price
Concord College McNair Scholar**

**Dr. D. Anne Cavalier, Mentor
West Virginia University Institute of Technology
1999-2000**

In the days following the Confederate firing on Fort Sumter, April 12, 1861, Virginia's reaction was as divided as the Union. Although the action of the new Confederacy was a cause for celebration by a majority of the eastern citizenry, the political leaders west of the Alleghenies reacted quite differently. On April 17, in a secret session, the Richmond Secession Convention voted that Virginia would secede from the Union and join the Confederacy. Of the forty-seven delegates representing Trans-Allegheny Virginia, only eleven voted for the ordinance and four abstained. By April 19, John S. Carlile, "the most outspoken of the western Unionists"¹ returned to the west, and the process by which the great state of Virginia would be irrevocably divided was begun.

The dismemberment of Virginia, however was not a sudden impulse born from a fear of war, abolition fever, or Methodist domination. Neither was there real Union unanimity within the western section. The timing, though incidental to the division, has obscured the sectional issues that lay between Virginia's two regions. There was an underlying, pervasive lack of unity and a history of diverse and conflicting interests between the eastern section of Virginia and the western region beyond the Appalachian Mountains. The purpose of this study was to examine the differences that existed between the two sections of Virginia in order to clarify the disunity that existed in Virginia and to dispel the suppositions that the ultimate division into two Virginias was caused by the Civil War.

¹ Richard Orr Curry. *A House Divided* (Pittsburgh: University of Pittsburgh Press, 1964). 2.

Among West Virginia historians most agree that the action was not as precipitous as the public opinion of post-Civil War contemporaries passionately espoused. There are only slight variations in the literature concerning the motivations of the statehood leaders, but there was no question that the timing was perfect for a nearly unnoticed, non-violent, longtime-coming coup. Slavery was the dividing factor in the national conflict, but for most western Virginians maintaining the institution was not worth destroying the constitution. *The Kanawha Valley Star* reported the opinion that "the people of the West are pro-slavery from principle and we venture the assertion that there are more abolitionists east of the Blue Ridge than west of it."²

What had brought about this divergence of loyalties within the great state of Virginia? Western Unionists did not see themselves as traitorous Virginians, but rather their region as truly a separate entity. Waitman T. Willey, one the most loyal of the statehood leaders said:

It seems to be supposed that this movement for a new State has been conceived since the breaking out of the rebellion, and was a consequence of it Not so . . . The question of dividing the State of Virginia, either by the Blue Ridge mountain, or by the Alleghenies, has been mooted for 50 years The animosity existing at this time between the North and South is hardly greater than what has at times distinguished the relations between East and West Virginia, arising from a diversity of interests and geographical antagonisms.³

The problem was that those to the west of the mountains had very little in common with those to the east; and those in the east had very little concern for those in the west. The antagonism grew nearly as unyielding as the mountains that separated west from east. Although most westerners agreed with state's rights, they did not

² Charles Ambler, *Sectionalism in Virginia from 1776 to 1861* (New York: Russell & Russell, 1964), 310.

³ Charles Ambler, *Waitman T. Willey* (Huntington, WV: Standard Printing & Publishing Co., 1954), 77.

necessarily believe that their interests would be protected under the Confederacy, any better than it had been under Virginian domination. In the little that was recorded of the mass meetings and among statehood leaders, the primary goal was to keep Virginia in the Union; it was only secondary to create a new separate state.⁴

The west held slaves and came into the Union as a slave state with an amendment that promised to voluntarily provide for eventual emancipation. The original issue of the Emancipation Proclamation did not apply to West Virginia; the 18,371 slaves in the western counties were freed with the Thirteenth Amendment. In 1861 though, westerners felt slavery was a southern concern, which affected them only slightly. As historian James McGregor wrote; "the contest of 1861 dawned with eastern and western Virginia as widely apart in manners, custom, and sympathies as though thousands of miles intervened between them."⁵

The differences between the two sections became apparent early in the history of whites west of the Appalachian Mountains, America's first natural barrier to expansion. At first Virginia used western territory for payment of war debts. Untold acres of land were sold, bought, traded and resold. Hundreds of acres were transferred, or claimed by a government of men none of whom had ever been on the western side of the mountains. Families who had cleared and tamed a wilderness often found

⁴ Richard Orr Curry, *A House Divided*. Virgil A. Lewis, *How West Virginia was Made* (West Virginia: News Mail Company Public Printers, 1909).

⁵ James C. McGregor, *The Disruption of Virginia* (New York: The MacMillian Company, 1922), 90.

themselves dispossessed. Despite preemption and prior claim rules, suits and counter-suits went on for decades.⁶

His advice went unheeded but in 1784 George Washington wrote:

There is nothing which binds one country to another but interest. Without this cement the western inhabitants, who more than probably will be composed in a great degree of foreigners, can have no predilection for us, and a commercial connection is the only tie we can have upon them.⁷

Physically the west did not even look like the Tidewater or the Piedmont and the western settler was not of the same nationality or traditions as those in the east. The economic interests of the western citizens were limited due to natural forces and the lack of investment by the east in the form of internal improvements. The west was well endowed with all the needs of a frontier society, but the very bounty of the land contributed to the isolation and sectionalist feelings of the west. An 1870 handbook written by early West Virginia commissioner and historian, Joseph Diss DeBar explained the significance of the land to the self-sufficient attitudes developed by western inhabitants in this way:

Few were actuated by higher motives than love of adventure, and the gratification of their immediate wants through the manly sport of the forest and mountains. Game and fish, and even wild fruit and honey are everywhere abundant, and the slovenly cultivation of a few half cleared acres in this genial climate furnished in abundance the bread and other necessaries of the settler's frugal fare.⁸

The majority of settlers to the western lands were from nations such as Ireland, Germany, Scotland and Wales. Those who came from other states were lured over the

⁶ Otis Rice, *The Allegheny Frontier: West Virginia Beginnings, 1730-1830* (Lexington: The University Press of Kentucky, 1970). Otis Rice and Stephen Brown, *West Virginia: A History* (Kentucky: The University Press of Kentucky, 1993).

⁷ Charles Henry Ambler, *Sectionalism in Virginia From 1776 to 186*. 48.

mountains by a desire for adventure and the availability of cheap land. The low value placed on western property, however, also promoted antagonism; relatively few westerners could meet the property qualifications required to vote. There were not many who came across the mountains from Virginia, but those who did were generally the younger sons of planters who came to establish aristocracies of their own. Most brought with them slaves.

The west ranged from mountainous to hilly planes and narrow valleys that were sparsely dotted with small family farms, and, though the land was rich in natural resources, most of it was buried below the technology of the time. Using the same methods that the Indians had employed westerners began processing salt. Tobias Ruffner has been credited with the first drilling efforts, which would allow salt to become a major export, and give rise to the beginnings of the coal industry. The Salt industry would peak in the 1840s, but its boom would bring with it a number of slaves. Coal would not become a major industry until after the Civil War. Unsited to the plantation system or widespread tobacco cultivation; and with markets quite distant and difficult to reach, Ambler wrote that the westerners focused only on "those products which could walk to market."⁹

By 1861 Virginia was a very rich, very old, and very powerful state. Virginia's decision to join the Confederacy was crucial to the Southern Cause. Although Virginia resisted national disunion, ultimately her commercial and philosophic bond with Southern concerns proved too strong. Western Virginians', however, had a huge

⁹ Joseph H. Diss Debar, *West Virginia Handbook and Immigrant's Guide* (Parkersburg: Gibbons Brothers, 870). 12.

mountain range separating them from almost all contact with the rest of the state; and owning few slaves, had little concern with protecting the institution. With the east cutoff as a viable outlet "the western region, following natural law, commercial communications . . . [were] almost wholly with the . . . section of the United States drained by the Mississippi."¹⁰

Western citizens were enormously interested in a more equitable distribution of the proceeds from taxes, and the retention of the three-fifths tax base for slaves. They also wanted reform in voting qualifications and representation in the General Assembly, the governing body of Virginia. The aristocracy in the east had retained political power, and the tax policy favored the large eastern slaveholders. Tax financed improvements went almost exclusively for maintenance of eastern interests, which contributed to western animosity. Complaints that "slave capital had encroached upon the personal right of free white men of the west . . ." were regularly forwarded to the General Assembly. The "slaveowner" it was reported, "paid only \$1.20 taxes annually on a slave valued at \$1,200" while "the small merchant with a capital of \$600 was made to pay \$60."¹¹

The very ingenuity the west used in marketing their goods, added to the neglectful way with which the General Assembly had continued to postpone the daunting task of cutting roads through the mountains. An article in 1852 pointed out that goods produced in the west had to "almost circumnavigate their own state" for use

⁹ Charles Henry Ambler, *Sectionalism in Virginia from 1776 to 1861*. 14.

¹⁰ James C. McGregor, *The Disruption of Virginia*. 17.

¹¹ Ambler, *Sectionalism in Virginia*. 334.

by eastern Virginia.¹² Since Virginia had failed to invest in a connecting system of roads or waterways, the war did pose a distinct threat to western Virginia. Virtually cut off from the Confederate protection the west lay relatively open for Union domination.

Their northern and western familiarity and relations, beyond the commercial, extended to ties within education and religion. While eastern Virginian sons were educated almost exclusively in southern Universities; few western sons were educated at all. Those that were educated were primarily taught in or by northern born and educated teachers. When the churches clashed over the slavery issue both northern and southern ministers wooed the western district. Mainly, the westerners simply continued to worship with traditional mountain devotion to God and nature ignoring, as much as possible, the moral significance of slavery.

Virginia, in response to the continual clamor of the western citizenry, had two Constitutional Conventions. The first was held in 1829-30 and produced almost no reform for the west. The 1829-30 Convention was attended by some of the biggest names in American and Virginian history. Ignoring the petitions that had been sent from the west, the convention was a complete failure for the west and the resulting constitution was a virtual restatement of the original. Following the defeat of reform for the west, mass meetings were held to discuss a possible secession convention.

Nothing came of the meetings and there was a reduction of tensions by the election of a more western friendly governor and the building of the Baltimore & Ohio line. By 1849, however, western agitation and eastern fear lead to the call for a second convention. The 1850-51 sessions would become known as the Reform Convention.

¹² J. D. B. De Bow, *De Bow Review* (New Orleans: Office, Exchange Place, 1852). 39.

This time the roster of members, who were called to order on October 14, 1850, was totally new. Gone were the well-known and powerful leaders of the past. Although many were still adamantly conservative, there were some that were inclined towards concession. Virginia was suffering from economic stagnation, soil depletion and the slave-abolition controversy was growing volatile. Virginia needed to strengthen her position and suddenly she realized that she had a whole area of untapped resources west of the Appalachian Mountains.

The debates were much the same as they had been twenty years earlier. The decision to adjourn, however, and await the results of the census was what led to the much-needed reform. Property qualifications for voting were dropped and representation was adjusted in the west's favor. The western citizens went back across the mountains feeling quite pleased with the results of the convention. Little note was taken of the retention of the three-fifths tax. "Although westerners hailed the constitutional changes as a victory for democracy in Virginia, they bought their gains at a heavy price scarcely realized at the time," wrote Rice and Brown of the tax issue.¹³

For the next ten years east and west were more closely aligned than they had ever been. Both sections opposed the extreme measures that the lower southern states were advocating and despite the fact that John Brown's Raid took place on what would become West Virginia soil, it was not a western plot, and John Brown was not from western Virginia. The famous Ruffner Pamphlet was simply an exhortation on the economic drain of slavery to the state and not an abolitionist inspired document.

¹³ Rice and Brown, *West Virginia: A History*. 98.

Despite the separate interests, the neglectful policies, the antagonistic feelings and the dissimilar resources of the two sections, there were a significant number of Confederate sympathizers and there was slavery in the west. There are no accurate numbers of western men who fought in the Civil War on either side, but it is now believed that including guerilla or "bushwhackers," Confederates did have support in western Virginia. In the census of 1860 the total number of Virginia slaves was 490,865 with a white population of only 1,047,299. The total number of slaves in the western counties in that census was 18,371. The largest number of slaves beyond the Appalachian Mountains was concentrated in the counties of Jefferson, Kanawha, Berkeley, Greenbrier, Hardy, Hampshire, and Monroe. Jefferson's 634 slaveholders owned 3,960 slaves. On the other hand, Calhoun had 9 slaves, Webster 3, Hancock 2 and McDowell none at all. None of the counties of eastern Virginia were without a significant number of slaves. There were just sixteen eastern counties with under a thousand slaves each, and eleven with between ten and fifteen thousand per county. 2,339 of Henrico's citizens owned 20,041 slaves.¹⁴

With Virginia's decision to secede, western Virginia was left to protect its own interests once more. Western leaders once again called mass meetings. All past grievances were vividly remembered and rehashed. In addition to past animosities, most of the promises of internal improvements made in 1850 had been postponed, or abandoned. Most disheartening of all was that increased western representation had failed to keep Virginia in the Union. Virginia had continually failed to take advantage of

¹⁴ Virginia Statistics 1860. <http://members.aol.com/jweaver301/nc/vawhite.html>. Access June 14, 1999

the land beyond the Appalachian Mountains. After a history of delayed economic development, and diverse philosophical and political interests, western Virginia was virtually a separate entity. There had been two Constitutional Conventions called to mollify the western petitions of neglect and oppression. The state enjoyed ten years of relative harmonious, if distant, relations. "Looking backward from the year 1861," wrote McGregor, "we see a succession of abortive attempts to unite the sections of the State." When primarily eastern Virginia chose the Confederate Cause "all her old sectional wrongs came up to her again," but he continued "the disruption of the state, was to be used as the last resort."¹⁵ It was the work of delegates from twenty-seven western counties that created the Restored Government of Virginia and started the statehood movement. It was congressional debates and compromise, however, that dictated the actual division of the two states of Virginia. Following two years of political maneuvering and infighting among statehood leaders, West Virginia became the thirty-fifth state June 20, 1863.

¹⁴ McGregor, *The Disruption of Virginia*, 19, 73.

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Vancomycin Resistance in *Staphylococcus aureus*

Authors:

Donna Privett
Dr. Darla J. Wise

Committee:

Dr. Darla J. Wise, Chairperson
Dr. Ronald Canterbury
Dr. Roger Sheppard

Vancomycin resistance in *Staphylococcus aureus*
Donna Privett and Dr. Darla J. Wise

ABSTRACT:

The development of antibiotic resistance in microorganisms has been cause for great concern of late. Recently, vancomycin resistant *Staphylococcus aureus* strains have been discovered. Vancomycin has been one of the only antibiotics left that can be given to a patient with a *S. aureus* infection since its development of methicillin resistance. The objective of this project was to determine if a particular non-clinical isolate of *S. aureus* has a naturally occurring vancomycin resistant subpopulation. Additionally, this isolate was examined for its ability to develop resistance due to low dose exposure to the antibiotic. Comparison of the normal growth rate to the growth rate of the cultures grown at the minimum inhibitory concentration (4 µg/ml) vancomycin, which did not grow, suggests that there is no pre-existing subpopulation with naturally occurring resistance to vancomycin. However, cultures grown initially in vancomycin concentrations of 0.01 µg/ml vancomycin were capable of growth at 0.1 µg/ml vancomycin, while cultures not previously exposed to vancomycin were not capable of growth at this concentration. This may suggest that this strain has the ability to develop resistance by multiple low dose exposures to vancomycin. However, this study was a preliminary study, with potential expansion to defining a more specific explanation of the development of a resistance to vancomycin by *S. aureus*.

Vancomycin resistance in *Staphylococcus aureus*

Introduction

A newspaper article in a book written by Dr. Stuart B. Levy titled "The Antibiotic Paradox" tells of a fire in the Coconut Grove Nightclub in Chicago, Illinois in 1943 (Levy, 1992). This fire claimed the lives of hundreds of people and could have been much worse, if not for some major advances in burn treatment in the previous years. Once the skin has been damaged, as in burn victims, a microorganism known as *Staphylococcus aureus* can enter the body, where it circulates in the bloodstream causing high fevers, shock and death. Prior to the Coconut Grove Nightclub fire there were no agents readily available to treat infections caused by this microorganism. The advent of this fire marks the occasion of the trial of a new drug that was previously only available through government sources.

Penicillin originally was a highly guarded medical secret and was reserved for military use only, especially since all of this occurred in the early 1940's during World War II (Levy, 1992). Its limited use stemmed from the reluctance of the government and pharmaceutical houses to put large amounts of resources into the development of a relatively unknown substance. The United States government finally agreed to the release of this new drug for use on the victims of the Coconut Grove fire. This proved to be one of the most important clinical trials of penicillin. Penicillin earned the accolade of "miracle drug" because of its unique ability to rapidly control infectious bacteria that once had been fully expected to kill the patient. Not only did it kill bacteria in living

tissue, but also in dead tissue. This is a feat that no other antibiotic could perform thus far.

Alexander Fleming, who discovered penicillin in 1928, warned against the unsupervised use of this drug (Levy, 1992). He stated that misuse could lead to the selection and propagation of mutant forms of bacteria that would be resistant to the drug. Fleming had derived such mutant forms of bacteria in the lab by growing susceptible strains in low amounts of penicillin and then increasing the amounts of the antibiotic, which caused them to adapt to their changing environment. They developed cell walls that were much less permeable to the penicillin so that it could not penetrate and kill the bacteria.

Against Fleming's warnings, the drug was then made available as an over-the-counter medicine in the early 1950s (Levy, 1992). This invited misuse by the public using it for diseases that were not responsive to penicillin and taking dosages that would not totally eradicate the bacteria. The surviving bacteria then could grow and multiply with the mutant forms being less susceptible to the penicillin. Thus began the age of antibiotic resistance and the hopes of ever controlling the bacterial world. As a result, penicillin is rarely helpful in treating bacterial infections today.

Antibiotic resistance is the ability of the cell to grow in the presence of a chemical that normally inhibits an essential cell function. Bacteria may change their cellular structure to be able to survive the attacks of an antibiotic drug (Hwang, 1998). Once they become resistant to a drug, it is no longer effective in treating the infection. Some types of resistance may be passed on to other unrelated bacteria, increasing the number of infections that can no longer be treated with antibiotic drugs. As antibiotic resistance can

affect so many people, it is a growing global concern and poses a major public health threat.

Antibiotic resistance is important for several reasons. There are only a limited number of antibiotics available to treat bacterial illnesses (Hwang, 1998). If you have an infection caused by resistant bacteria, more toxic and expensive drugs may be required to treat the infection. This can result in longer hospital stays and higher healthcare costs. Also, antibiotic resistance can spread to other bacteria. In extreme cases, some bacterial infections may become untreatable because no current antibiotics are effective in killing the resistant bacteria.

The world is heading for a public healthcare crisis (Ho et al., 1998). At least thirty new diseases, such as AIDS, Ebola, several kinds of hepatitis and other deadly diseases have emerged over the past twenty years, while old infectious diseases, such as tuberculosis, cholera, malaria, and diphtheria are coming back worldwide.

The bubonic plague--caused by the bacteria *Yersinia pestis*--killed one-third of Europe's population in the 1300's, but had been controlled with antibiotics like streptomycin and gentamycin, until 1995 when a sixteen year old boy in Madagascar failed to respond to the antibiotics (Nordenburg, 1998). This was the first documented case of an antibiotic resistant plague.

As stated earlier, antibiotics were introduced in the early 1940's, but resistance didn't appear until the early 1950's (Ho et al., 1998). Resistance to penicillin and ampicillin in *S. aureus* went from 0% in 1952 to more than 95% in 1992. The new flouroquinolone antimicrobial, ciprofloxacin, was also used to combat *S. aureus* infections but within one year—from 1991 to 1992—resistance to it rose from 5% to 80%. By 1990 every

common pathogenic bacterial species had developed varying degrees of resistance to different antibiotics and some often exhibiting multiple drug resistances. In addition to *S. aureus*, some such bacteria include: *Streptococcus pneumoniae* which causes pneumonia and otitis media, *Streptococcus pyrogenes* which causes strep throat, *Haemophilus influenzae* causes meningitis, *Enterococcus faecium* causes intestinal infections and *Vibrio cholerae* that causes cholera, along with several other bacterial species.

There are a number of factors that contribute to the increasing resistance in bacteria and the resurgence of old infectious diseases (Ho et al., 1998). Two factors are population growth and rapid urbanization, which combined help to spread the resistant bacteria. These along with wars, civil and natural disasters, the rapid increase of international air travel, and the growing traffic in trade lead to an increase in bacterial resistance. Expanding areas of human habitation, the consequent environmental destruction, and social changes also add to the increasing resistance. The clustering of children in daycare centers and the growing numbers of the elderly in nursing homes are among the larger contributors to social change that provide environments allowing for the transmission of resistance and appearance of resistant diseases. There is also complacency towards infectious disease in the public health sector and collapse of public health systems due to economic or social crisis. Such factors also add to the spread of resistant bacteria, along with the overuse and abuse of antibiotics in intensive farming and medicine.

Bacteria use a number of different mechanisms to develop resistance. Resistance can be intrinsic or acquired (Hawkey, 1998). Intrinsic resistance is a naturally occurring trait arising from the biology of the organism. Acquired resistance occurs when a bacterium

that has been sensitive to antibiotics develops resistance and can occur by mutation or acquisition of new DNA. Bacteria easily transfer DNA or plasmids to each other, regardless of relatedness, and if the resistance genes are passed on they are picked up immediately.

Bacteria may also make use of enzymes that inhibit the activity of the antibiotic (Hawkey, 1998). An example of this would be in bacterial strains that once were highly susceptible to penicillin developing resistance by synthesizing an enzyme known as β -lactamase to cleave the β -lactam ring of the penicillin causing it to become ineffective.

Another mechanism for developing resistance is for the bacteria to protect the target from antibiotic action by preventing the antibiotic from entering the cell or pumping it out faster than it flows in (Hawkey, 1998). β -Lactam antibiotics in Gram negative bacteria gain access to the cell through a water filled hollow membrane protein known as a porin. In the case of imipenem resistant *Pseudomonas aeruginosa*, lack of the specific D2 porin confers resistance, as imipenem cannot penetrate the cell.

Resistance can also occur by cell wall modification, which is the best known mechanism for developing resistance (Hawkey, 1998). Gram positive bacteria, such as *S. aureus*, are typically sensitive to penicillin because they have peptidoglycan in their cell walls, which is the target of penicillin. A simple modification of this target would then render the penicillin ineffective, because it could no longer bind to it.

Another mechanism is the protection of the target from the antibiotic by production of an alternative target (Hawkey, 1998). These bacteria are able to produce enzymes that are resistant to the antibiotic while also continuing to produce the original sensitive target. The best known example of this is the alternative penicillin binding protein

(PBP2a) that is produced in addition to the normal penicillin binding proteins by methicillin resistant *S. aureus*. The protein is encoded in the *mecA* gene and because PBP2a is not inhibited by antibiotics such as flucloxacillin, the cell continues to synthesize peptidoglycan and thus has a structurally sound cell wall.

These means of acquiring resistance can be enhanced by the improper use of antibiotics. Every time a patient takes an antibiotic for an infection the drug may kill most of the bacteria, but a few may survive by mutation or acquiring resistance genes from other bacteria (Nordenburg, 1998). These genes can multiply quickly; developing resistant strains. All bacteria may be killed though the use of very high doses of antibiotics; however, a patient with a resistant bacteria would not be able to tolerate such high doses of the antibiotic that would be required to kill the bacteria (Hawkey, 1998).

Antibiotic resistance is a very serious problem. We as a society, patients and physicians, need to change our practices on antibiotic use, or one day we may destroy our arsenal of antibiotics. Over-prescribing of wide spectrum antibiotics by doctors is a major contributor to antibiotic resistance (Hwang, 1998). Doctors also need to perform adequate testing to ensure that the infection is not viral before prescribing an antibiotic. Viral infections are not responsive to antibiotic treatment; therefore, patients should not expect them when told they have a viral infection. When a bacterial infection has been confirmed by the proper testing, the patient needs to follow the instructions of the doctor on how to take the medication properly to insure eradication of the bacteria. Certain strains of enterococci bacteria no longer respond to vancomycin, which is a last resort drug that was supposed to be able to beat any bacterial infection.

Researchers are focusing on diversifying our arsenal of antibiotics. After the 1950's, drug companies scaled back their antibiotic development efforts (Nemecek, 1997). This trend ended in 1994, when a survey that depicted that the number of medicines and vaccines in development for infectious disease had increased by thirty-three percent.

S. aureus is one of the most common causes of nosocomial and community acquired infections (Smith et al., 1999). *S. aureus* lives harmlessly on approximately ten percent of the population's skin. Infections occur when the bacteria get into the bloodstream. It is the most common cause of surgical wound infections and second only to coagulase-negative staphylococci as a cause of nosocomial bloodstream infections. After the initial success of penicillin in treating *S. aureus* infections, resistant strains began to emerge. Approximately seventy-eight percent of *S. aureus* isolates are resistant to penicillin. Methicillin and other semi-synthetic penicillins were successful in treating these penicillin resistant strains until the 1980's, when methicillin resistant *S. aureus* became endemic in hospitals.

Since the emergence of methicillin resistant strains, the glycopeptide vancomycin has been the only line of defense for staphylococcal infections (Smith et al., 1999). The recent emergence of glycopeptide resistance in coagulase-negative staphylococci has heightened concern about whether *S. aureus* could acquire glycopeptide resistance; and potentially producing morbidity and mortality rates similar to those caused by *S. aureus* infections in the era before antibiotics.

In the 1950's hospitals began to report that staphylococci infections resisted penicillin. In the 1970's, staphylococci infections began to resist methicillin, which was an even stronger antibiotic. Then in 1996, staphylococci became resistant to vancomycin. This

marks the third major evolution that *S. aureus* has undergone in order to resist the latest antibiotics in medicine's armory. In May 1996, the federal Centers for Disease Control and Prevention (CDC) confirmed documentation of the first partial failure of vancomycin, which for more than a quarter century has cured staphylococci infections when other antibiotics failed. In Japan, a child recovering from heart surgery acquired a staphylococci infection that was unresponsive to the usual vancomycin treatment. It was finally conquered with a high dose of vancomycin in combination with other antibiotics.

Due to the emergence of vancomycin resistant organisms, it is now a restricted antibiotic (Michel et al., 1997). Its use in most hospitals requires the approval of the infectious disease unit. Resistant mutants are very rare except for vancomycin resistant enterococci and staphylococci. Vancomycin kills bacteria mainly by inhibiting bacterial cell wall synthesis. However, it also damages the bacterial cell membrane and interferes with bacterial RNA synthesis. Susceptibility of *S. aureus* to vancomycin has a breakpoint of minimum inhibitory concentration (MIC) less than 4 $\mu\text{g/mL}$ (Milewski et al., 1996). Moderately increased vancomycin MIC's have been noted among some clinical isolates of coagulase-negative staphylococci and glycopeptide resistant variants or mutants of staphylococci have also been isolated in several laboratories (Sieradzki et al., 1997).

While studying the effect of cell wall synthesis inhibitors on the expression of methicillin resistance in *S. aureus*, observations of rare staphylococcal cells that were able to form colonies on agar with 6 and even 12 $\mu\text{g/mL}$ of vancomycin have been reported (Sieradzki et al., 1997). One mutant, for which the vancomycin MIC was 100 $\mu\text{g/mL}$, had the unique ability to remove vancomycin from the surrounding medium. A

key feature of the resistance mechanism in this mutant is some alteration of cell wall structure, which allows the capture of the glycopeptide molecules at the periphery cells distant from the sites of cell wall biosynthesis, which becomes protected from the antibiotic.

It is important that vancomycin resistance be taken seriously, because it is one of the few, if not the only, antibiotics left in the fight against staphylococci infections. The topic of research of this project is to evaluate the susceptibility of a non-clinical isolate of *S. aureus* to vancomycin. This will be determined by the growth of a culture of *S. aureus* in the absence of vancomycin and comparing it to the growth of it in the presence of different concentrations of vancomycin. Growth will be determined by measuring the optical density of each culture. In addition, this project will also determine the ability of the culture of *S. aureus* to develop resistance to vancomycin due to low dose prior exposure to the antibiotic.

Proposal

In a previously published paper by Sieradzki et al (1997) a possible mechanism of vancomycin resistance in *S. aureus* was tested. The results of this study suggests that the inhibition of cell wall turnover in *S. aureus* by vancomycin is due to the blocking of relevant hydrolytic enzymes to their cell wall substrates at the outer surface of the bacterium. However, this study did not allow for a clear-cut and fully satisfying mechanism for the vancomycin resistance of *S. aureus*.

The objective of this study will be to determine if vancomycin resistant *S. aureus* are present in non-nocosimal isolates without prior exposure to vancomycin. The presence of a naturally occurring resistant strain will be determined by exposing a non-nocosimal isolate of *S. aureus* to its MIC of vancomycin, which is 4 μ g/ml. Another experiment will be preformed to determine the ability of *S. aureus* to develop resistance after prior sub-MIC exposure to vancomycin. To do this, a sub-MIC concentration of vancomycin will be added to an overnight culture for prior exposure, after which the culture will be grown in a concentration of vancomycin at or higher than the MIC.

The bacterial strain used in this study is a non-clinical isolate of *S. aureus* obtained from Presque-Isle Cultures (Presque-Isle, PA). This strain will be grown on Brain Heart Infusion (BHI) agar. For each experiment, colonies from the BHI agar are to be transferred into 50mls of BHI broth and placed into a water bath of 37°C to incubate overnight. On the following day 0.5mls of this culture will be transferred to 50mls of BHI broth. The optical density (OD) of this culture will be monitored and recorded at a wavelength of 600 nanometers every 30 minutes in order to prepare a growth curve for

this culture. Once a normal growth curve has been obtained, a similar experiment will be performed with the addition of 4 μ g/ml of vancomycin to the 50mls of BHI broth. The OD of this culture will also be monitored and recorded every 30 minutes and a growth curve prepared for it as well. Comparison of these two growth curves will determine the existence of a naturally occurring resistant strain. All procedures will be performed in triplicate for further analysis.

In a subsequent experiment, an overnight culture of *S. aureus* will be prepared using BHI and 1 μ g/ml vancomycin and allowed to incubate overnight in 37°C water bath. The following day 0.5mls of this culture will be transferred to 50mls of BHI and then an additional 4 μ g/ml of vancomycin will also be added. The OD of this culture will be monitored and recorded at a wavelength of 600 nanometers every 30 minutes and a growth curve prepared. This will determine the ability of this strain of *S. aureus* to develop vancomycin resistance due to prior low dose exposure of the bacteria to the antibiotic. Experiments will be performed in triplicate for further analysis.

Analysis of results will be to compare log-phase growth rates of *S. aureus* with and without vancomycin. Also the amount of time required to initiate log-phase and complete log-phase growth will be examined. Determination of statistical significance between growth rates will be analyzed using the paired t-test.

Methods and Materials

Growth of *S. aureus*.

The bacterial strain used in this study is a non-clinical isolate of *Staphylococcus aureus*. This strain was grown on Brain Heart Infusion (BHI) agar and transferred to BHI broth. The cultures used were prepared by transferring colonies of the bacteria into 50 ml of broth, which were then placed in a water bath of 37°C to incubate overnight. To measure the optical density (OD), at 600 nanometers, 0.5ml of this overnight culture was transferred to 50ml of broth. One milliliter of this culture was then transferred to a 1ml cuvette and the optical density was measured; thereafter, the optical density was measured every thirty minutes to prepare a growth curve for this strain of bacteria. Vancomycin, at a final concentration of 4µg/ml, was added to a similar overnight culture the following day to determine the existence of a naturally occurring resistant strain.

Low dose prior exposure to vancomycin.

Concentrations of vancomycin lower than 4µg/ml, starting at 1µg/ml, were used to grow the culture in overnight. This culture was then be exposed to 4µg/ml of vancomycin the following day to determine whether or not this bacterial strain has the capability of developing resistance to vancomycin. The addition of concentrations of vancomycin that were lower than 4µg/ml have been chosen because it has been documented that *S. aureus* clinical strains have a MIC of 4µg/ml.

No growth having been observed with this overnight concentration of 1µg/ml, the isolate was then placed in lower concentrations of 0.1µg/ml and 0.01µg/ml until growth was observed. This will help to evaluate the susceptibility of the bacteria to the antibiotic.

After all growth curves were obtained, they were then used to compare the relative growth of each culture. This gives an indication of the bacteria's ability to develop resistance after prior exposure to vancomycin. This data was then analyzed using the Kruskal-Wallis test and conclusions of the ability to develop resistance were made.

Results

The normal growth curve for this strain of *S. aureus* was obtained and is represented by Figure 1. The mean and standard deviation for the growth of this strain was determined using the growth of three similar, untreated cultures. The SD was found to be 0.002 and the mean slope of the log phase of growth was determined to be $0.0196 \pm \text{SD}$.

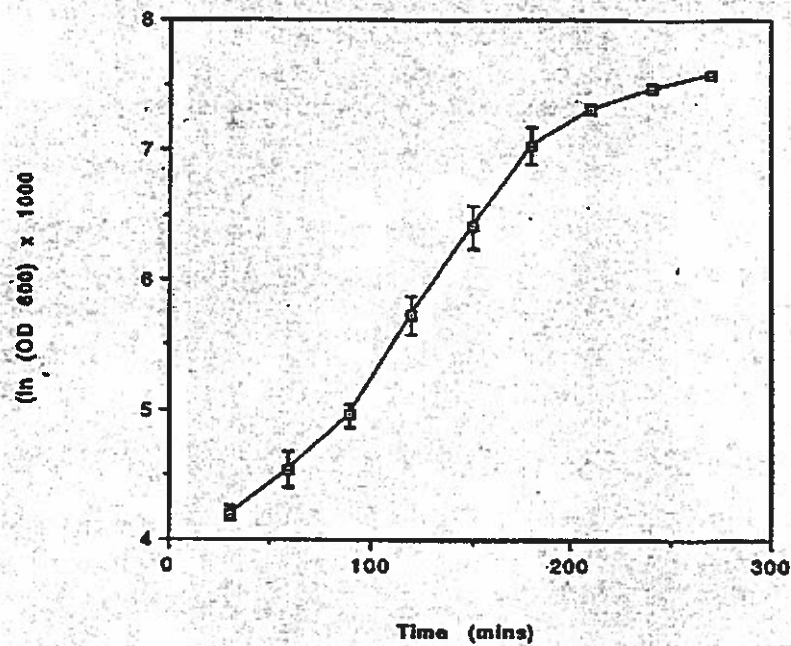
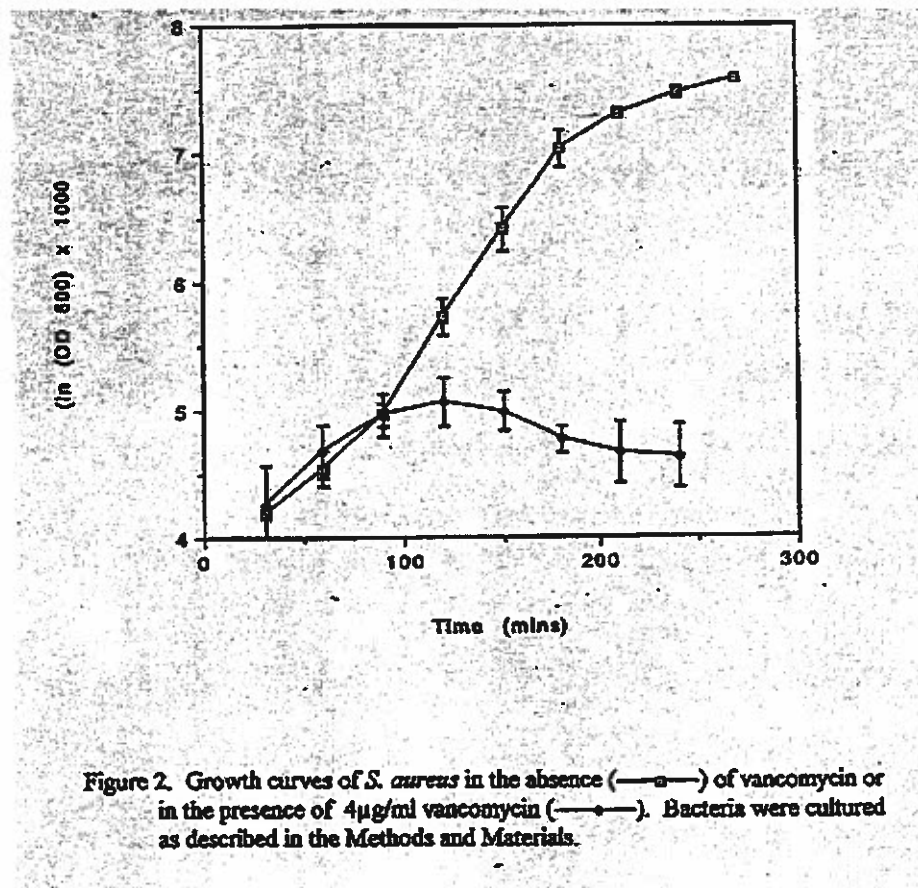


Figure 1. Growth curve of *S. aureus* in the absence of vancomycin. The organism was grown as described in the Methods and Materials.

An overnight culture was prepared and used to inoculate media containing a concentration of 4 $\mu\text{g/ml}$ (MIC for vancomycin in *S. aureus*) vancomycin (Milewski et al, 1996). Figure 2 represents the growth rate of this culture which demonstrates that this strain is unable to grow in the presence of 4 $\mu\text{g/ml}$ vancomycin.



To test for the ability of this strain to develop resistance following low dose exposure to the antibiotic, an overnight culture was to be started in culture media plus 1 $\mu\text{g/ml}$ vancomycin. However, repeated attempts to culture the bacteria at this concentration of vancomycin failed, even though growth was plentiful in media without

antibiotic. Having obtained this information, an overnight culture containing 0.1 $\mu\text{g/ml}$ was tried and no growth was observed.

These attempts at obtaining overnight cultures having failed, an overnight culture containing 0.01 $\mu\text{g/ml}$ vancomycin was found to have growth the following day. This culture was then used to inoculate media containing concentration of 5 $\mu\text{g/ml}$ of vancomycin. No growth was observed in these cultures. Therefore an overnight culture grown in 0.01 $\mu\text{g/ml}$ vancomycin was used to inoculate cultures containing 1.0 and 0.1 $\mu\text{g/ml}$ vancomycin. Growth was only observed in the media containing 0.1 $\mu\text{g/ml}$ vancomycin. The growth rate of this culture is illustrated in Figure 3.

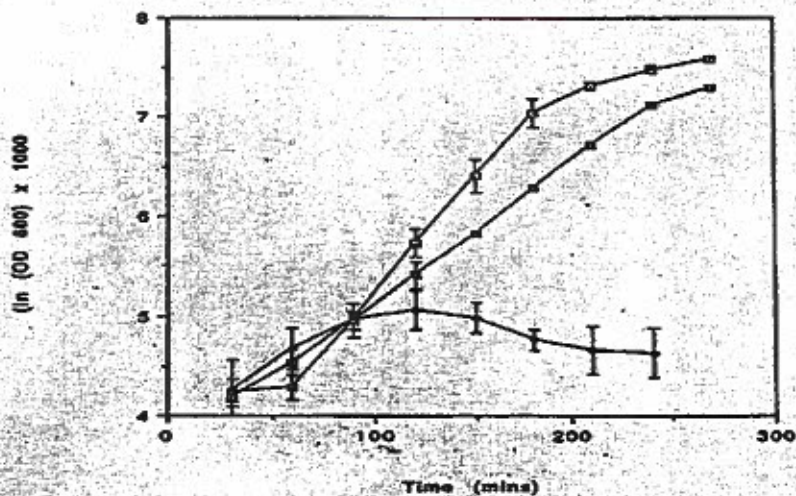


Figure 3. Growth curves of *S. aureus* in the absence (—) of vancomycin, in the presence of 4 $\mu\text{g/ml}$ vancomycin (---), or *S. aureus* exposed to 0.01 $\mu\text{g/ml}$ vancomycin, then cultured in 0.1 $\mu\text{g/ml}$ vancomycin (—). Bacteria were cultured as described in the Methods and Materials.

In comparing the normal growth rate of this culture to that of the cultures grown at 4 μ g/ml vancomycin and those grown with a low dose prior exposure to vancomycin, a Levene's statistical test was performed on the data and found to have a value of 12.49 with $p < 0.024$. This shows that a non-parametric test such as the Kruskal-Wallis test is needed to evaluate these data. It was determined by the Kruskal-Wallis test for independent samples that these growth rates statistically differ from one another ($H = 3.86$, $p < 0.05$).

Discussion

When bacterial cells develop the ability to grow in the presence of a concentration of antibiotic which is at or greater than the MIC for that bacteria, it has developed resistance. As stated, there are a number of ways that bacteria can accomplish this. Once the bacteria become resistant it is of great importance that the method by which it becomes resistant is elucidated and an alternate remedy for the infections of these bacteria are found. Research to find new and improved antibiotics is of utmost importance if the medical world is to stay on top of organisms like *Staphylococcus aureus* that evolve to resist numerous antibiotics so rapidly.

A non-clinical isolate of *S. aureus* was tested for a subpopulation of naturally occurring vancomycin resistant bacteria and also for the ability to develop resistance as a result of prior low dose exposure to vancomycin. This culture was originally isolated from a human lesion, deposited in the American Type Culture Collection, and has been used as a reference strain since 1922. This isolate was then obtained by Presque Isle where four passages of the culture were made prior to obtaining the isolate. During the course of the experiment, three more passages were made.

By using this strain there was no observed evidence for an existing subpopulation of vancomycin resistant *S. aureus*. This may be due to the time period in which this strain was isolated. In 1922 bacterial antibiotic resistance was virtually unheard of, as antibiotics were not in widespread clinical use. Antibiotics were not introduced for public use until the 1940's and the first signs of resistant bacteria were not observed until the 1950's (Ho et al, 1998). Therefore, this strain was probably not exposed to antibiotics and has no biased subpopulation of organisms harboring resistance.

As demonstrated in Figure 2, when exposed to 4 $\mu\text{g/ml}$ vancomycin, the MIC of vancomycin for *S. aureus*, this isolate is unable to grow. It is not until the organism is placed in vancomycin concentrations well below the MIC (0.01 $\mu\text{g/ml}$), that growth of the organism is observed. Interestingly, the 0.01 $\mu\text{g/ml}$ overnight low dose prior exposure to vancomycin did allow for growth at 0.1 $\mu\text{g/ml}$ (Figure 3). This may suggest a propensity for the organism to develop resistance to an antibiotic with repeated low dose exposures.

The exact mechanism for the development of vancomycin-resistance in *S. aureus* is currently in the process of being investigated. Recent research suggests that this is not the result of a "glycopeptide resistance phenotype" (Sieradzki et al., 1997). However, some of these authors suggest that the mechanism is an alteration of the cell wall structure.

Our study suggests that low dose prior exposure to vancomycin may be necessary for development of resistance to vancomycin by this isolate of *S. aureus*. However, the data in this study are very preliminary and have been performed with few replicates. Each experiment was performed in triplicate, which may not be a large enough sample size for accurate comparison.

By using the 1922 isolate and growing the isolate with low dose exposures of vancomycin and slowly increasing the concentration of vancomycin over time, one could theoretically observe changes in the cell wall structure of *S. aureus* in response to vancomycin over time. One reason that the more recent strains may be able to resist higher concentrations of vancomycin is that prior exposure and subsequent resistance to other antibiotics may have afforded the necessary cell wall alterations for tolerance to

higher doses of vancomycin. *S. aureus* has been found to have developed vancomycin resistance only recently and therefore, an isolate that is fairly new could be better suited for a research project in determining the current existence of a naturally occurring resistant subpopulation. For example, some isolates of *S. aureus* have been found to grow in the presence of 6 to 12 $\mu\text{g/ml}$ vancomycin (Sieradzki et al., 1997).

Further research is necessary to help scientists understand the mechanisms by which resistant bacteria develop. It is very important that we stay ahead of these resistant bacteria, if we hope to stay in control of these deadly organisms.

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Leaving Domestic Violence 1

LEAVING DOMESTIC VIOLENCE:
EXPLORING SELF CONCEPT AS A PART OF THE PROCESS

Evangeline Miller Reed

Submitted for 1998-1999 McNair Scholar Research Program
Concord College

Mentor: Judy C. Smith

Leaving Domestic Violence 2

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ABSTRACT

This study examined the process of leaving abusive relationships. Self concept was introduced as the measure. Women who entered a domestic violence shelter in West Virginia were asked to relate their personal experience in terms of self esteem, decision making and attitude on a twenty statement survey. Fifty-two women responded to the survey instrument. The results, some interpretations, and implications for further research are discussed.

INTRODUCTION

Women who are continuously involved in abusive relationships experience a wide range of psychological changes. One of those changes, the decision to leave, embraces one of the most vital steps a woman can encounter during the course of the relationship. Between 1992 and 1996 an estimated 800,000 female victims of intimate violence received assistance from a victim service agency shortly after the crime (National Crime Victimization Survey, 1992-1996). Of this estimated number, only 1 in 6 actually made the decision to leave their abuser. In West Virginia, a domestic homicide occurs every 14 days; one out of every three murders in the state is related to domestic violence ("Crime in West Virginia," Uniform Crime Reports, WV Department of Public Safety, 1997). Many survivors of domestic violence state that how others perceived them and how they perceived themselves had a great influence on what decisions they made. According to a national survey, 3.5 % of female victims of intimate violence reported that the incident of violence was not important enough for them to seek assistance (National Crime Victimization Survey, 1992-96). This finding says a great deal about the patterns

involved in leaving abusive relationships. Could low-self esteem and attitude hinder this process? Literature concerning how women leave abusive situations has not been reviewed to the extent that a knowledge base exists. However the research available has implied that leaving is a major component to the recovery process.

This current study proposes to examine the psychological responses of women who leave abusive situations and if their own self-concept is related to that process. A model of entrapment in and recovery from an abusive relationship will be used as a guideline, while the third phase of this model, disengaging, will be used as the catalyst for change. To gather the relevant information necessary, 13 domestic violence shelters across West Virginia will be targeted for survey. The survey will be administered by staff to victims on a voluntary basis only. Questions are designed to encourage responses from women that will clearly expose their perceptions of leaving. Precisely, the study hopes to evaluate self concept as the point of reference in the disengagement phase, which is an integral part of the leaving process. The shelters in West Virginia were chosen based on the number of women who utilize them and the extent to which critical data could be obtained.

By examining particular responses of women in West

Virginia, it is expected that the exploration will reveal significant factors that play a role in leaving abuse. Another objective of this study is to explore the value of assistance that women receive and the importance given to the leaving process.

SIGNIFICANCE OF STUDY

As an abusive relationship advances, barriers such as fear, social isolation, and negative self-image are increasingly reinforced. The cycle of violence will continue until the victim either leaves or loses her life. It has been observed that women change their self-concept as part of their process of leaving (Ferraro & Johnson, 1983). Therefore, it seems appropriate to examine the understanding that women have concerning leaving the abuse.

LIMITATIONS OF STUDY

This study is limited to residents who enter a domestic violence shelter in West Virginia. The length of time that surveys will be available is contained to 2 months,

therefore, simple random sampling is the method for collection. The survey was designed by the researcher and the parameters are subjective to personal perceptions.

DEFINITION OF TERMS

1. "Domestic violence" or "abuse": Attempting to cause or intentionally, knowingly or recklessly causing physical, threatening, psychological, or sexual harm to another with or without dangerous or deadly weapons. In addition to the above, any attempt to control, manipulate or demean another using sexual, physical or emotional tactics.

2. "Self-esteem": To admire or approve one's own self-worth, while accepting or feeling accepted by others without jeopardizing the value of one's own beliefs.

3. "Disengagement": To disconnect, detach or release from abusive or hurtful situations. To separate, even disassociate self.

REVIEW OF RELATED LITERATURE

Domestic violence has long been a complex phenomenon in society. Abuse can be considered as any "attempt to control, manipulate, or demean another individual using physical, emotional, or sexual tactics" (Wilson, 1997). Domestic violence does not discriminate, but evidence shows that "women are the recipients of physical and sexual abuse at least 10 times more frequently than are men" (United States Department of Commerce Statistics, 1989). The present study will examine the psychological responses of women in the leaving process and relate those responses to women who stay in domestic violence shelters in West Virginia. The majority of research available on domestic violence concerns itself with preventive measures and why women stay in abusive relationships. Very little is known about how women are able to leave the abuse, let alone their responses to leaving. Previous research on the leaving process focuses on the general population of women who have either left or attempted to leave an abusive relationship. The research says many different patterns exist and women who consider leaving the abuse clearly change according to their level of awareness surrounding their particular circumstances. In the late 1980's, it was documented that women may leave and go

back to the relationship many times. "Women's leaving patterns have been observed to look similar to wave-like excursions in and out of the relationship" (Limandri, 1987). The goal of this study is to specify whether or not changes in self-concept are associated with leaving abusive situations. In a study done by Ulrich, it was determined that "many women report leaving as a result of personal growth" (Ulrich, 1991).

In order to justify how important the self-concept is to the leaving process, it is necessary to characterize just how women assume their role in abusive situations. Confirmed by previous research, many people take to different realities when encountered with dangerous or unrestrained relations. In a 1996 study, Forte found that "long-term involvement in hostilities severely challenges the sense of self of soldiers, police officers, slaves, prisoners of war, and battered women" (Forte et al., 1996, p. 70). With this in mind, one can assume that perceptions stemming from self-defeat can be generalized to the larger population.

Several studies have attempted to explain the association of self-concept and leaving abuse. In one study, "the application of Gilligan's self-in-relationship framework was used to help understand the extrication process that women go through in terms of the disappearance and then reconstruction of self" (Ulrich, 1989).

For another researcher, " a gradual awareness of victimization may and can lead women to experience feelings of anger that act as a catalyst to remove them from the relationship" (Ferraro & Johnson, 1983). Another study says that the nature of being a victim is nurtured by societal roles rather than a women's psychological makeup. This means that "leaving is a series of restructured coping skills. These levels are experienced as women enter a violent relationship, manage the violence, experience a loss of self, re-evaluate the relationship as violent, and leave" (Mills, 1985). A similar view is that the abuse has some meaning to the women. The report says that "women's selves emerge and re-emerge throughout their recovery" (Landenburger, 1989). Altogether these studies are significant in describing change as the primary factor in leaving abuse. For this study, the process of entrapment in and recovering from an abusive relationship modeled by Karen M. Landenburger, will be examined.

Model of a Process of Entrapment in and Recovery From an Abusive Relationship

A. The Four Stages

1. Binding
2. Enduring
3. Disengaging
4. Recovering

The four stages identified present a process of entrapment in and recovering from an abusive relationship as researched in 1988 and 1989. This study described the experience of abuse within a significant relationship and how women's choices were influenced by these relationships over time. Interviews were held with 30 women, results were analyzed using constant comparative methods, and the model was based on women who were in and out of abusive relationships. The study also included women who had recently left abusive situations. Briefly, the binding phase is where initial relationships are formed and efforts to have a positive relationship lie with pleasing the other partner. Second, the enduring phase is where the woman feels responsible for the abuse, uses "covering up" tactics, and experiences great fear for herself while placing an elevated value on the relationship. Third, the disengaging phase represents the time that a woman begins to recognize other women like herself and how her relationship is defined by the abuse. Also she may seek help from those who are supportive of her rather than those who tend to question and blame her. She begins to struggle with what is more important, being loyal to her partner or to herself. This conflict is met with great turmoil and makes lasting impressions on one's self-esteem. Throughout this phase the "self" re-emerges time and time again and the woman becomes

overwhelmed. Lastly, the recovering phase is where she reorganizes her survival habits. She is connected to support and negotiates with herself her perceptions, feelings, and choices. If she has not left the abuse, she may prepare to do so and at some point extinguish the relationship.

To help initialize an understanding of the self-concept in the leaving process, the disengagement phase was chosen as the initiating factor. As explained by Landenburger, this phase is where psychological change is evident. Even though these stages intertwine themselves continually, this is where women experience some of their greatest fears. Not only is the abuse at heightened levels, the woman begins to deal with her own emotional reality, making way for change. Landenburger states that a "woman may have alternate views of herself. She may see her *self* as a qualified and successful person, but may also see herself as worthless because she perceives her *self* as unable to fulfill her role as a partner. Also, regaining positive images of *self* is a process just as the declining sense of *self* was a process" (Landenburger, 1989). Another related aspect is that if the abuse is no longer validated, realities may diminish to the point that a woman looks within herself for solutions and comfort. Furthermore, as attitudes change so does the concept of worth and importance.

METHODOLOGY

Participants

Women who utilized a domestic violence shelter in the state of West Virginia from June 1999 to July 1999 were canvassed as potential respondents on a volunteer basis. The participants were asked to only reply if they had been in the shelter for at least 48 hours.

Measure

A twenty statement survey was constructed by the researcher with five questions relating to respondent characteristics. Six items referred to self-concept, three items to decision making, and six items to attitude and behavior style. The questionnaire was tested for reliability using a pilot survey administered to eleven randomly selected subjects. The questionnaire was constructed in Likert format with a five point scale ranging from strongly agree to strongly disagree (see Appendix).

Procedure

The director of each registered shelter was contacted by telephone for prior approval. Ten of the thirteen shelters agreed to participate and nine responded by

returning the surveys in a provided postage-paid envelope. Fifty two women responded out of one hundred nineteen surveys sent. Thirty one of the fifty five counties in West Virginia were represented by the nine shelters.

DATA ANALYSIS

Upon completion and collection of the questionnaires, the data was entered into The Statistical Package for Social Sciences (SPSS) for Windows to tabulate frequencies. Percentages were analyzed with regard to self-concept, decision making characteristics, and attitude. Survey results suggest that the respondents have a healthy self-concept. Thirty-three percent agree and twenty-eight percent strongly agree that they feel positive about themselves and their lives.

SELF CONCEPT

Strongly agree	28%
Agree	33%
Undecided	17%
Disagree	13%
Strongly disagree	8%

Questions 6,10,11,12,19, and 20 represent self-concept (see Appendix).

DECISION MAKING CHARACTERISTICS

Strongly agree	18%
Agree	37%
Undecided	21%
Disagree	14%
Strongly disagree	8%

Questions 7,8, and 9 were used to gather responses that expose decision making abilities. A total of fifty-five percent were confident that they made their own choices. Further analysis showed that one-fourth of the respondents were undecided on their potential to make decisions independently.

ATTITUDE/BEHAVIOR STYLE

Strongly agree	41%
Agree	33%
Undecided	9%
Disagree	12%
Strongly disagree	3%

One objective of the study was to relate women's attitudes in reference to self-concept. Seventy-four percent strongly agreed and agreed that their attitude was important to them. It was also reported that twelve percent had opposing views. Questions 13,14,15,16,17, and 18 were used

to solicit attitudes on feelings, other people, and change (see Appendix).

Cultural dimensions were significant in that over eighty percent were of Caucasian heritage.

Asian/Pacific Islander	Black/African American	White Caucasian	Native American	Other	Missing
0%	8%	83%	2%	5%	2%

Other useful findings include prior shelter utilization, and application of counseling services during respondents stay in a shelter. Questions 4 and 5 solicited responses for current and future use. Results show that seventy-one percent (cumulative), have used a domestic violence shelter before and would again if necessary. The highest represented age is between twenty-five and thirty-four. A noted eighty-two percent who were receiving counseling services at the time said they planned to take advantage of those services after leaving the shelter.

DISCUSSION

It can be determined that women who leave abusive situations do in fact maintain some level of self esteem. Whether it be positive or negative, is of value to them alone and cannot be judged as unimportant. The results of

the survey show that women who utilized shelter services in West Virginia have an understanding of the leaving process. The study revealed self-concept as a recognizable factor for women and that they agree on the influence it has in their lives. The results also suggest that these women have a strong desire to make decisions with assistance. However, an equally important concern is the number of those who were undecided on their ability to make decisions. Additionally, the women identified themselves as having a deserving attitude towards others and change. One key factor is the anticipation these women held with regard to future services. This assumption favors awareness and understanding of the complexity of domestic violence and self-concept.

CONCLUSIONS

Leaving domestic violence should be theorized as a process that stands apart from the violence itself. Maybe with the expansion of programs and education that focus on individual empowerment, women can use their strengths to survive and eventually leave the abuse. Finally, with the understanding that leaving an abusive situation involves a change in attitude, the helping profession can begin to incorporate self esteem as a primary component to the development of safe and healthy relationship.

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APPENDIX

SURVEY OF THE LEAVING PROCESS: WEST VIRGINIA DOMESTIC
VIOLENCE SHELTERS

PLEASE CIRCLE ONLY ONE RESPONSE

1. What is your age?
18-24 25-34 35-44 45-54 55-64 65 and over

2. What is your ethnic background?
Asian/Pacific Islander Black/African American White/Caucasian
Native American Other

3. Have you ever used a domestic violence shelter before?
yes no

4. Have you received counseling services before?
yes no

5. Do you plan to seek counseling services in the future?
yes no

6. Today is a better day than yesterday.
strongly agree agree undecided disagree strongly disagree

7. I tend to make good decisions.
strongly agree agree undecided disagree strongly disagree

8. I direct my own life and actions.
strongly agree agree undecided disagree strongly disagree

9. I usually follow the advice of others.
strongly agree agree undecided disagree strongly disagree

10. I have confidence in myself.
strongly agree agree undecided disagree strongly disagree

11. I do not care what others think of me.
strongly agree agree undecided disagree strongly disagree
12. I often feel as though I am trapped.
strongly agree agree undecided disagree strongly disagree
13. It is wrong to hurt others.
strongly agree agree undecided disagree strongly disagree
14. No one understands how I feel.
strongly agree agree undecided disagree strongly disagree
15. I deserve a better life.
strongly agree agree undecided disagree strongly disagree
16. Sometimes I am mean to myself.
strongly agree agree undecided disagree strongly disagree
17. I am ready for a change.
strongly agree agree undecided disagree strongly disagree
18. I feel that I have support.
strongly agree agree undecided disagree strongly disagree
19. I feel good about who I am.
strongly agree agree undecided disagree strongly disagree
20. My life is important to me.
strongly agree agree undecided disagree strongly disagree

Statistics

	N	
	Valid	Missing
AGE age	5	1
ETHNIC ethnic	6	0
USAGE prior useage	6	0
SERVICE prior service	6	0
FUTURE future	6	0
BETTERDY better day	5	1
DECISION decisions	6	0
DIRECT direct own life	6	0
ADVICE follow advice	6	0
CONFIDEN confidence	5	1
OTHERS others think of me	6	0
TRAPPED feel trapped	6	0
HURT wrong to hurt others	6	0
FEEL feel	5	1
DESERVE deserve better life	6	0
MEAN mean to self	6	0
CHANGE change	6	0
SUPPORT support	6	0
GOOD feel good about self	6	0
LIFE life important	6	0

AGE age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	11	1	16.7	20.0	20.0
	14	1	16.7	20.0	40.0
	18	1	16.7	20.0	60.0
	2	1	16.7	20.0	80.0
	7	1	16.7	20.0	100.0
	Total	5	83.3	100.0	
Missing	999	1	16.7		
	Total	1	16.7		
Total		6	100.0		

ETHNIC ethnic

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	16.7	16.7	16.7
	1	2	33.3	33.3	50.0
	3	1	16.7	16.7	66.7
	4	1	16.7	16.7	83.3
	43	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

USEAGE prior usage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		3	50.0	50.0	50.0
	0	1	16.7	16.7	66.7
	25	1	16.7	16.7	83.3
	27	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

SERVICE prior service

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		3	50.0	50.0	50.0
	0	1	16.7	16.7	66.7
	14	1	16.7	16.7	83.3
	38	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

FUTURE future

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	50.0	50.0	50.0
2	1	16.7	16.7	66.7
3	1	16.7	16.7	83.3
47	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

BETTERDY better day

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	16.7	20.0	20.0
15	1	16.7	20.0	40.0
2	2	33.3	40.0	80.0
23	1	16.7	20.0	100.0
Total	5	83.3	100.0	
Missing	9	16.7		
Total	1	16.7		
Total	6	100.0		

DECISION decisions

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	16.7	16.7	16.7
10	1	16.7	16.7	33.3
11	1	16.7	16.7	50.0
23	1	16.7	16.7	66.7
3	1	16.7	16.7	83.3
5	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

DIRECT direct own life

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16	16.7	16.7	16.7
1	1	16.7	16.7	33.3
18	1	16.7	16.7	50.0
3	1	16.7	16.7	66.7
7	2	33.3	33.3	100.0
Total	6	100.0	100.0	
Total	6	100.0		

ADVICE follow advice

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	16.7	16.7	16.7
	13	1	16.7	16.7	33.3
	15	1	16.7	16.7	50.0
	17	1	16.7	16.7	66.7
	2	1	16.7	16.7	83.3
	4	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

CONFIDEN confidence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	16.7	20.0	20.0
	16	1	16.7	20.0	40.0
	18	1	16.7	20.0	60.0
	2	1	16.7	20.0	80.0
	7	1	16.7	20.0	100.0
	Total	5	83.3	100.0	
Missing	9	1	16.7		
	Total	1	16.7		
Total		6	100.0		

OTHERS others think of me

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	16.7	16.7	16.7
	11	1	16.7	16.7	33.3
	13	1	16.7	16.7	50.0
	19	1	16.7	16.7	66.7
	3	1	16.7	16.7	83.3
	6	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

TRAPPED feel trapped

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	1	16.7	16.7	16.7
10	1	16.7	16.7	33.3
11	1	16.7	16.7	50.0
22	1	16.7	16.7	66.7
4	1	16.7	16.7	83.3
5	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

HURT wrong to hurt others

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	2	33.3	33.3	33.3
1	1	16.7	16.7	50.0
2	1	16.7	16.7	66.7
42	1	16.7	16.7	83.3
7	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

FEEL feel

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	1	16.7	20.0	20.0
16	1	16.7	20.0	40.0
17	1	16.7	20.0	60.0
2	1	16.7	20.0	80.0
8	1	16.7	20.0	100.0
Total	5	83.3	100.0	
Missing 9	1	16.7		
Total	1	16.7		
Total	6	100.0		

DESERVE deserve better life

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	2	33.3	33.3	33.3
18	1	16.7	16.7	50.0
2	1	16.7	16.7	66.7
28	1	16.7	16.7	83.3
4	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

MEAN mean to self

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	1	16.7	16.7	16.7
15	1	16.7	16.7	33.3
22	1	16.7	16.7	50.0
4	2	33.3	33.3	83.3
6	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

CHANGE change

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	1	16.7	16.7	16.7
1	1	16.7	16.7	33.3
15	1	16.7	16.7	50.0
2	1	16.7	16.7	66.7
27	1	16.7	16.7	83.3
7	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

SUPPORT support

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	2	33.3	33.3	33.3
1	1	16.7	16.7	50.0
18	1	16.7	16.7	66.7
29	1	16.7	16.7	83.3
4	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

GOOD feel good about self

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	1	16.7	16.7	16.7
11	1	16.7	16.7	33.3
12	1	16.7	16.7	50.0
15	1	16.7	16.7	66.7
5	1	16.7	16.7	83.3
7	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

LIFE life important

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	16.7	16.7	16.7
	1	2	33.3	33.3	50.0
	15	1	16.7	16.7	66.7
	30	1	16.7	16.7	83.3
	5	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

