ABSTRACT

RODERICK L. BOYCE: Investigation of an Outbreak of Methicillin-Resistant *Staphylococcus aureus* Among United States Marine Corps Recruits During Basic Training
(Under the direction of Dr. Louise M. Ball)

An increase in community–acquired (CA) methicillin-resistant *Staphylococcus aureus* (MRSA) infections among graduating Marine Corps recruits prompted this investigation by the Navy Environmental Preventive Medicine Unit Number Two (NEPMU-2).

The purpose of this investigation was to assess the prevalence of MRSA colonization among 367 recruits during their 12-week training period from March through June 2002. Prevalence was initially 4.1% upon entry to training. The anterior nasal mucosa of recruits was cultured upon their entry into recruit training and two subsequent samples were taken before and after a 56-hour training regimen required for all Marines prior to graduation, known as the crucible.

By using the data collected, statistical analysis was completed on the results to determine if colonization was impacted by recruit training and if there was a significant relationship between MRSA and the risk factors of age, sex, geographic location prior to recruit training, race, and hospitalization within the last twelve months.

To my wife and best friend, Devetta, who has supported me throughout our marriage and especially this past year during my pursuit of a graduate degree.

To my children, Nissan, Spencer, and Makayla, all my love.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ATCC | American Type Culture Collection |
| BN | battalion |
| c | columns |
| CA | community-acquired |
| CDC | Centers for Disease Control and Prevention, Atlanta, Georgia |
| CDR | Commander (US Navy) |
| $\chi^2$ | chi-squared |
| df | degrees of freedom |
| ESRI | Environmental Systems Research Institute, Inc. |
| Fe | iron |
| GIS | geographic information system |
| $H_0$ | null hypothesis |
| HIV | human immunodeficiency virus |
| $H_2O_2$ | hydrogen peroxide |
| IgG | immunoglobulin G |
| IPDI | in-processing drill instructor |
| ISMT | indoor simulated marksmanship trainer |
| LCDR | Lieutenant Commander (US Navy) |
| MCRD | Marine Corps Recruit Depot, Parris Island, South Carolina |
| MIC | minimal inhibitory concentration |
| ml | milliliter |
| µm | micrometer |

| | |
|---|---|
| MRSA | methicillin-resistant *Staphylococcus aureus* |
| NEHC | Navy Environmental Health Center, Portsmouth, Virginia |
| NEPMU-2 | Navy Environmental Preventive Medicine Unit Number Two, Norfolk, Virginia |
| PRP | penicillinase-resistant penicillins |
| PT | physical therapy |
| r | rows |
| RMR | recruit medical readiness |
| SSSS | staphylococcal scalded skin syndrome |
| TSB | trypticase soy broth |
| USS | United States Navy Ship |

# I. INTRODUCTION

## A. Purpose

The purpose of the outbreak investigation was to provide sufficient evidence that MRSA carriage increases during Marine recruit training and to determine whether an intervention strategy, such as antibiotic prophylaxis, is necessary during the basic recruit training process. If an intervention strategy is deemed necessary, NEPMU-2 will recommend a strategy to the appropriate medical department chain-of-command. Over a period of months in late 2001 and early 2002, a U.S. Navy physician from the Marine Corps Recruit Depot (MCRD) medical clinic, Parris Island, South Carolina noticed a growing number of community-acquired (CA) methicillin-resistant *Staphylococcus aureus* (MRSA) skin infections (see Figures 1.1 and 1.2). As a result, the Navy Environmental Preventive Medicine Unit Number Two (NEPMU-2), Norfolk, Virginia, was contacted to investigate the problem. Historically, MRSA infections mainly affect hospitalized and at risk populations. However, there are relatively few definitive reports on the risk factors for CA MRSA among healthy populations including Marine recruits and shipboard personnel. Available literature suggests that healthy people harbor MRSA in their anterior nares and certain environmental conditions can lead to transmission. Close quarters, sharing personal items, and poor hygiene may contribute to transmission and subsequent infection.

The frequency of MRSA cases discovered in Marine recruits at the Camp Lejeune School of Infantry, a training regimen that immediately follows basic recruit training, strongly suggests that colonization occurs during basic recruit training.

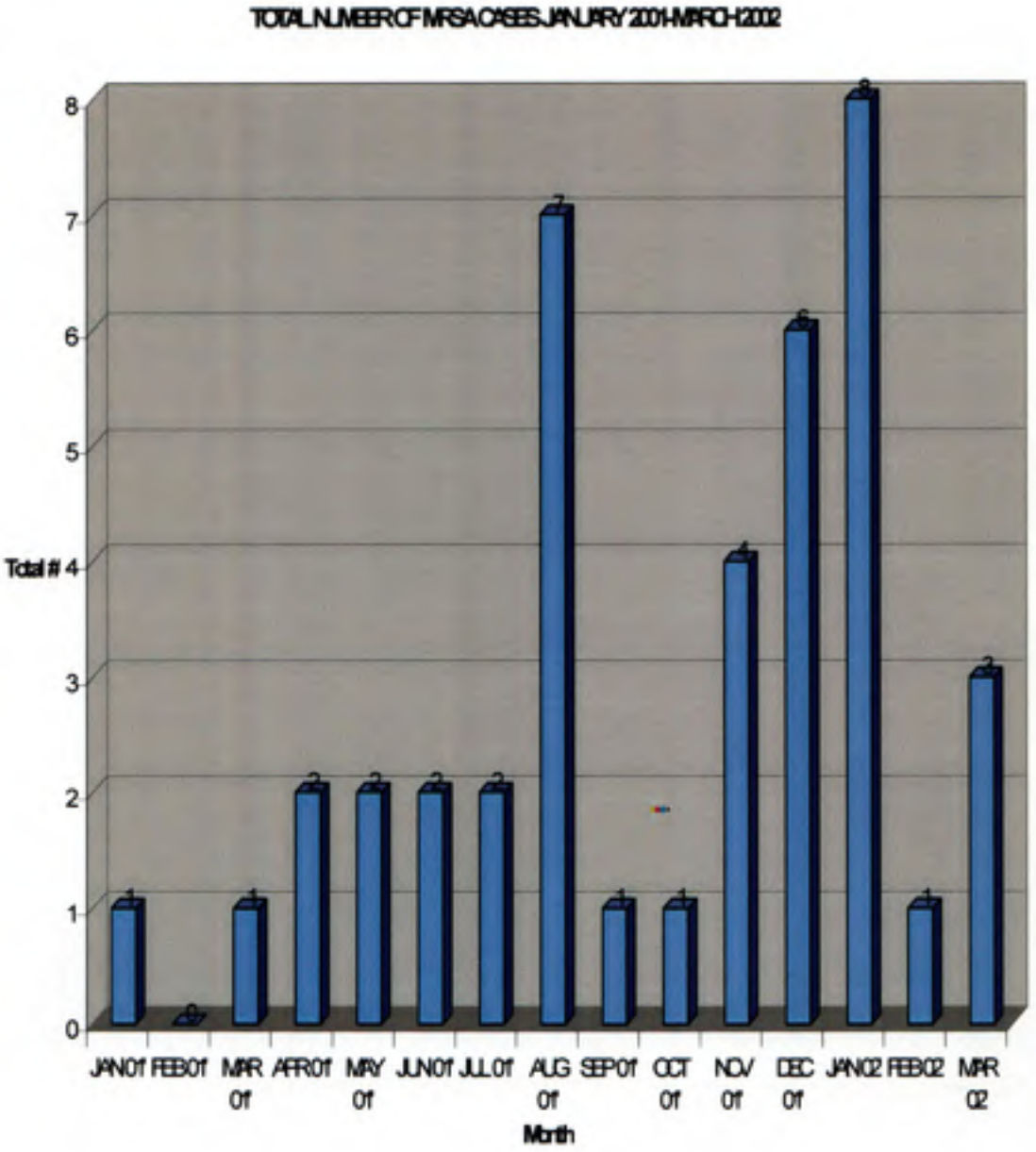
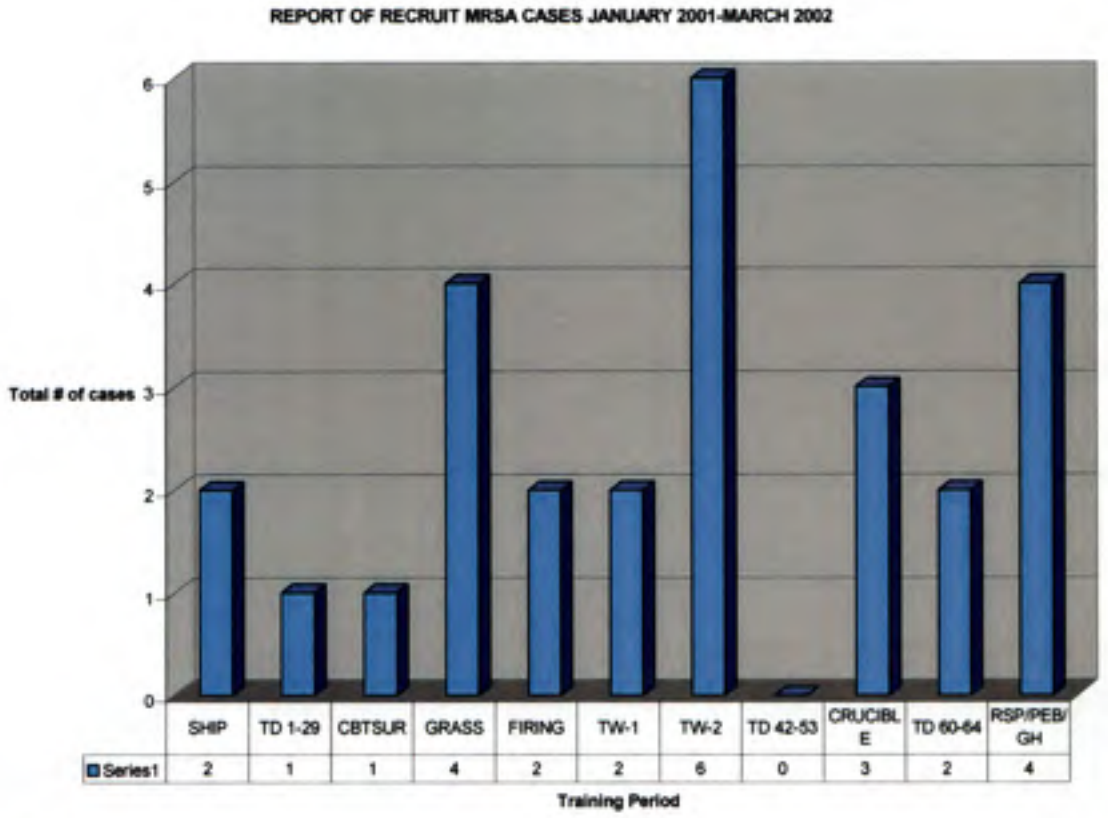



Figure 1.1 – MRSA Cases Reported by Beaufort Naval Hospital
(Hospital Records – Unpublished)




**LEGEND**
SHIP=ARRIVAL WEEK
TD=TRAINING DAY
CBTSUR=SWIM QUALS
GRASS=RIFLE RANGE WEEK #1
FIRING=RIFLE RANGE WEEK #2
TW=TEAM WEEK
RSP=RECRUIT SEPERATION PLATOON
GH=GRAD HOLD
PEB=PHYSICAL EVALUATION BOARD

Figure 1.2 – Recruit MRSA Cases Reported by MCRD Medical Clinic
(Hospital Records – Unpublished)

The decision to conduct an investigation on the outbreak of MRSA by NEPMU-2 was prompted by the request for assistance from the MCRD medical staff regarding the unusual number of CA MRSA skin infections, lost duty days of infected Marine recruits and the question of need for prophylaxis of recruits during basic training.

The first step in the investigation was to determine the existence of an outbreak of CA MRSA among recruits and recent graduates. This was accomplished by

confirming diagnoses through culture of suspected wounds, review of case reports from Camp LeJeune, and review of laboratory logbooks from Beaufort Naval Hospital. In crowded conditions, like those in a recruit training environment, MRSA colonization is known to contribute to infection. Consequently, for the purposes of the investigation, a case was defined as a MRSA positive culture, from either human or environmental samples. The investigation also included a questionnaire to assess background information and demographics, and the culturing of environmental surfaces in high use areas such as barracks, barbershops, and medical and training equipment.

## B. Background

Methicillin, a semi-synthetic, beta-lactamase resistant penicillin, was first introduced in 1959. Shortly after the introduction of methicillin, isolates of *Staphylococcus aureus* were reported to be resistant to this agent. The first reported outbreaks of MRSA infections occurred in Europe in the early 1960's. Since the onset of methicillin resistance, MRSA has become a major nosocomial pathogen, and more recently, a community-acquired pathogen.

The mechanism of resistance is the ability of *Staphylococccus aureus* to produce beta-lactamase, which can be encoded on plasmids or chromosomes. The hyper-production of beta-lactamase allows the organism to render beta-lactam antibiotics, like penicillin and methicillin, ineffective. The most scientifically accepted mechanism for resistance in MRSA is the production of an additional penicillin binding protein, found in the bacterial cell membrane, which prevents proper function of the antibiotic. (Eadon, 1991)

The distribution of MRSA is now global, and treatment of infections caused by MRSA has become increasingly difficult due to resistance of MRSA to other classes of antimicrobial agents. One of the biggest concerns surrounding the broadening resistance of MRSA is that intermediate susceptibility to vancomycin has been reported. This is an alarming trend given that vancomycin is currently the treatment of choice for most MRSA infections. (Benenson, 1995)

Currently, MRSA colonization of hospital patients and health care workers is common, which increases the likelihood of transmission among patients, especially in health care settings. This colonization increases the difficulty in establishing infection prevention measures and may ultimately contribute to the rise in community-acquired infections.

**1. Literature Review Summary**

Due to the nature of the outbreak investigation conducted by NEPMU-2 and the suspected source of colonization, the literature review of MRSA focused on the community-acquired rather than nosocomial studies. Five articles were reviewed and summarized in the following paragraphs.

"Population-Based Community Prevalence of Methicillin-Resistant Staphylococcus aureus in the Urban Poor of San Francisco," by Charlebois et al, was a study to determine the prevalence and risk factors for colonization with *Staphylococcus aureus* and methicillin resistance among an urban poor community in San Francisco. The sample included 833 homeless and marginally housed adults, and the results revealed 22.8% colonization with *Staphylococcus aureus*. The overall prevalence for MRSA was 2.8% and the risk factors identified in this study were intravenous drug use,

HIV antibody status, race, age, prior endocarditis, and hospitalization within the last year. A significant point of this study was that the risk factor of hospitalization within the previous year contributed to the CA MRSA transmission. The CA MRSA isolate differed from the clinical isolate and this difference may be attributed to the fact that the more drug resistant strains may be less likely to persist in the absence of the selective pressure of antibiotic exposure experience in the hospital setting. The most significant conclusion was that CA MRSA among healthy individuals without known risk factors is rare. (Charlebois et al, 2001) This will be important in the present investigation when the risk factors for colonization are analyzed.

"Methicillin-Resistant *Staphylococcal aureus* Evolution in Australia Over 35 Years," by Turnidge and Bell, was a retrospective study based on the theory that CA MRSA strains differ from hospital acquired MRSA strains and that CA MRSA was spreading throughout the country. In national prevalence studies by the Australian Group on Antimicrobial Resistance, evidence was presented that the prevalence of MRSA increased in each capital city of Australia from 1986-1998. The pathogen is now believed to have migrated and become endemic in all regions of Australia, with the aboriginal ethnic communities showing the largest prevalence rates. The significance of this study is the conclusion that MRSA now has a community reservoir in Australia and that MRSA will eventually establish itself as a major community pathogen with increased resistance to antimicrobial agents. (Turnige and Bell, 2000)

The article by Hunt et al, "Four Pediatric Deaths from Community-Acquired Methicillin-Resistant *Staphylococcus aureus* – Minnesota and North Dakota, 1997-1999," from the Morbidity and Mortality Weekly Report, published by the Centers for

Disease Control and Prevention (CDC), addressed investigated cases of four pediatric patients who acquired CA MRSA without possessing any of the established risk factors. All four of the pediatric cases were fatal due to their exposure to MRSA, the delayed use of antibiotics to which MRSA was susceptible, and organ-system damage that the organism caused. The significance of this report is that none of the cases involved patients with established risk factors (intravenous drug use, resident of long-term care facility, and previous hospitalization). Additionally, none of the patients' family members possessed any of the established risk factors. The authors noted that, although MRSA has been predominantly a nosocomial infection, community-acquired infections are seen in pediatric hospitals, day care centers, and among minorities in other countries. The significance of this article was that MRSA colonization may be spreading due to evidence of community-acquired MRSA isolates in people with no established risk factors. These four cases of CA MRSA demonstrate the potential severity of the infection, and the need for improved future surveillance of community-acquired infections. (Hunt et al, 1999)

The article by LaMar et al, "Sentinel Cases of Community-Acquired Methicillin-Resistant *Staphylococcus aureus* onboard a Naval Ship," addressed two cases of an outbreak of cutaneous CA MRSA onboard the USS Seattle. The article focused on the medical presentations of the two cases and the fact that the two patients had no known risk factors of MRSA colonization or infection. The authors illustrated three important aspects of care. First, the antimicrobial susceptibility testing of the two cases showed similar trends. Second, in addition to selected antibiotic therapy, incision and drainage of infections should augment pharmaceutical treatment. Last, prevention

and control of MRSA should target both medical staff and patients. The article concluded that additional studies are needed to assess prevalence and the ability for MRSA to spread within ships and other military units, which generally involve healthy adults with no known risk factors.

An article by Lindenmayer et al, "Methicillin-Resistant *Staphylococcus aureus* in a High School Wrestling Team and the Surrounding Community," was a case series and retrospective cohort study. The purpose of the study was to describe a community outbreak of MRSA and to investigate transmission and infection of MRSA in a Vermont high school wrestling team from 1993 to 1994. The outcome was measured by infection or colonization with MRSA of a wrestling team member during the period of the study. The local hospital and a health maintenance organization laboratory identified the MRSA positive infections. During the study, the authors were unable to establish any known risk factors from the wrestling team or the community, although seven of the 32 team members tested positive for MRSA (6 infected, 1 colonized). Conclusions were that MRSA was transmitted among the wrestling team, and infections that do not respond to standard antibiotic therapy among healthy participants of contact sports with boils should be suspected as MRSA.

## II. STAPHYLOCOCCUS AUREUS

*Staphylococcus aureus* is a gram-positive, catalase-positive, coagulase-positive cocci. The name *Staphylococcus* is derived from the Greek name, *staphylé*, which means "a bunch of grapes." (Murray, 1998) *Staphylococcus aureus* colonies appear with a golden color on complex media, with a size range of 0.5 to 2 μm, and can be arranged as single cells, irregular clusters, or pairs (see Figure 2.1). It is a common human pathogen and reported to be found in the anterior nasal mucosa of between 20% to 30% of the general population of the United States. (Benenson, 1995) It is the most common cause of acute pyogenic, or pus-forming, infections and accounts for 16% of all hospital-acquired infections. The exact percentage of community-acquired infections is unknown due to the relatively recent transmission of the organism throughout the community.

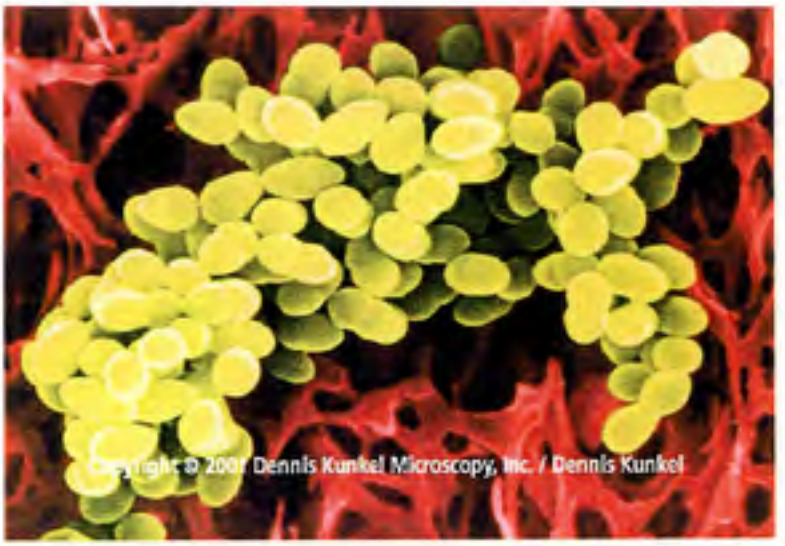



Figure 2.1 – Microscopic Photograph of MRSA

In 1880, *Staphylococcus aureus* was first identified as a cause of serious wound infections and septic shock. It was noted by historians that wound infections killed more soldiers than weapons used in combat prior to World War II. The change in number of infections after World War II was due to the introduction of antibiotics, most notably penicillin, which was used to eradicate the infection. (Salyers, 2002)

## A. EPIDEMIOLOGY

MRSA primarily affects hospital patients, and it is found in every country in the world. The reason for its global presence is that *Staphylococcus aureus* is a persistent member of microbial flora in 20% to 30% of the general population. (Benenson, 1995) The prevalence of MRSA varies drastically in different geographic regions of the country and world. Prior to the 1980's, medical treatment facilities in the United States reported very few MRSA infections brought into the facility from patients in the community. However, in the 1990's, medical treatment facilities reported an increase in MRSA infections in patients entering the hospital from the community. This trend of CA MRSA has continued and medical treatment facilities are now reporting that 30% to 58% of MRSA isolates are obtained from patients who were colonized prior to admission. (Crossley, 1997)

An important factor in the transmission of MRSA is the difference between infection and colonization, because a person can be colonized from several weeks to several months without ever becoming infected. Colonization is the presence of MRSA, in or on the body, commonly anterior nares, without causing illness. Infection is the presence of MRSA, in or on the body that causes illness. The reason for this important distinction is that MRSA can be spread from person-to-person, through

contact with inanimate objects, and via airborne droplets from a colonized person with an upper respiratory illness. In the hospital setting, three main reservoirs for MRSA are patients, health care workers, and the inanimate environment. (CDC, 2002)

The at-risk population for CA MRSA includes diabetic patients, individuals with chronic skin conditions, dialysis patients, intravenous drug users, and individuals with the human immunodeficiency virus (HIV). All of these groups show increased colonization, but studies have yet to reveal the reason for this increase. The community spread of MRSA appears to be related to previous hospital admission and some studies have shown transmission to family members and ultimately throughout the community via the primary transmission routes. Insufficient available data on healthy populations prevents an assessment of the impact on this group. (CDC, 2002)

## B. VIRULENCE FACTORS

*Staphylococcus aureus* is a well-adapted pathogen due to its ability to invade minor skin breaks or mucous membranes and to colonize rapidly, which ultimately protects the organism from the immune defenses of the host. It is efficient at developing antibiotic resistance quickly, transferring and receiving genetic information, and producing a wide range of toxins. These factors contribute to the virulence, which is its lethality and ability to survive extreme conditions, of MRSA and its ability to survive under extreme conditions. (Eadon et al, 1991)

### 1. Structural Components

The capsule of *Staphylococcus aureus* is a loose fitting, polysaccharide layer (slime layer) found on the exterior portion of the staphylococcal cell wall. The function of the capsule is to protect the bacteria by inhibiting chemotaxis and phagocytosis of the

organism by polymorphonuclear leukocytes. In addition, the capsule inhibits the proliferation of mononuclear cells after mitogen exposure, and facilitates the adherence of bacteria to synthetic material used in invasive surgical procedures.

Peptidoglycan is a major structural component of the staphylococcal cell wall. The layer is composed of peptide cross-linked glycan chains that are built with 10 to 12 alternating subunits of N-acetylmuramic and N-acetylglucosamine. The function of the peptidoglycan layer is to provide osmotic stability and stimulate production of endogenous pyrogen, which has an activity similar to an endotoxin. Additional functions include chemo-attraction of leukocytes, which is necessary in abscess formation, and the inhibition of phagocytosis.

The surface of most strains of *Staphylococcus aureus* is coated with protein A. This coating is distributed uniformly within the staphylococcal cell wall and covalently linked with the peptidoglycan layer. The function of protein A within the cell wall is to inhibit antibody-mediated clearance of the bacteria. Based on its covalent link to the peptidoglycan layer, protein A also functions as a leukocyte chemoattractant.

Teichoic acids are species-specific polymers, which contain phosphate and are also bound to the peptidoglycan layer of the cell wall. The function of teichoic acids is the regulation of cationic concentration at the cell membrane and binding to fibronectin, which mediates the attachment of the bacteria to mucosal surfaces. Due to species specificity, ribitol teichoic acid is only present in *Staphylococcus aureus*. This is important because it enables differentiation of *Staphylococcus aureus* from other staphylococcal species in the laboratory. Teichoic acids can stimulate an antibody

response through its binding to peptidoglycan, so this response can be used to detect the presence of staphylococcal disease.

Teichoic acids can also be bound to the cytoplasmic membrane through lipophilic linkage. The cytoplasmic membrane is the innermost layer of the staphylococcal cell wall. It consists of a complex of proteins, lipids and a minute amount of carbohydrates. Primary membrane functions are to provide an osmotic barrier for the bacteria, regulate all transport in and out of the cell, and provide the site for biosynthetic and respiratory enzymes. (Murray, 1998) Figure 2.2 illustrates the structural components of the staphylococcal cell wall.

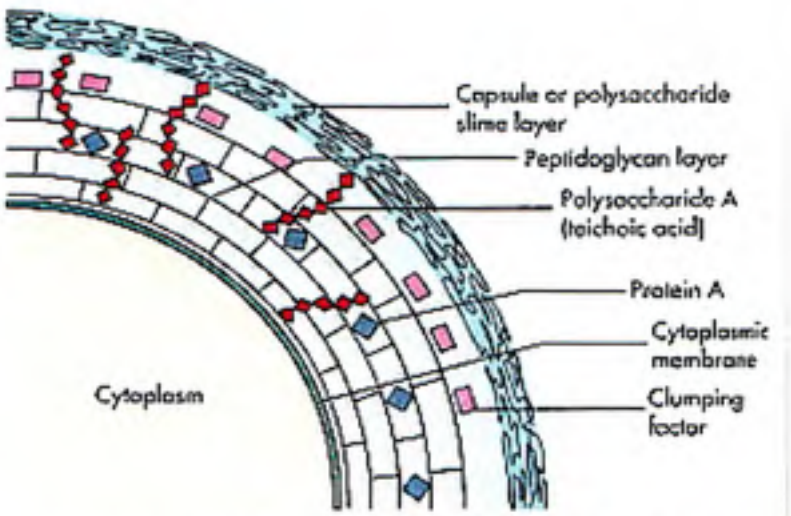



**FIGURE 22-2** Structure of staphylococcal cell wall.

Figure 2.2 – Structure of Staphylococcal Cell Wall (Murray, 1998)

## 2. Toxins

Four toxins produced by the bacteria contribute to its lethality. These toxins that are produced include cytotoxins, exfoliative toxins, toxic shock syndrome toxin-1, and enterotoxins.

Cytotoxins produced by *Staphylococcus aureus* consist of five different types, which are all cytolytic, or membrane damaging toxins. These types include alpha, beta, delta, gamma toxins, and leukocidin. Alpha toxins are responsible for disrupting the smooth muscle in blood vessels, and are toxic to hepatocytes, erythrocytes, and platelets. Beta toxins are responsible for tissue destruction and the abscess formation characteristic of staphylococcal diseases. Delta toxins are thermostable proteins that disrupt cellular membranes through a detergent-like action. Gamma toxins are responsible for the lysis of erythrocytes, but two separate proteins are required for the activation of the toxin. Leukocidin facilitates structural changes in the cell membrane, pore formation, and intensified permeability to cations. Staphylococcal species that produce leukocidin are usually resistant to phagocytosis from the host organism.

The exfoliative toxins that are produced by *Staphylococcus aureus* produce diseases of the skin, specifically the epidermis. The action of exfoliative toxins, which are serine proteases, includes splitting of the intracellular bridges in the stratum granulosum epidermis, a specialized layer of the skin. This toxin is responsible for staphylococcal scalded skin syndrome (SSSS).

Toxic shock syndrome toxin-1 is secreted during the growth of some isolates of *Staphylococcus aureus*. The toxin is responsible for causing toxic shock syndrome,

which produces a rash, fever, and hypotension. These symptoms are generally followed by desquamation and disruption in the function of multiple organ systems.

Enterotoxins consist of five serologically distinct toxins, which are classified as A through E. The importance of enterotoxins is that they are resistant to hydrolysis by gastric acids and jejunal, or intestinal, enzymes and they are able to survive temperatures up to 100° C for thirty minutes. The enterotoxins act through binding and activating mast cells, stimulating intestinal peristalsis and affecting the central nervous system, which is responsible for nausea and intense vomiting. (Murray, 1998)

**3. Enzymes**

There are seven different types of staphylococcal enzymes, which are coagulase, catalase, hyaluronidase, fibrinolysin, lipase, nuclease, and penicillinase. These enzymes are important in the virulence of *Staphylococcus aureus*. Coagulase is found in two forms in *Staphylococcus aureus*, which are the bound form (also known as the clumping factor) and the free form. The primary function of coagulase is to catalyze the conversion of fibrinogen to insoluble fibrin. This is important in forming a fibrin layer around a staphylococcal abscess and preventing phagocytosis by the host organism. Catalase is essential to the bacteria for catalyzing the conversion of hydrogen peroxide to oxygen and water. Hyaluronidase is essential for facilitating the spread of *Staphylococcus aureus* in tissues by hydrolyzing hyaluronic acids that are present in connective tissue. Fibrinolysin is utilized to dissolve fibrin clots and is present in most strains of *Staphylococcus aureus*. Lipases are essential for the survival of *Staphylococcus aureus* in the lipid-containing areas of the body, because they hydrolyze lipids. This enzyme is responsible for the formation of staphylococcal infections of

subcutaneous tissues and the skin. Nuclease is a thermostable enzyme with an unknown role in pathogenesis, but it is often used as a marker for *Staphylococcus aureus* in laboratory tests. When penicillin was introduced in the 1940's, most of the staphylococcal isolates were sensitive to the antibiotic. Shortly after the introduction of penicillin, staphylococcal isolates developed resistance to the antibiotic through production of penicillinase, or beta-lactamase. This type of resistance can be transferred to other *Staphylococcus aureus* organisms. (Murray, 1998)

## C. DISEASES

*Staphylococcus aureus* can cause numerous diseases and infections via production of toxins or by invasion and destruction of tissues. Most disease results from direct toxin activity, but skin infections and tissue damage result from invasion through broken skin. A foreign body, such as surgical instruments or clinical equipment, can introduce staphylococcal disease, but in much lower numbers. Additionally, people with depressed immune systems may be more susceptible to staphylococcal infection due to the body's inability to fight disease through normal chemotaxis or phagocytosis. Most commonly, *Staphylococcus aureus* causes three types of disease: toxin-mediated, cutaneous, and systemic.

### 1. Toxin-Mediated

Toxin-mediated staphylococcal disease includes scalded skin syndrome, impetigo, toxic shock syndrome, and food poisonings. Scalded skin syndrome was first discovered and described by Gottfried Ritter von Rittershain in 1878 in infant children. This syndrome is characterized by a sudden onset of perioral erythema, which is a redness and inflammation around the mouth. Blisters caused by the syndrome cover the

entire body within two days, and evidence of the blisters being caused by a toxin is based on the absence of organisms or leukocytes in the clear fluid. Impetigo is a form of scalded skin syndrome, except that the blisters and erythema that form localized disease do not extend beyond the boundary of the blisters. The significance of impetigo is that it is a highly communicable disease that can impact the transmission of *Staphylococcus aureus*. (Murray, 1998)

The first documented outbreak of toxic shock syndrome occurred in Australia in 1928 as a result of injection with a vaccine contaminated with *Staphylococcus aureus*. Rapidly multiplying *Staphylococcus aureus* organisms release toxin into the bloodstream characterize the disease. The resulting systemic disease is characterized by fever, rash, hypotension, and multi-organ system involvement.

Food-borne illnesses are commonly caused by staphylococcal intrusion into the food chain and are classified as intoxication instead of infection. This is due to toxin-related illness rather than illness caused by the actual organism. Symptoms of staphylococcal food poisonings include vomiting, diarrhea, and abdominal cramping. The significance of food-borne intoxication is that heating contaminated foods destroys the bacteria, but it does not inactivate the toxin.

**2. Cutaneous**

Cutaneous infections caused by *Staphylococcus aureus* include previously mentioned impetigo, folliculitis, furnucles, and carbuncles. Wound infections are also a result of contamination by the organism, and they generally originate from a surgical procedure or trauma. Folliculitis is an infection in the hair follicle characterized by pus forming beneath the epidermal surface, which is termed pyogenic. Furnucles are an

expanded version of folliculitis with large, painful nodules containing a collection of necrotic tissue. Carbuncles form when furuncles extend to deeper subcutaneous tissue, resulting in fever and chills due to systemic spread of the bacteria.

**3. Systemic**

Systemic infections are due to either staphylococcal toxins invading the bloodstream or aspiration of contaminated oral secretions. Common infections include bacteremia, endocarditis, pneumonia, osteomyelitis, and septic arthritis. Bacteremia, or seeding of the bloodstream, usually results from a skin infection or introduction of a contaminated catheter, and can proliferate to other parts of the body, including the heart. Symptoms of endocarditis involve influenza-type signs of illness, which can evolve into the disruption of cardiac output, and in some cases septic embolization. It is a very serious disease with a case fatality rate of fifty percent.

Respiratory diseases caused by *Staphylococcus aureus* can result from contamination of the bloodstream and distribution to the respiratory system or by aspiration of oral secretions that are contaminated with the organism. Pneumonia is characterized from radiographs that disclose abscesses, which are a result of the bacteria's ability to produce cytotoxins.

Osteomyelitis results from the dissemination of staphylococcal toxins from the bloodstream to bone. In some cases, the disease may result from a proliferation of disease from an adjacent area, such as the skin. Symptoms of osteomyelitis include a vascularized bony growth on long bones and high fever in children and intense back pain due to vertebral infection and fever in adults. A significant fact regarding osteomyelitis detection is that radiographic evidence of the disease does not become

apparent until three weeks following the onset of symptoms. Joints are affected in the form of septic arthritis, a disease that tends to attack people with mechanically abnormal joints. Painful joints, generally the large joints of the shoulder, knee and hip, and purulent discharges, characterize the disease. (Salyers, 2002)

## III. DATA COLLECTION

The data and all relevant information for this outbreak investigation was collected by a three-team group of two officers and one enlisted, which consisted of an physician epidemiologist, microbiologist, and preventive medicine technician from the Navy Environmental Preventive Unit Number Two, Norfolk, Virginia. Funding for the investigation was provided by the Navy Environmental Health Center (NEHC), Portsmouth, Virginia and MCRD Naval Medical Clinic, Parris Island, South Carolina. Table 3.1 exhibits the timeline for the outbreak investigation.

**Table 3.1**
**Timeline of MRSA Investigation**

| VISIT | DATES | NUMBER OF PERSONNEL | VISIT LENGTH (DAYS) | ACTIVITY DESCRIPTION |
|---|---|---|---|---|
| FIRST | 25-29 MAR 2002 | 3 | 5 | Facilities evaluation; procedural review; begin prevalence survey; initial swabbing of 2nd/4th Battalions; staff and environmental sampling. |
| SECOND | 03-06 JUN 2002 | 3 | 4 | Pre-Crucible 2nd/4th Battalion, staff, and environmental sampling. |
| THIRD | 11-13 JUN 2002 | 3 | 3 | Post-Crucible 2nd/4th Battalion, staff and environmental sampling; evaluation of need for further visits. |

## A. Investigation Design and Protocol

The purpose of this investigation was to address an outbreak of MRSA infections among Marine recruits and recent graduates by determining the prevalence of MRSA colonization during basic recruit training. The results of the investigation provide the foundation for intervention recommendations and baseline data for future comparisons. At risk personnel were identified as those individuals entering basic training at MCRD, Parris Island. Initial prevalence data were derived from sampling recruits upon entry into basic training. Two follow-up samples collected by the NEPMU-2 investigation team provided incidence rates of MRSA colonization during the training period. Risk factors considered in the investigation included age, sex, race or ethnicity, geographic location prior to basic training, hospitalization within the last twelve months, antibiotic use, sharing personal items, and current complaint of skin sores.

Prior to the investigation, a review of Beaufort Naval Hospital laboratory records confirmed a significant number of MRSA skin infections in MCRD recruits over the last year. After establishing an outbreak, NEPMU-2 personnel developed a plan to investigate the source of MRSA. Based on current literature support of MRSA colonization as an avenue for infection in crowded living conditions, determination of recruit colonization was chosen as the best method of investigation. For that reason, in this investigation a case is defined as a positive culture of MRSA from a human or environmental sample. Prior to collection of human samples, a member of the NEPMU-2 investigation team briefed the Marine recruits on the nature and purpose of the testing (see Figure 3.1). Time, place, and personal data were gathered from Marine

recruits using questionnaires (see Figure 3.2) developed by NEPMU-2 staff, which were utilized to access demographic, risk factor, and background information. In addition to nasal swab samples, environmental samples were collected from areas of high use during training because of the potential for MRSA transmission from environmental surfaces to humans. Recruit training staff and medical personnel in close contact with the recruits during their training were also cultured for MRSA colonization to assist in determining the source of colonization.

**Speech for MRSA Questionnaire**

Today we will be swabbing your noses looking for bacteria that can cause serious skin infections. Skin infections from this bacteria have increased among recruits over the last year. You can carry this bacteria in your nose and transmit it to others if the conditions are right. Conditions like close quarters, sharing personal items, lengthy exposure to heat and humidity, and not being able to shower.

In order for us to get a better idea of why there are more infections, we are testing each recruit at the start of training, before the crucible, and after the crucible. Your participation will help us figure out how to protect future recruits.

The questionnaire you are about to fill out will provide us with additional information important to our investigation. Please listen carefully to the following instructions:

1. Please put down an answer for each question. **DO NOT LEAVE ANY BLANKS.** If you leave blanks we will come back to you for an answer.
2. Please circle only one answer for race.
3. If you were hospitalized, meaning you were admitted to the hospital, please note the **MONTH, YEAR, and REASON** for hospitalization (this includes outpatient surgery).
4. Please write the **CITY and STATE** where you **spent the MAJORITY** of your time **BEFORE coming to Parris Island.**
5. Answer yes to #11 if you shower daily. Answer no to #11 if you cannot shower daily. If you cannot, please write how often you can shower.
6. If you have ever been told that you had an infection resistant to antibiotics or treatment, please circle yes for #13. **DO NOT answer yes if you are simply ALLERGIC to antibiotics.**
7. If you have had a resistant infection write down the **month and year** you had the infection.
8. For the last question, skin sores refer to things like boils, cellulites, impetigo, and infected bites or abrasions. **DO NOT CIRCLE YES for acne, cuts, scrapes, or bites that are not infected.**
9. **If you do not understand a question PLEASE ASK one of us.**

Figure 3.1 – NEPMU-2 Speech for MRSA Investigation

**MCRD Parris Island MRSA Investigation**

**Patient Information Questionnaire**

1. Name (last, first) _____ _____

2. SS# _____

3. Date _____

4. Age _____

5. Race: **Black** **Hispanic** **Asian** **American Indian**

**Caucasian** **Mixed** **Other**

6. List any medications you are taking _____

7. Were you hospitalized at any time over the last year (including outpatient surgery)?

**YES NO**

8. If you answered yes to number 7, why and when (month and year)?

_____

9. Where did you live for the last 6 months? _____

10. Have you shared any personal items with other recruits (e.g. tweezers, clippers, clothing, towels, sheets, or pillows)?

**YES NO**

11. Are you able to shower daily?

**YES NO**

12. If not, how often can you shower? _____

13. Have you ever been told you had an infection resistant to antibiotics (e.g. penicillin)?

**YES NO**

14. Do you have any skin sores?

**YES NO**

Figure 3.2 – NEPMU-2 MRSA Investigation Questionnaire

## B. Limitations

This paragraph explains the limitations of this outbreak investigation. The nature of the investigation does not require the use of a formal research protocol, but produces less valid statistical significance of the results. The dynamic nature of turnover of recruits within platoons from separation (administrative or medical) and set-backs in training generated gains and losses in the investigated platoons. Additional limitations of this investigation included possible ineffective collection procedures, initial positives testing negative in subsequent samples (sampling error), and a nonrandom sample population due to inability to sample entire recruit population.

## C. Equipment

Table 3.2 lists the equipment and supplies that were utilized by the NEPMU-2 investigation team for collecting human and environmental samples.

**Table 3.2**
**Equipment and Supplies**

| Supplies | Manufacturer | Unit | Number | Total |
|---|---|---|---|---|
| MRSA Screen Agar | Remel | Pack | 10/pack | 498 |
| Blood Agar Plates | Remel | Case | 100/case | 970 |
| TSB Media | Remel | Case | 100/case | 624 |
| Swabs | Remel | Pack | 100/pack | 500 |
| Gram Stain Set | Remel | Set | 1/set | 1 |
| Bacti-Staph Latex Agglutination | Remel | Kit | 150/kit | 4 |
| Oxacillin Disks | Fisher | Pack | 500/pack | 1 |
| Catalase 0.05 ml/ampule | Fisher | Pack | 50/pack | 1 |

## D. Procedures

Data, which included background, risk factor, and demographic information, and samples for culture were collected by the investigation team from NEPMU-2. Due to the timing of basic recruit training and the need to rapidly characterize the environment contributing to MRSA infections in recruits, two incoming recruit training battalions were chosen by the NEPMU-2 investigation team for survey and analysis of MRSA colonization. Selected training battalions were the all male Fox Company, 2nd Recruit Training Battalion and the all female Oscar Company, 4th Recruit Training Battalion. Fox Company included 273 male Marine recruits from Platoons 2048, 2049, 2050, 2052, 2053, and 2054. Platoon 2054 was disbanded during the training period and the recruits were reassigned to the other platoons within Fox Company. Oscar Company included 94 female Marine recruits from Platoons 4020 and 4021. Staff members included barbers, medical, dental, and basic recruit training personnel and totaled 67 members, 23 females and 44 males.

Environmental samples were collected from areas that are frequently used by recruits throughout basic training, such as barracks (living spaces), the medical clinic, barbershop, in-processing center, training pool, weapon ranges, and chapel. Figure 3.3 exhibits the locations of the environmental samples on a base map of MCRD.

Human samples were collected from the two recruit training battalions and staff members by using a culturette to swab the right and left nares, with special attention to the anterior aspect, where MRSA tends to be found. Following the collection of a human sample, the swab was returned to the carrier, the aqueous ampule broken, and the swab was then used to transfer the sample to a blood agar plate. Environmental

samples were similarly collected by swabbing the surface of interest, and with a damp culturette transferring the sample directly to blood agar plates. This procedure involved streaking the plate while rotating the swab to ensure inoculation of the agar plate with the suspected bacteria. Prepared plates were incubated for 24 hours at a temperature between 34° and 37° C and checked for growth following the required incubation period. Plates with any colonized growth were further tested. A catalase test was performed on all samples to determine the presence of staphylococcal bacteria. Agglutination testing on catalase positive samples was used to identify *Staphylococcus aureus* species. Agglutination positive samples were then plated on blood agar with an oxacillin disk to ascertain whether the bacteria was resistant to beta-lactams. After 18-24 hours of incubation, the plates were evaluated for growth. Plates showing bacterial growth up to the disk (termed "no zone") were identified as possible MRSA. Such samples were inoculated into a tube of sterile broth and incubated for 12-24 hours. If adequate growth occurs, a sterile swab was used to transfer a sample to the MRSA plate. After 24 hours, growth on the plate indicates the sample is MRSA. Confirmation of MRSA was accomplished by determining drug sensitivities, gram staining, and showing a typical MRSA resistance pattern (see Figure 3.4 for decision matrix). Figures 3.5, 3.6, and 3.7 detail the catalase test, staphaurex, and MRSA test procedures utilized by the NEPMU-2 microbiologist.

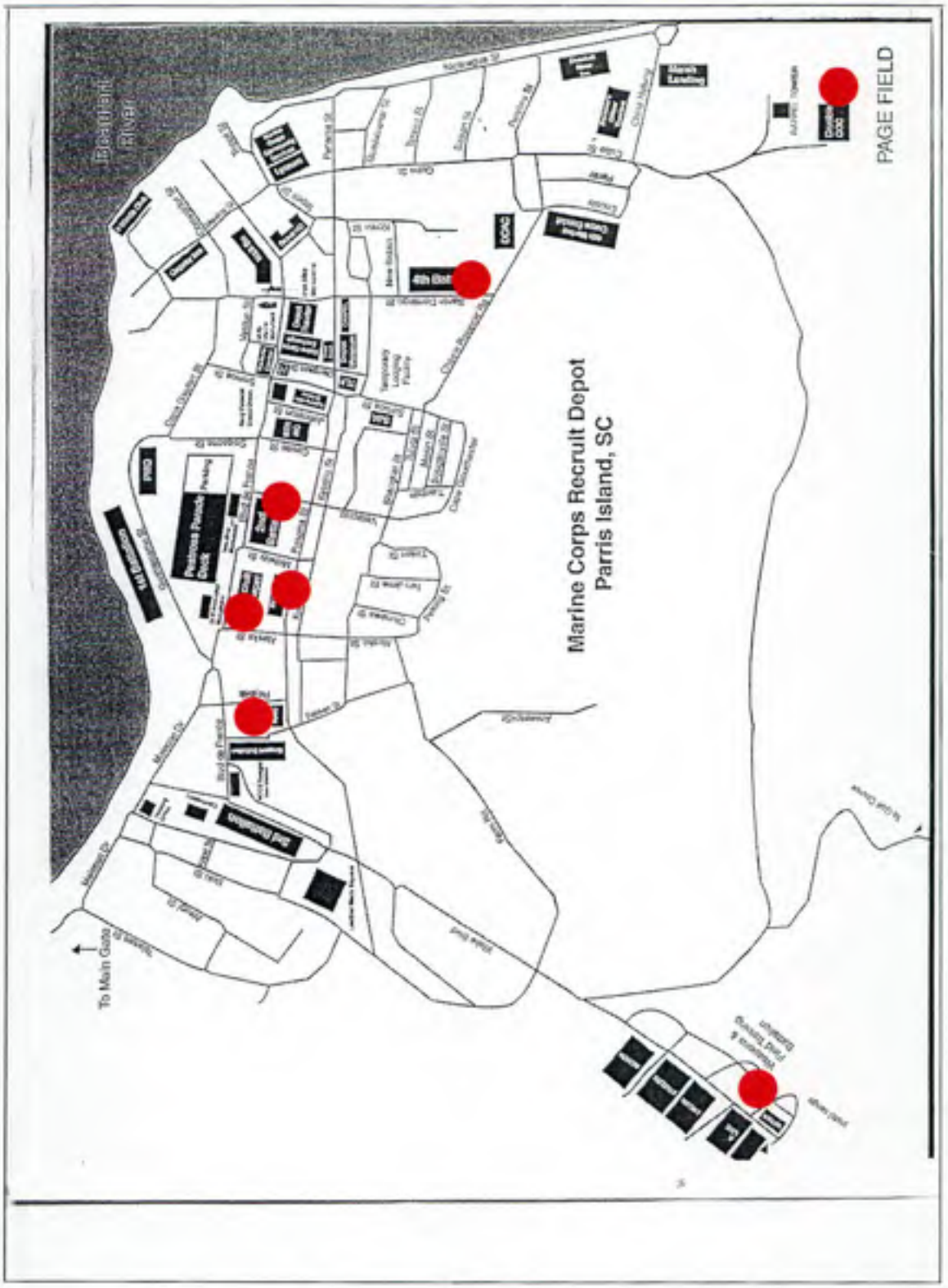



Figure 3.3 – Base map of MCRD, Parris Island, SC Showing The Locations of Environmental Samples

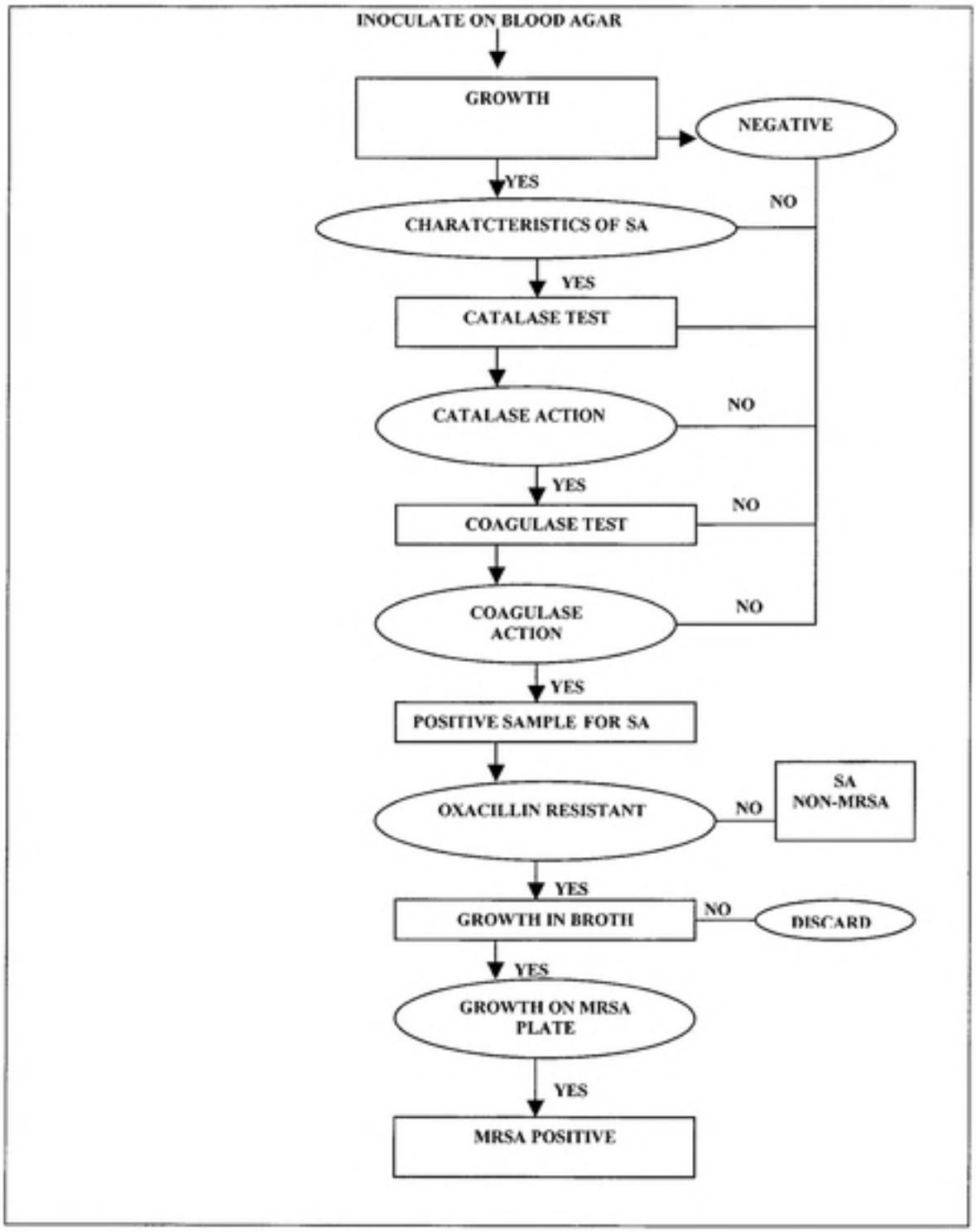



Figure 3.4 – Decision Matrix for Human and Environmental Cultures

**CATALASE TEST PROCEDURE**

**PURPOSE:**

Catalase is an enzyme that decomposes hydrogen peroxide ($H_2O_2$) into oxygen and water. Chemically, it is a hemoprotein, similar in structure to hemoglobin, except that the four iron atoms in the molecule are in an oxidized (Fe+ + +) rather than reduced (Fe+ +) state.

**PRINCIPLE:**

Hydrogen peroxide forms as an oxidative end product of aerobic carbohydrate metabolism. If allowed to accumulate $H_2O_2$ do so with peroxidase enzymes, in a manner similar to Catalase, except only on ferric ion is contained per molecule.

$H_2O_2$ ----Catalase----> $H_2O + O_2$ (gas bubbles)

The Catalase test is used to differentiate streptococci from staphylococci.

**MATERIALS:**

Hydrogen peroxide (3%) * * STORE AT ROOM TEMP. (15-30°C)
Culture of organism to be tested
Wooden applicator sticks
Glass microscope slides
Pasteur pipettes

**PROCEDURE:**

1. With the top of a wooden applicator stick, transfer a portion of an isolated colony to a glass slide.
2. Add one drop of 3% hydrogen peroxide.
3. Watch for rapid and sustained production of gas bubbles or effervescence.

**INTERPRETATION:**

Rapid appearance and sustained production of gas bubbles or effervescence constitutes a positive test. Catalase is present in erythrocytes and care must be taken to avoid carry over of red blood cells with the colony.

**CONTROLS:**

The hydrogen peroxide reagent must be tested with Staphylococcus aureus (positive control) and S. pyogenes (negative control) each day before performing the test on unknown isolates. Results of quality control tests are recorded in the Quality Control Log. Corrective actions for quality control problems with the Catalase test are as follows:

For S. aureus – If negative, repeat the test. If still negative, open a new bottle of hydrogen peroxide reagent, discard the old bottle, and repeat the test. If still negative, report the results to the Microbiology Supervisor.
For S. pyogenes – Test using the quality control strain of Streptococcus pneumonia. If negative, repeat testing and report as above.

**REFERENCES:**

1. McLeod, M.B., and J. Gordon. 1923. Catalase production and sensitivities to hydrogen peroxide amongst bacteria with a scheme of classification based on these principles. J. Pathol. Bacteriol. 26:325-331.
2. Taylor, W.I., and D. Achanzer. 1972. Catalase Test as an aid in their Identification of Medical Bacteria. (2nd.ed.) Williams and Wilkins, Baltimore.
3. McFaddin, J.F. 1980. Biochemical Tests for Identification of Medical Bacteria. (2nd.ed.) Williams and Wilkins, Baltimore.
4. Koneman, E.W., S.D. Winn Jr. (eds.) 1988. Color Atlas and Textbook of Diagnostic Microbiology (3rd.ed.) J.B. Lippincott, Philadelphia.

Figure 3.5 – NEPMU-2 Biological Detection Department Catalase Test Procedure

**STAPHAUREX**

**PRINCIPLE:** Plasma coagulase tests are frequently used to assist with the identification of *Staphylococcus aureus*. Two distinct factors are involved independently. The slide coagulase test detects cell-associated clumping factor referred to as bound coagulase, which reacts with fibrinogen to cause aggregation of the organism. The tube coagulase test detects extracellular staphylocoagulase referred to as free coagulase. This activates prothrombin initiating clot formation in the plasma. Approximately 97% of human isolates of *S. aureus* possess both factors. Over 95% of human strains of S. aureus produce protein A independently of clumping factor or staphylocoagulase. This may be cell-associated and/ or extracellular. The staphaurex reagent consists of polystyrene latex particles, which have been coated with fibrinogen and IgG. When mixed on a slide with a suspension of *S. aureus* a reaction of clumping factor with the fibrinogen, and/ or protein A with the IgG causes rapid, strong agglutination of the latex particles.

**SPECIMEN:** Cultures may be tested directly from the primary culture plate if there is sufficient growth. Alternatively a subculture should be made on a blood or nutrient agar for subsequent testing.

**MATERIALS:** The following materials are provided in the kit:

Test latex suspension
Disposable Reaction Cards
(Please note they may be cut when performing less than 6 tests. Do not touch or bend the reaction areas).
Disposable sampling and mixing sticks

**PROCEDURE:**

1. Each bottle of latex reagent contains a minimum of 1.7 ml (sufficient for 40 tests). Shake the latex to obtain an even suspension and dispense a drop into a circle on the reaction card for each culture to be tested.
2. Take a mixing stick and pick up some of the culture by touching it with the flat end of the stick. An amount of growth equivalent to six average-sized colonies should be picked.
3. Emulsify the sample of culture in a drop of latex by rubbing with the flat end of the stick. Rub thoroughly, but not too vigorously or the surface of the card may be damaged. Spread the latex over approximately half the area of the circle. Discard the mixing stick safe for disposal.
4. Rotate the card gently for up to 20 seconds and examine for agglutination holding the card at normal reading distance (25-35 cm) from the eyes. Do not use a magnifying lens. The patterns obtained are clear-cut and can be recognized under any normal lighting condition.
5. Dispose of the card into a double-bagged red biohazard trash bag. Do not reuse.

**INTERPRETATION AND REPORTING OF RESULTS:** A positive result is indicated by the development of an agglutinated pattern showing clearly visible clumping of the latex particles with clearing of the milky background. Most positive reactions will be almost instantaneous. A negative result is indicated when the latex does not agglutinate and the milky appearance remains substantially unchanged throughout the test. It should be noted that traces of granularity may be seen in negative patterns due to the particulate nature of both reactants. Increased granularity may be observed if the latex suspensions are rotated for more than 20 seconds. Rough or stringy reactions appear as white specks of stringy aggregates. When accompanied by a milky background they should be recorded as negative. When accompanied by a clear background they are likely to be positive.

**QUALITY CONTROL:** Quality control testing is performed on a daily basis. *S. aureus* will be used for the positve control, ATCC # 25923. *S. epidermidis* will be used for the negative control, ATCC # 1228. All results will be recorded on the Microbiology Daily Quality Control Log. Any discrepancies will be noted on the log sheet along with the appropriate corrective action. All log sheets will be reviewed by the Microbiology Supervisor on a monthly basis.

**REFERENCES:** Staphaurex package insert. Murex Biotech Limited. 1997.

Figure 3.6 – NEPMU-2 Biological Detection Department Staphaurex Test Procedure

**METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS DETECTION (MRSA)**

**INTRODUCTION:** MRSA Screen Agar is used for detection of methicillin-resistant Staphylococcus aureus (MRSA). These strains are resistant to penicillinase, resistant to penicillin's (PRP's) such as methicillin, oxacillin, and nafcillin. Resistance to penicillin in S. aureus was observed soon after introduction of penicillin in the late 1940's. Methicillin resistant strains of S. aureus began to emerge in Europe and by the late 1960's, MRSA began to be isolated in the United States. It is important to detect these strains as soon as possible because therapy is limited to a few drugs. They are usually multiply resistant organisms. In addition to PRP's they are resistant to erythromycin and clindamycin and frequently to tetracycline and gentamycin. MRSA cultures often consist of two populations one which is susceptible and one, which is resistant (so called occult resistant strains). The methicillin resistant population grows more slowly, prefers a lower incubation temperature, incubation and high salt concentration.

**PRINCIPLES:** Mueller-Hinton Agar is a standardized medium for the disc diffusion procedure for antimicrobial susceptibility testing of aerobic bacteria. Sodium chloride is added to improve growth of the PRP-resistant subpopulations of so called "occult resistant" strains. Oxacillin is used because there are more reports of resistant strains associated with this drug than with methicillin or nafcillin.

**MATERIALS:** * * STORE ALL MATERIALS AS PER MANUFACTURERS SPECIFICATIONS. 890921. * *

1. MRSA Screen agar.
   * Beef extract 2.0gm
   * Acid hydrolysate of Casein 17.5gm
   * Starch 1.5gm
   * Agar 17.0gm
   * Sodium chloride 40.0gm
   * Oxacillin 6.0gm
2. Ancillary culture media and reagents.
3. Blood agar plate for quality control.

**SPECIMEN COLLECTION & TRANSPORT:** This medium is not intended for used directly with specimens or mixed cultures. The organism to be tested must first be in pure culture and presumptively identified as a coagulase positive Staphylococcus.

**PROCEDURE:**

1. Prepare the inoculum by suspending several isolated colonies of the S. aureus test isolate from an 18-24 hour culture into a tube of sterile broth. Adjust the turbidity to a #0.5 MacFarland standard.
2. Saturate a cotton swab with broth suspension and press out excess fluid against the inner wall of the tube.
3. Spot inoculate MRSA Screen Agar by gently pressing the swab onto the agar surface. (Include a blood agar plate as a nonselective growth control. By marking the bottom of the plate into several wedge shaped sections, as many as 8 isolates may be tested per plate).
4. Incubate the culture plates at 35°C for a full 24 hours but no longer. It is important that the temperature not exceed 35°C.

**RESULTS:**

1. After 24 hours incubation, growth on the plate indicates that the isolate is an MRSA. No growth indicates that the organism is not an MRSA.
2. Confirmation is accomplished by determining the minimal inhibitory concentration (MIC) with a PRP drug and showing a typical MRSA resistance pattern.

**QUALITY CONTROL:**

1. Inoculation of the blood plate is a nonselective quality control test.
2. For the MRSA plates examine them for deterioration (e.g. organism contamination, discoloration, drying/cracking etc.).
3. Check plate performance by inoculating sample plates with pure cultures of stable, control organisms that produce expected results. The following are recommended.

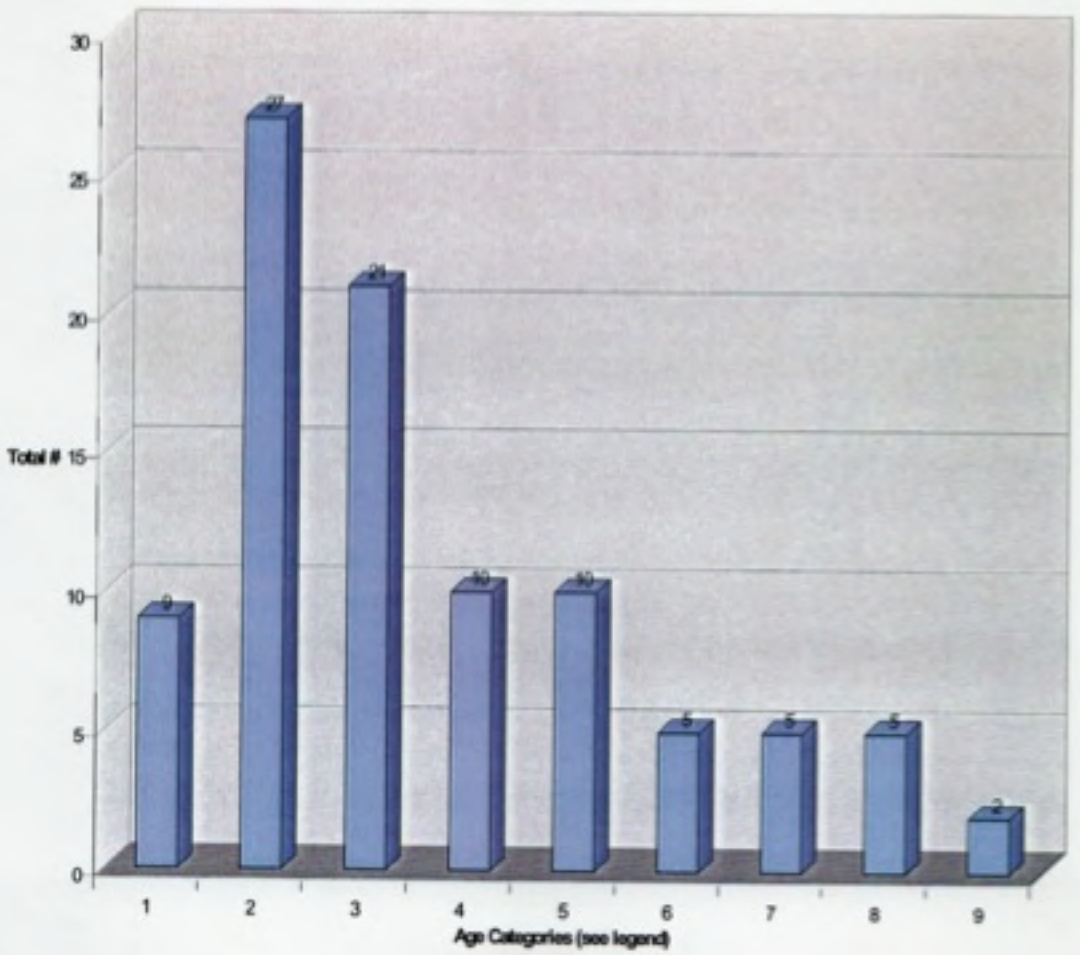
| TEST STRAIN | EXPECTED RESULTS |
|---|---|
| S. aureus ATCC #25923 | No growth |
| " " ATCC #43300 | growth |

**LIMITATIONS:** Occasionally S. aureus isolates with borderline oxacillin susceptible MIC's between 2-4 mcg/ml may show trace growth within 24 hours. It is recommended that any equivocal results demonstrated on the screening plate be confirmed with a standard MIC test. Strains with beta-lactamase mediated resistance may be detected using a Cefinase disc and by their susceptibility when tested with discs containing beta-lactamase in combination with acid. Coagulase negative staphylococci may produce false resistance on this medium. Since this is a screening procedure all isolates that may grow on this medium should be tested quantitatively by broth or agar dilution to confirm oxacillin resistance and also resistance to erythromycin, clindamycin and other antimicrobial agents.

Figure 3.7 – NEPMU-2 Biological Detection Department MRSA Test Procedure

## IV. RESULTS

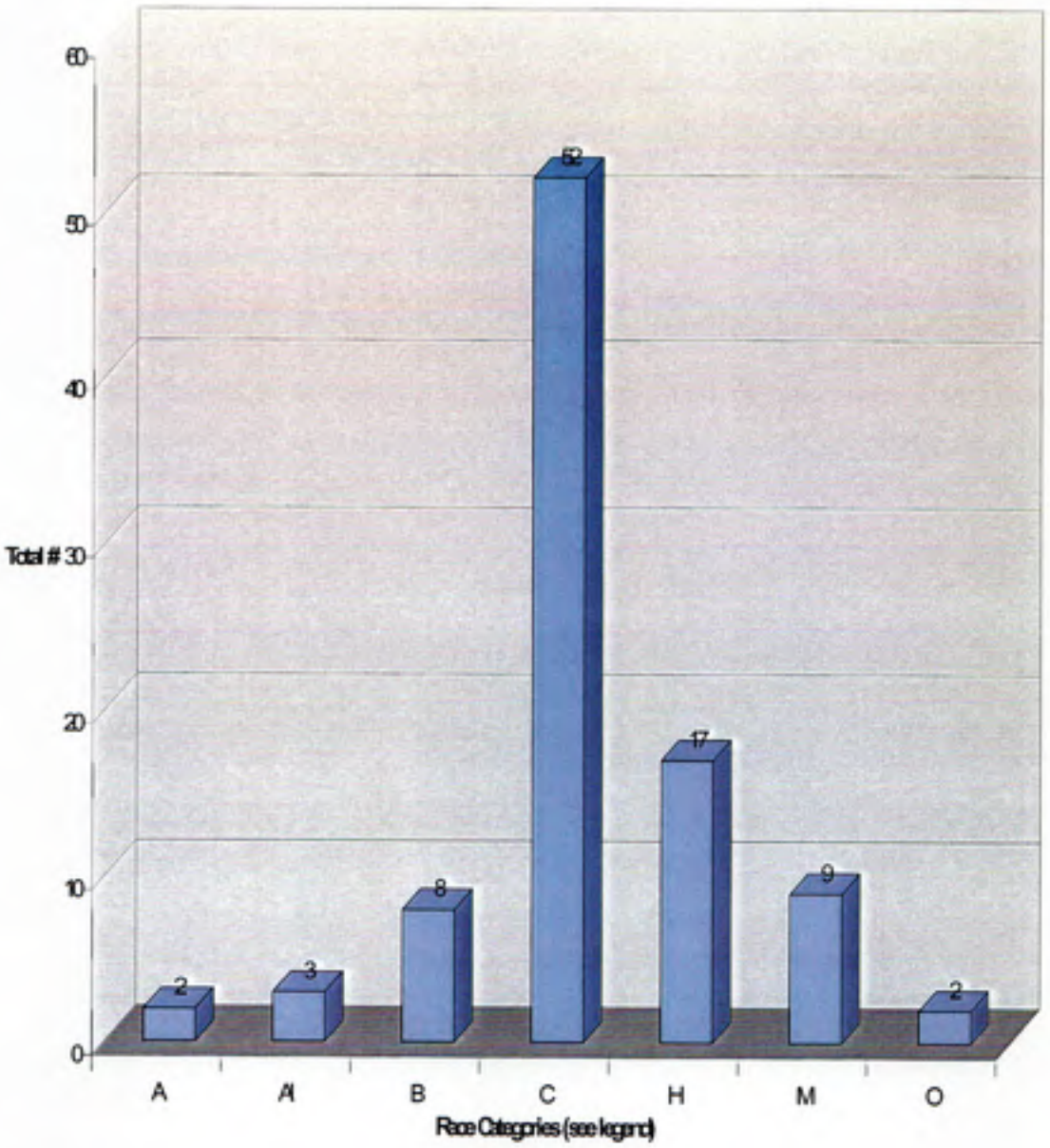
Figures 4.1, 4.2, 4.3, and 4.4 show the distribution of age and race of the initial recruit participants in March 2002.




**LEGEND**

1 – Age 17
2 – Age 18
3 – Age 19
4 – Age 20
5 – Age 21
6 – Age 22
7 – Age 23
8 – Age 24
9 – Age 26

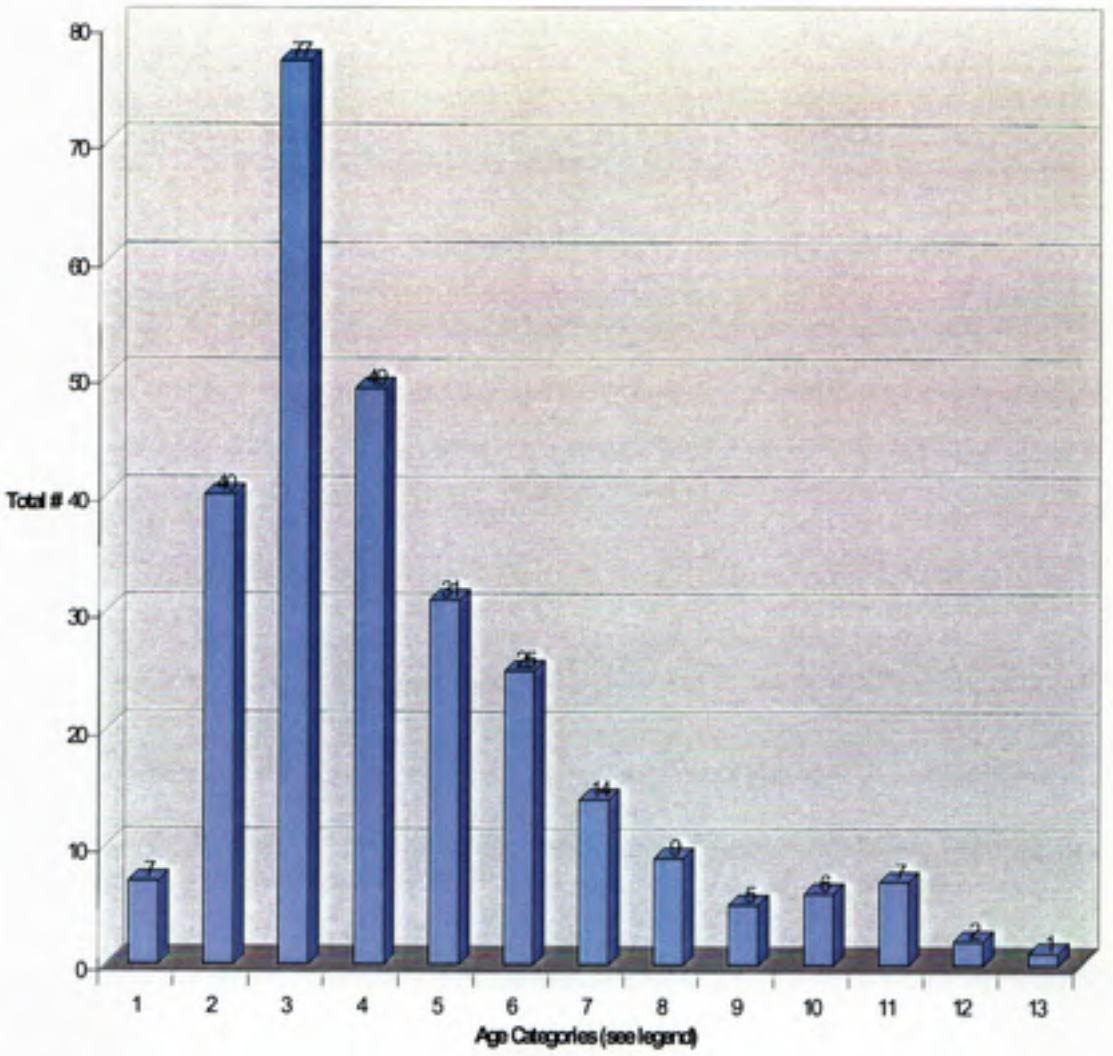
Figure 4.1 – Age Distribution of Female Recruits




**LEGEND**

A – Asian
AI – American Indian
B – Black
C - Caucasian
H – Hispanic
M – Mixed
O – Other

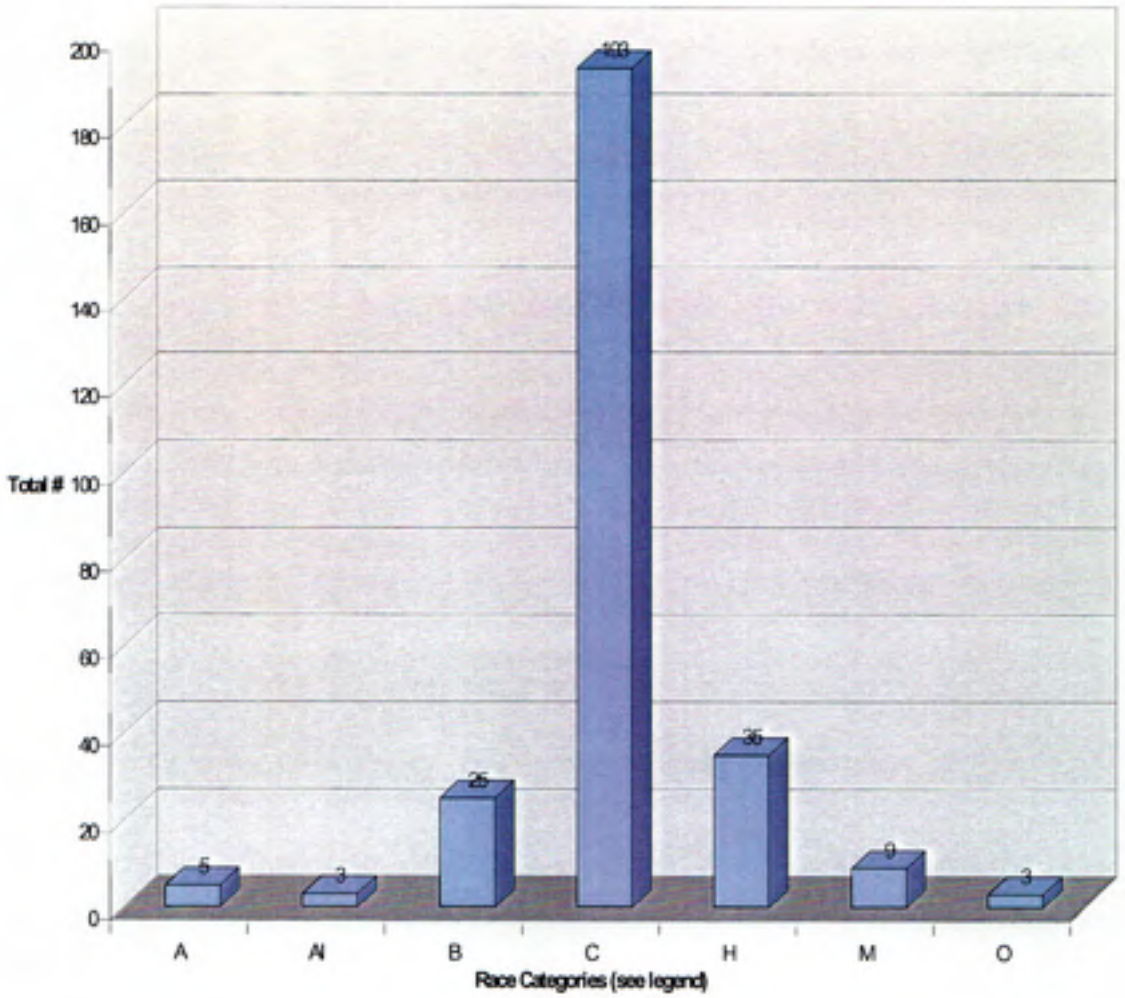
Figure 4.2 – Race Distribution of Female Recruits




**LEGEND**

| | |
|---|---|
| 1 – Age 17 | 8 – Age 24 |
| 2 – Age 18 | 9 – Age 25 |
| 3 – Age 19 | 10 – Age 26 |
| 4 – Age 20 | 11 – Age 27 |
| 5 – Age 21 | 12 – Age 29 |
| 6 – Age 22 | 13 – Age 31 |
| 7 – Age 23 | |

Figure 4.3 – Age Distribution of Male Recruits




**LEGEND**

A – Asian
AI – American Indian
B – Black
C - Caucasian
H – Hispanic
M – Mixed
O – Other

Figure 4.4 – Race Distribution of Male Recruits

Tables 4.1 and 4.2 provide the age and race distribution percentages for the investigated recruit populations.

**Table 4.1**
**Age Distribution Percentages**

| Age | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 29 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Female | 10% | 29% | 22% | 11% | 11% | 5% | 5% | 5% | - | 2% | - | - | - |
| Male | 3% | 15% | 28% | 18% | 11% | 9% | 5% | 3% | 2% | 2% | 3% | 0.7% | 0.3% |

**Table 4.2**
**Race Distribution Percentages**

| Race | A | AI | B | C | H | M | O |
|---|---|---|---|---|---|---|---|
| Female | 2% | 3% | 10% | 55% | 18% | 10% | 2% |
| Male | 2% | 1% | 9% | 71% | 13% | 3% | 1% |

## A. Data

Table 4.3 exhibits the results of the environmental and human samples collected during the investigation.

**Table 4.3**
**Results of Environmental Samples**

| LOCATION | SITES CULTURED | DATE | RESULT |
|---|---|---|---|
| Audiology | Headset 1 | 3/26/02 | negative |
| | Headset 2 | 3/26/02 | negative |
| | Headset 3 | 3/26/02 | negative |
| | Headset 4 | 3/26/02 | negative |
| | Switch 1 | 3/26/02 | negative |
| | Switch 2 | 3/26/02 | negative |
| | Switch 3 | 3/26/02 | negative |
| | Switch 4 | 3/26/02 | negative |
| Recruit Admin Center | Phone 1 | 3/26/02 | negative |
| | Phone 2 | 3/26/02 | negative |
| | Phone 3 | 3/26/02 | negative |
| | Phone 4 | 3/26/02 | negative |
| | Desktop 1 | 3/26/02 | negative |
| | Desktop 2 | 3/26/02 | negative |
| | Desktop 3 | 3/26/02 | negative |
| | Desktop 4 | 3/26/02 | negative |
| | Desk chair 1 | 3/26/02 | negative |
| | Desk chair 2 | 3/26/02 | negative |
| | Desk chair 3 | 3/26/02 | negative |

| LOCATION | SITES CULTURED | DATE | RESULT |
|---|---|---|---|
| | Desk chair 4 | 3/26/02 | negative |
| Physical Therapy | Stairmaster | 3/26/02 | negative |
| | Recline Bike | 3/26/02 | negative |
| | Chair 1 | 3/26/02 | negative |
| | Chair 2 | 3/26/02 | positive |
| | E-stim Pad | 3/26/02 | negative |
| | Cryocuff-shoulder | 3/26/02 | negative |
| | Cryocuff-knee | 3/26/02 | negative |
| Optometry | Refractor 5440 | 3/26/02 | negative |
| | Refractor 5403 | 3/26/02 | negative |
| | Glaucoma 5603 | 3/26/02 | negative |
| | Frame 1 | 3/26/02 | negative |
| | Frame 2 | 3/26/02 | negative |
| Recruit Medical Readiness | Floor Mat Site 1 | 3/27/02 | negative |
| | Floor Mat Site 2 | 3/27/02 | negative |
| | Floor Mat Mite 3 | 3/27/02 | negative |
| | Floor Mat Site 4 | 3/27/02 | negative |
| Chapel | Pew Back 1 | 3/28/02 | negative |
| | Pew Back 2 | 3/28/02 | negative |
| | Pew Back 3 | 3/28/02 | negative |
| | Pew Seat 1 | 3/28/02 | negative |
| | Pew Seat 2 | 3/28/02 | negative |
| | Pew Seat 3 | 3/28/02 | negative |
| Recruit Barbershop | Chair 1 | 3/28/02 | negative |
| | Chair 2 | 3/28/02 | negative |
| | Chair 3 | 3/28/02 | negative |
| | Chair 4 | 3/28/02 | negative |
| Pool (pre-recruit use) | Life Vest (neck area) | 4/29/02 | negative |
| | Male Cammie Blouse (neck area) | 4/29/02 | negative |
| | Deck Area Near Ladder (south end) | 4/29/02 | negative |
| | Male Shower Deck | 4/29/02 | negative |
| | Female Cammie Blouse (neck area) | 4/29/02 | negative |
| Pool (post-recruit use) | Female Shower Deck | 4/29/02 | positive |
| | Poolside Mats (left side) | 4/29/02 | negative |
| | Male Shower Deck | 4/29/02 | negative |
| | Female Cammie Blouse (neck area) | 4/29/02 | negative |
| | Male Cammie Blouse (neck area) | 4/29/02 | negative |
| | Poolside Mats (right side) | 4/29/02 | negative |
| Pool Water | Deep End (right side) | 4/29/02 | negative |
| | Deep End (left side) | 4/29/02 | negative |
| | Shallow End (right side) | 4/29/02 | negative |
| | Shallow End (left side) | 4/29/02 | negative |
| ISMT | 2052, Rm 113, Rifle Buttstock 1 | 5/17/02 | negative |
| | 2052, Rm 113, Rifle Buttstock 3 | 5/17/02 | negative |
| | 2052, Rm 113, Rifle Buttstock 4 | 5/17/02 | negative |
| | 4th BN Oscar, Rm 106, Rifle 1 | 5/17/02 | negative |
| | 4th BN Oscar, Rm 106, Rifle 3 | 5/17/02 | negative |
| | 4th BN Oscar, Rm 106, Rifle 4 | 5/17/02 | negative |
| 2nd BN Barracks | 2048 Shower Floor | 6/6/02 | negative |
| | 2048 Toilet Handle | 6/6/02 | negative |
| | 2048 Sink Handle | 6/6/02 | negative |
| | 2049 Shower Floor | 6/6/02 | negative |
| | 2049 Toilet Handle | 6/6/02 | negative |
| | 2049 Sink Handle | 6/6/02 | negative |
| | 2050 Shower Floor | 6/6/02 | negative |
| | 2050 Toilet Handle | 6/6/02 | negative |
| | 2050 Sink Handle | 6/6/02 | negative |
| | 2052 Shower Floor | 6/6/02 | negative |
| | 2052 Toilet Handle | 6/6/02 | negative |
| | 2052 Sink Handle | 6/6/02 | negative |
| | 2053 Shower Floor | 6/6/02 | negative |
| | 2053 Toilet Handle | 6/6/02 | negative |
| | 2053 Sink Handle | 6/6/02 | negative |
| 4th BN Barracks | 4020 Shower Floor | 6/6/02 | negative |
| | 4020 Toilet Handle | 6/6/02 | negative |
| | 4020 Sink Handle | 6/6/02 | negative |
| | 4021 Shower Floor | 6/6/02 | negative |
| | 4021 Toilet Handle | 6/6/02 | negative |

| LOCATION | SITES CULTURED | DATE | RESULT |
|---|---|---|---|
| Pugil Stick Area | 4021 Sink Handle | 6/6/02 | negative |
| | Chin Strap Helmet 1 | 6/11/02 | negative |
| | Chin Strap Helmet 2 | 6/11/02 | negative |
| | Vest #1 | 6/11/02 | negative |
| | Vest #2 | 6/11/02 | negative |
| | Right Glove | 6/11/02 | negative |
| | Left Glove | 6/11/02 | negative |

Tables 4.4, 4.5, 4.6, 4.7 and 4.8 exhibit the results of human samples collected during the investigation. Tables 4.4, 4.5, and 4.6 represent the cultures collected during the first site visit outlined in Table 3.1. Tables 4.7 and 4.8 represent cultures collected during the second and third site visits (pre- and post crucible). The following legend interprets the highlighted areas of the tables:

- MRSA positive result or previous hospitalization
- MRSA positive result and previous hospitalization
- Recruits gained during investigation

**Table 4.4**
**Results for Staff Personnel (March 2002)**

| DEPARTMENT | STAFF # | AGE | RACE | SEX | CITY ORIGIN | STATE ORIGIN | MRSA POSITIVE | PRIOR HOSPITALIZED |
|---|---|---|---|---|---|---|---|---|
| **RMR** | 1 | 20 | B | F | Beaufort | SC | no | no |
| | 2 | 22 | C | M | Beaufort | SC | no | no |
| | 3 | 20 | C | M | Beaufort | SC | no | no |
| | 4 | 19 | C | F | Beaufort | SC | no | no |
| | 5 | 20 | C | M | Beaufort | SC | no | no |
| | 6 | 18 | B | F | Beaufort | SC | no | no |
| | 7 | 19 | M | F | Great Lakes | IL | no | no |
| | 8 | 25 | C | M | Beaufort | SC | no | **yes** |
| | 9 | 38 | C | M | Beaufort | SC | no | no |
| | 10 | 34 | C | M | Beaufort | SC | no | no |
| | 11 | 28 | C | M | Walterboro | SC | no | no |
| **PT Clinic** | 12 | 21 | B | M | Beaufort | SC | no | no |
| | 13 | 25 | B | M | Lady's Island | SC | no | no |
| | 14 | 33 | O | F | Newport | RI | no | no |
| | 15 | 20 | B | M | Beaufort | SC | no | **yes** |
| | 16 | 19 | A | F | Port Royal | SC | no | no |
| | **17** | **21** | **B** | **F** | **Port Royal** | **SC** | **yes** | no |
| | 18 | 37 | C | M | Beaufort | SC | no | no |
| | 19 | 30 | B | M | Beaufort | SC | no | no |
| | 20 | 36 | C | M | Ridgeland | SC | no | no |
| | 21 | 36 | C | M | Beaufort | SC | no | no |
| | 22 | 37 | C | M | Beaufort | SC | no | **yes** |
| **Audiology** | 23 | 32 | C | F | Lady's Island | SC | no | **yes** |
| | 24 | 42 | C | M | Beaufort | SC | no | **yes** |
| | 25 | 39 | C | F | Beaufort | SC | no | no |
| **Dental** | 26 | 36 | C | F | Beaufort | SC | no | no |
| | 27 | 30 | C | M | Beaufort | SC | no | no |
| | 28 | 21 | C | M | Beaufort | SC | no | no |
| | 29 | 21 | O | F | Beaufort | SC | no | no |

| DEPARTMENT | STAFF # | AGE | RACE | SEX | CITY ORIGIN | STATE ORIGIN | MRSA POSITIVE | PRIOR HOSPITALIZED |
|---|---|---|---|---|---|---|---|---|
| **Dental** | 30 | 21 | B | M | Norfolk | VA | no | no |
| | 31 | 21 | H | F | Beaufort | SC | no | no |
| | 32 | 20 | B | M | Beaufort | SC | no | no |
| | 33 | 36 | C | F | Sigonella | Italy | no | no |
| | 34 | 21 | M | F | Beaufort | SC | no | **yes** |
| | 35 | 19 | M | M | Beaufort | SC | no | **yes** |
| | 36 | 19 | B | F | Savannah | GA | no | **yes** |
| | 37 | 22 | B | F | Beaufort | SC | no | **yes** |
| | 38 | 20 | H | M | Beaufort | SC | no | no |
| | 39 | 22 | C | M | Beaufort | SC | no | no |
| | 40 | 24 | H | M | Beaufort | SC | no | no |
| **IPDI** | 41 | 29 | B | F | Laurel Bay | SC | no | no |
| | 42 | 26 | H | F | Beaufort | SC | no | no |
| | 43 | 34 | B | M | Beaufort | SC | no | no |
| | 44 | 25 | A | M | Beaufort | SC | no | no |
| | 45 | 26 | C | M | Beaufort | SC | no | no |
| | 46 | 35 | B | M | Beaufort | SC | no | no |
| | 47 | 29 | H | M | Beaufort | SC | no | no |
| | 48 | 34 | B | F | Beaufort | SC | no | no |
| | 49 | 26 | B | F | Beaufort | SC | no | no |
| | 50 | 25 | B | M | Beaufort | SC | no | **yes** |
| | 51 | 26 | C | M | Beaufort | SC | no | no |
| | 52 | 35 | H | M | Beaufort | SC | no | no |
| | 53 | 26 | C | M | Beaufort | SC | no | no |
| | 54 | 30 | H | M | Beaufort | SC | no | no |
| | 55 | 28 | O | F | Beaufort | SC | no | no |
| | 56 | 33 | C | M | Beaufort | SC | no | no |
| | 57 | 32 | B | M | Beaufort | SC | no | no |
| | 58 | 29 | C | M | Beaufort | SC | no | no |
| | 59 | 30 | C | M | Beaufort | SC | no | no |
| | 60 | 29 | C | M | Beaufort | SC | No | no |

| DEPARTMENT | STAFF # | AGE | RACE | SEX | CITY ORIGIN | STATE ORIGIN | MRSA POSITIVE | PRIOR HOSPITALIZED |
|---|---|---|---|---|---|---|---|---|
| **Optometry** | 61 | 21 | B | M | Beaufort | SC | no | no |
| | 62 | 34 | B | M | Beaufort | SC | no | no |
| | 63 | 54 | B | M | Beaufort | SC | no | no |
| | 64 | 23 | B | F | Beaufort | SC | no | no |
| **Barbershop** | 65 | 27 | B | M | Beaufort | SC | no | no |
| | 66 | 28 | B | M | Beaufort | SC | no | no |
| | 67 | 30 | C | F | Seabrook | SC | no | no |



**Table 4.5**
**Results for Initial Female Recruits (March 2002)**

| PLATOON | RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| **4020** | 1 | 17 | F | C | Harlan | KY | 40831 | no | no |
| | **2** | **18** | **F** | **C** | **Mocksville** | **NC** | **27028** | **yes** | no |
| | 3 | 20 | F | C | Groveland | FL | 34736 | no | no |
| | **4** | **18** | **F** | **C** | **Mechanicsville** | **VA** | **23111** | **yes** | no |
| | 5 | 21 | F | B | Havelock | NC | 28532 | no | no |
| | 6 | 19 | F | C | Richfield | MN | 55440 | no | no |
| | 7 | 20 | F | C | Buzzards Bay | MA | 02532 | no | no |
| | 8 | 21 | F | H | Oklahoma City | OK | 73124 | no | no |
| | 9 | 19 | F | C | Fayetteville | AR | 72701 | no | no |
| | 10 | 24 | F | C | Waco | TX | 76715 | no | no |
| | **11** | **22** | **F** | **C** | **Baldwin** | **NY** | **11510** | **yes** | **yes** |
| | 12 | 18 | F | B | Carney's Point | NJ | 08064 | no | no |
| | 13 | 23 | F | H | Bronx | NY | 10451 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 14 | 17 | F | A | Port St Lucie | FL | 34981 | no | no |
| | 15 | 18 | F | C | Crawfordville | FL | 32326 | no | no |
| | 16 | 20 | F | B | Triangle | VA | 22172 | no | yes |
| | 17 | 17 | F | M | Burton | MI | 48519 | yes | no |
| | 18 | 23 | F | C | Gilbert | PA | 18331 | no | no |
| | 19 | 19 | F | C | New Castle | PA | 16105 | no | no |
| | 20 | 21 | F | C | North Bergen | NJ | 07047 | yes | no |
| | 21 | 18 | F | M | Charlotte | NC | 28208 | no | no |
| | 22 | 24 | F | B | Shelby | NC | 28150 | no | no |
| | 23 | 24 | F | C | Richmond | KY | 40475 | no | no |
| | 24 | 18 | F | C | New Orleans | LA | 70126 | no | no |
| | 25 | 21 | F | M | Albany | GA | 31703 | no | no |
| | 26 | 22 | F | C | Indianapolis | IN | 46282 | no | no |
| | 27 | 21 | F | H | Fort Worth | TX | 76163 | no | no |
| | 28 | 22 | F | C | Wauwatosa | WI | 53201 | no | no |
| | 29 | 19 | F | C | Andover | MN | 55304 | no | no |
| | 30 | 19 | F | C | Limington | ME | 04049 | no | no |
| | 31 | 20 | F | AI | Fort Cobb | OK | 73038 | no | no |
| | 32 | 19 | F | C | Allenstown | NH | 03275 | no | no |
| | 33 | 22 | F | H | Orlando | FL | 32877 | no | no |
| | 34 | 20 | F | C | Havelock | NC | 28532 | no | no |
| | 35 | 19 | F | O | Burke | VA | 22009 | no | no |
| | 36 | 19 | F | H | Aurora | CO | 80016 | no | no |
| | 37 | 18 | F | H | Miami | FL | 33111 | no | no |
| | 38 | 21 | F | AI | Twin Lakes | MN | 56089 | no | no |
| | 39 | 19 | F | M | Coatesville | PA | 19320 | no | no |
| | 40 | 18 | F | B | Davisboro | GA | 31018 | no | yes |
| | 41 | 19 | F | C | Buckhannon | WV | 26201 | no | no |
| | 42 | 17 | F | C | Royston | GA | 30662 | no | no |
| 4021 | 43 | 18 | F | C | Cuero | TX | 77954 | no | no |
| | 44 | 21 | F | C | Lafayette | LA | 70509 | no | no |
| | 45 | 19 | F | H | Brentwood | CA | 94513 | no | no |
| | 46 | 23 | F | C | Buffalo | NY | 14225 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 47 | 20 | F | M | Huntley | IL | 60142 | no | no |
| | 48 | 19 | F | O | Hanes City | FL | 33844 | no | no |
| | 49 | 17 | F | C | Brenham | TX | 77833 | no | no |
| | 50 | 18 | F | M | National City | CA | 91951 | no | no |
| | 51 | 19 | F | M | Westminster | CA | 92685 | no | no |
| | 52 | 18 | F | A | Garden Grove | CA | 92842 | no | no |
| | 53 | 24 | F | C | Raleigh | NC | 27615 | no | no |
| | 54 | 18 | F | C | Burleson | TX | 76097 | no | no |
| | 55 | 20 | F | M | Oxnard | CA | 93030 | no | no |
| | 56 | 22 | F | C | Gladstone | IL | 61437 | no | no |
| | 57 | 18 | F | C | Modesto | CA | 95397 | no | no |
| | 58 | 17 | F | C | Franklin | KY | 42135 | no | no |
| | 59 | 19 | F | H | Santa Rosa | CA | 95404 | no | no |
| | 60 | 17 | F | C | Anderson | CA | 96007 | no | no |
| | 61 | 20 | F | H | San Angelo | TX | 76909 | no | no |
| | 62 | 19 | F | H | Edinburg | TX | 78540 | no | no |
| | 63 | 18 | F | H | East Haven | CT | 06512 | no | no |
| | 64 | 19 | F | C | Williamsburg | KY | 40769 | no | no |
| | 65 | 26 | F | C | Medina | OH | 44258 | no | no |
| | 66 | 19 | F | H | West Valley City | UT | 84119 | no | no |
| | 67 | 19 | F | H | Modesto | CA | 95397 | no | no |
| | 68 | 20 | F | C | Afton | NY | 13730 | no | no |
| | 69 | 18 | F | C | Chicago | IL | 60412 | no | no |
| | 70 | 19 | F | C | Bellevue | WA | 98009 | no | no |
| | 71 | 17 | F | C | Brenham | TX | 77833 | no | no |
| | 72 | 18 | F | H | Sacramento | CA | 94205 | no | no |
| | 73 | 18 | F | C | Ellensburg | WA | 98926 | no | yes |
| | 74 | 23 | F | C | LaGrangeville | NY | 12540 | no | no |
| | 75 | 18 | F | C | McHenry | IL | 60051 | no | no |
| | 76 | 18 | F | M | Calipatria | CA | 92233 | no | no |
| | 77 | 17 | F | C | Port Angeles | WA | 98363 | no | no |
| | 78 | 18 | F | C | Cranston | RI | 02920 | no | no |
| | 79 | 26 | F | C | Marietta | GA | 30060 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 80 | 21 | F | H | Houston | TX | 77220 | no | no |
| | 81 | 19 | F | B | Waterloo | IA | 50703 | no | no |
| | 82 | 18 | F | H | Santa Ana | CA | 92703 | no | no |
| | 83 | 18 | F | C | Hemet | CA | 92544 | no | no |
| | 84 | 18 | F | AI | Weatherford | TX | 76085 | no | no |
| | 85 | 23 | F | C | Northwood | OH | 43619 | no | no |
| | 86 | 19 | F | C | Salem | OR | 97314 | no | no |
| | 87 | 20 | F | C | Salt Lake City | UT | 84170 | no | no |
| | 88 | 18 | F | C | Naples | FL | 34103 | no | no |
| | 89 | 21 | F | C | Phoenix | AZ | 85098 | no | no |
| | 90 | 21 | F | B | St Louis | MO | 63166 | no | no |
| | 91 | 18 | F | B | Milburn | OH | 43447 | no | yes |
| | 92 | 24 | F | C | Muncie | IN | 47305 | no | no |
| | 93 | 18 | F | H | Tieton | WA | 98947 | no | no |
| | 94 | 18 | F | B | Gilbert | AZ | 85299 | no | no |

**Table 4.6**
**Results for Initial Male Recruits (March 2002)**

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| 2048 | 95 | 20 | M | C | Madisonville | TN | 37354 | no | no |
| | 96 | 27 | M | C | Ringgold | GA | 30736 | no | no |
| | 97 | 20 | M | B | Tallahassee | FL | 32301 | no | no |
| | 98 | 19 | M | C | Metter | GA | 30439 | no | no |
| | 99 | 18 | M | C | Tampa | FL | 33601 | no | no |
| | 100 | 21 | M | C | Interlachen | FL | 32148 | no | no |
| | 101 | 23 | M | C | Hiram | GA | 30141 | no | no |
| | 102 | 20 | M | C | Kennesaw | GA | 30144 | yes | no |
| | 103 | 19 | M | C | Candler | NC | 28715 | no | no |
| | 104 | 19 | M | C | Watkinsville | GA | 30677 | no | no |
| | 105 | 19 | M | C | Jacksonville | FL | 32203 | no | no |
| | 106 | 27 | M | C | Winston-Salem | NC | 27102 | no | no |
| | 107 | 26 | M | C | Lanexa | VA | 23089 | no | no |
| | 108 | 27 | M | C | Plant City | FL | 33566 | no | no |
| | 109 | 21 | M | H | Kissimmee | FL | 34744 | no | no |
| | 110 | 25 | M | H | Orlando | FL | 32802 | no | no |
| | 111 | 17 | M | C | Bethera | SC | 29430 | no | yes |
| | 112 | 20 | M | C | Columbia | SC | 29201 | no | no |
| | 113 | 19 | M | H | Orlando | FL | 32802 | no | no |
| | 114 | 19 | M | AI | Mobile | AL | 36601 | no | no |
| | 115 | 19 | M | C | Tenille | GA | 31089 | no | no |
| | 116 | 19 | M | B | College Park | GA | 30301 | no | no |
| | 117 | 21 | M | C | Stuarts Draft | VA | 24477 | no | no |
| | 118 | 20 | M | C | Charleston | SC | 29423 | no | no |
| | 119 | 20 | M | C | Walhalla | SC | 29691 | no | no |
| | 120 | 22 | M | O | Candler | NC | 28715 | no | no |
| | 121 | 19 | M | B | Manning | SC | 29102 | no | no |
| | 122 | 19 | M | C | Poquoson | VA | 23662 | yes | no |
| | 123 | 19 | M | C | Mobile | AL | 36601 | no | no |
| | 124 | 22 | M | C | Hartwell | GA | 30643 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 125 | 21 | M | C | Friendsville | TN | 37737 | no | no |
| | 126 | 20 | M | C | Oak Ridge | TN | 37830 | no | no |
| | 127 | 20 | M | AI | Locust Grove | OK | 74352 | no | yes |
| | 128 | 19 | M | AI | Cherokee | NC | 28719 | no | no |
| | 129 | 20 | M | O | Orlando | FL | 32802 | no | no |
| | 130 | 18 | M | C | Hilton Head | SC | 29928 | no | no |
| | 131 | 22 | M | C | Tallahassee | FL | 32301 | no | no |
| | 132 | 19 | M | C | Earlysville | VA | 22936 | no | no |
| | 133 | 19 | M | B | Aiken | SC | 29801 | no | no |
| | 134 | 22 | M | C | Alabama | WV | 26237 | no | no |
| | 135 | 21 | M | C | Murphy | NC | 28906 | no | no |
| | 136 | 19 | M | C | Macon | GA | 31212 | no | no |
| | 137 | 20 | M | C | Waynesville | GA | 31566 | no | no |
| | 138 | 21 | M | C | Tifton | GA | 31794 | no | no |
| | 139 | 24 | M | H | Orlando | FL | 32802 | no | no |
| 2049 | 140 | 19 | M | C | Morrisville | NY | 13408 | no | no |
| | 141 | 18 | M | C | Princeton | NJ | 08540 | no | no |
| | 142 | 18 | M | C | Howell | NJ | 07731 | no | no |
| | 143 | 19 | M | C | Salem | MA | 01970 | no | yes |
| | 144 | 25 | M | H | Bayamon | PR | 00958 | no | no |
| | 145 | 18 | M | H | Kearny | NJ | 07032 | no | no |
| | 146 | 21 | M | C | Manchester | NJ | 08733 | no | no |
| | 147 | 19 | M | C | Windham | CT | 06280 | no | no |
| | 148 | 21 | M | C | Clayton | NJ | 08312 | no | no |
| | 149 | 23 | M | C | Dutch Harbor | AK | 99692 | no | no |
| | 150 | 18 | M | H | Jersey City | NJ | 07303 | no | no |
| | 151 | 18 | M | H | Philadelphia | PA | 19104 | no | no |
| | 152 | 20 | M | C | Rochester | NY | 14692 | no | no |
| | 153 | 19 | M | C | Unity | NH | 03887 | no | no |
| | 154 | 19 | M | C | Hamburg | NY | 14075 | no | no |
| | 155 | 20 | M | C | Merrimac | MA | 01860 | no | no |
| | 156 | 18 | M | C | Mount Sterling | KY | 40353 | no | no |
| | 157 | 21 | M | C | Monroe | NJ | 08831 | yes | no |
| | 158 | 19 | M | C | Troy | MI | 48099 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 159 | 19 | M | C | Ft Walton Beach | FL | 32548 | no | no |
| | 160 | 21 | M | C | Brookline | NH | 03033 | no | no |
| | 161 | 19 | M | C | Hanover | IN | 47243 | no | no |
| | 162 | 19 | M | C | Manville | NJ | 08835 | no | no |
| | **163** | **26** | **M** | **C** | **Towaco** | **NJ** | **07082** | **yes** | no |
| | 164 | 20 | M | C | Tauton | MA | 02780 | no | no |
| | 165 | 19 | M | A | Flushing | NY | 11355 | no | no |
| | 166 | 20 | M | C | Laconia | NH | 03247 | no | no |
| | 167 | 19 | M | C | Flat Rock | MI | 48134 | no | no |
| | 168 | 19 | M | C | Vineland | NJ | 08360 | no | no |
| | 169 | 19 | M | C | Indianapolis | IN | 46206 | no | no |
| | 170 | 19 | M | C | London | KY | 40741 | no | no |
| | 171 | 19 | M | C | Pepperell | MA | 01463 | no | no |
| | 172 | 20 | M | C | Lowell | MA | 01853 | no | no |
| | 173 | 20 | M | C | Middletown | OH | 45042 | no | no |
| | 174 | 22 | M | C | Long Branch | NJ | 07740 | no | no |
| | 175 | 26 | M | C | Alexandria | KY | 41001 | no | no |
| | **176** | **21** | **M** | **C** | **Winchendon** | **MA** | **01475** | **yes** | no |
| | 177 | 18 | M | M | Cincinatti | OH | 45202 | no | no |
| | 178 | 19 | M | H | Keansburg | NJ | 07734 | no | no |
| | 179 | 19 | M | C | Nashville | TN | 37202 | no | no |
| | 180 | 26 | M | C | Buffalo | NY | 14240 | no | no |
| | 181 | 18 | M | C | Wilmington | NC | 28402 | no | no |
| | 182 | 24 | M | H | Matawan | NJ | 07747 | no | no |
| | 183 | 22 | M | C | Saugus | MA | 01906 | no | no |
| | 184 | 20 | M | C | Anderson | IN | 46011 | no | no |
| **2052** | 185 | 20 | M | H | Miami Lakes | FL | 33010 | no | no |
| | 186 | 22 | M | M | Merritt Island | FL | 32953 | no | no |
| | 187 | 22 | M | C | Albertis | PA | 18011 | no | no |
| | 188 | 18 | M | C | Spartanburg | SC | 29306 | no | no |
| | 189 | 19 | M | C | Belton | SC | 29627 | no | no |
| | 190 | 19 | M | C | Bryant Pond | ME | 04219 | no | no |
| | 191 | 21 | M | C | Hoschton | GA | 30548 | no | no |
| | 192 | 18 | M | A | Centreville | VA | 20120 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 193 | 22 | M | C | Dothan | AL | 36302 | no | no |
| | 194 | 17 | M | C | Enon Valley | PA | 16120 | no | no |
| | 195 | 20 | M | C | Greensboro | NC | 27420 | no | no |
| | 196 | 23 | M | H | Harrison | NJ | 07029 | no | no |
| | 197 | 18 | M | C | Annapolis | MD | 21401 | no | no |
| | 198 | 22 | M | B | Ganesville | GA | 30501 | no | no |
| | 199 | 23 | M | C | New York | NY | 10001 | no | no |
| | 200 | 19 | M | H | Tampa | FL | 33601 | no | no |
| | 201 | 20 | M | C | Cocoa Beach | FL | 32931 | no | yes |
| | 202 | 21 | M | C | Thomasville | GA | 31792 | no | no |
| | 203 | 22 | M | C | Birmingham | AL | 35203 | no | no |
| | 204 | 21 | M | C | Atlanta | GA | 30301 | no | no |
| | 205 | 22 | M | C | Sterret | AL | 35147 | no | yes |
| | 206 | 24 | M | C | Covington | LA | 70433 | no | no |
| | 207 | 26 | M | H | Kissimmee | FL | 34744 | no | no |
| | 208 | 23 | M | C | Rye | NY | 10580 | no | no |
| | 209 | 20 | M | M | Woodhaven | NY | 11421 | no | no |
| | 210 | 23 | M | C | Guilderland | NY | 12084 | no | yes |
| | 211 | 18 | M | B | Greenville | SC | 29602 | no | no |
| | 212 | 20 | M | C | Uniondale | PA | 18470 | no | no |
| | 213 | 18 | M | O | Cheektowaga | NY | 14240 | no | no |
| | 214 | 19 | M | C | Queensland | Australia | N/A | no | no |
| | 215 | 18 | M | H | Brooklyn | NY | 11201 | no | no |
| | 216 | 22 | M | H | Ft Lauderdale | FL | 33310 | no | no |
| | 217 | 23 | M | C | Riverdale | GA | 30274 | no | no |
| | 218 | 19 | M | C | New York | NY | 10001 | no | no |
| | 219 | 19 | M | C | Annandale | VA | 22003 | no | no |
| | 220 | 25 | M | C | Royal Oak | MI | 48068 | no | no |
| | 221 | 18 | M | B | St Petersburg | FL | 33733 | no | no |
| | 222 | 20 | M | M | Miami | FL | 33101 | no | no |
| | 223 | 19 | M | H | Burke | VA | 22150 | no | no |
| | 224 | 19 | M | B | Detroit | MI | 48231 | no | no |
| | 225 | 19 | M | C | Anderson | SC | 29621 | no | no |
| | 226 | 24 | M | C | Nashua | NH | 03061 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 227 | 18 | M | C | Birmingham | AL | 35203 | yes | no |
| 2050 | 228 | 18 | M | C | Wilmington | OH | 45177 | no | no |
| | 229 | 19 | M | C | Monroe | LA | 71203 | no | yes |
| | 230 | 24 | M | C | St Clair Shores | MI | 48080 | no | no |
| | 231 | 21 | M | C | Unionville | TN | 37180 | no | no |
| | 232 | 22 | M | C | Dearborn Heights | MI | 48127 | no | no |
| | 233 | 20 | M | C | Columbus | OH | 43216 | no | no |
| | 234 | 22 | M | C | Sterling Heights | MI | 48311 | no | no |
| | 235 | 27 | M | C | Memphis | TN | 38101 | no | no |
| | 236 | 23 | M | C | Johnstown | PA | 15907 | no | no |
| | 237 | 18 | M | C | Ridge | NY | 11961 | no | no |
| | 238 | 24 | M | B | Herndon | VA | 20170 | no | no |
| | 239 | 21 | M | B | Linden | NJ | 07036 | no | no |
| | 240 | 19 | M | H | Miami | FL | 33101 | no | no |
| | 241 | 19 | M | C | Stonewall | LA | 71078 | no | no |
| | 242 | 23 | M | M | Smithtown | NY | 11787 | no | no |
| | 243 | 19 | M | C | Gaithersburg | MD | 20877 | no | no |
| | 244 | 19 | M | H | Bronx | NY | 10451 | no | no |
| | 245 | 21 | m | C | Linden | TN | 37096 | no | no |
| | 246 | 22 | M | C | Birmingham | AL | 35203 | no | no |
| | 247 | 18 | M | C | Westerville | OH | 43082 | no | no |
| | 248 | 19 | M | B | Detroit | MI | 48231 | no | no |
| | 249 | 20 | M | H | Bloomfield | NJ | 07003 | no | no |
| | 250 | 23 | M | H | Miami | FL | 33101 | no | no |
| | 251 | 18 | m | C | Honesdale | PA | 18431 | no | yes |
| | 252 | 22 | M | C | Long Island | NY | 11101 | no | no |
| | 253 | 20 | M | C | Westminster | MD | 21157 | no | no |
| | 254 | 18 | M | C | Clinton | MI | 49236 | no | no |
| | 255 | 19 | M | C | Newport | PA | 17074 | no | no |
| | 256 | 22 | M | C | Old Forge | PA | 18518 | no | no |
| | 257 | 17 | M | B | Detroit | MI | 48231 | no | yes |
| | 258 | 19 | M | C | Monroe | LA | 71203 | no | yes |
| | 259 | 23 | M | M | Lockport | NY | 14094 | no | no |
| | 260 | 21 | M | A | Northbergen | NJ | 07047 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 261 | 19 | M | C | Cuba | OH | 45114 | no | no |
| | 262 | 21 | M | H | Buffalo | NY | 14240 | no | no |
| | 263 | 22 | M | C | Joppa | MD | 21085 | no | no |
| | 264 | 19 | M | C | Endwell | NY | 13762 | no | yes |
| | 265 | 23 | M | B | Harrisburg | PA | 17105 | no | yes |
| | 266 | 19 | M | B | West Orange | NJ | 07052 | no | no |
| | 267 | 20 | M | C | Delaware | OH | 43015 | no | no |
| | 268 | 27 | M | C | Kew Gardens | NY | 11415 | no | no |
| | 269 | 19 | M | A | Flushing | NY | 11355 | no | no |
| | 270 | 19 | M | C | Jeanette | PA | 15644 | no | no |
| | 271 | 20 | M | C | Randolph | NJ | 07869 | no | no |
| | 272 | 19 | M | C | West Palm Beach | FL | 33416 | no | no |
| 2053 | 273 | 22 | M | B | Flowood | MS | 39205 | no | no |
| | 274 | 19 | M | C | Cranston | RI | 02904 | no | no |
| | 275 | 19 | M | C | Seven Hills | OH | 44131 | no | no |
| | 276 | 21 | M | C | New Canaan | CT | 06840 | no | no |
| | 277 | 21 | M | C | Lower Barrel | PA | 15068 | no | no |
| | 278 | 18 | M | H | Barceloneta | PR | 00617 | no | no |
| | 279 | 19 | M | H | Jackson Heights | NY | 11372 | no | no |
| | 280 | 22 | M | C | Bellingham | MA | 02019 | no | no |
| | 281 | 19 | M | B | Miami | FL | 33101 | no | no |
| | 282 | 21 | M | C | Foster | RI | 02825 | no | no |
| | 283 | 20 | M | C | Murfreesboro | TN | 37130 | no | no |
| | 284 | 19 | M | H | Miami | FL | 33101 | no | no |
| | 285 | 21 | M | C | Shelbyville | TN | 37160 | no | no |
| | 286 | 20 | M | B | Providence | RI | 02904 | no | no |
| | 287 | 18 | M | C | Clarksville | TN | 37040 | no | no |
| | 288 | 18 | M | C | Waynesboro | PA | 17268 | no | no |
| | 289 | 20 | M | C | Erie | PA | 16501 | no | no |
| | 290 | 23 | M | B | Virginia Beach | VA | 23450 | no | no |
| | 291 | 17 | M | C | Marietta | PA | 17547 | yes | no |
| | 292 | 21 | M | C | Stockport | OH | 43787 | no | no |
| | 293 | 29 | M | H | Guaynabo | PR | 00970 | no | no |
| | 294 | 20 | M | A | Cranston | RI | 02904 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 295 | 17 | M | C | Avon | CT | 06001 | no | no |
| | 296 | 20 | M | C | Syracuse | NY | 13220 | no | no |
| | 297 | 20 | M | C | Parma | OH | 44101 | no | no |
| | 298 | 20 | M | C | Stockport | OH | 43787 | no | no |
| | 299 | 20 | M | B | Miami | FL | 33101 | no | no |
| | 300 | 19 | M | C | Pittsburgh | PA | 15233 | no | no |
| | 301 | 20 | M | B | Portsmouth | VA | 23707 | no | no |
| | 302 | 20 | M | C | Clinton | MA | 01510 | no | no |
| | 303 | 25 | M | B | Brooklyn | NY | 11201 | no | no |
| | 304 | 27 | M | H | Miramar | FL | 33022 | no | no |
| | 305 | 18 | M | C | Dorset | VT | 05251 | no | no |
| | 306 | 19 | M | C | Warwick | RI | 02886 | no | no |
| | 307 | 27 | M | C | Alpharetta | GA | 30004 | no | no |
| | 308 | 18 | M | C | Pittsburgh | PA | 15233 | no | no |
| | **309** | **19** | **M** | **C** | **Moon Township** | **PA** | **15108** | **yes** | no |
| | 310 | 22 | M | C | New Milford | CT | 06776 | no | no |
| | 311 | 20 | M | H | New York | NY | 10001 | no | no |
| | 312 | 18 | M | C | Pawtucket | RI | 02860 | no | no |
| | 313 | 20 | M | C | Louisville | KY | 40232 | no | no |
| | 314 | 20 | M | H | Weston | FL | 33310 | no | no |
| | **315** | **21** | **M** | **C** | **Plainfield** | **CT** | **06374** | **yes** | **yes** |
| | 316 | 24 | M | C | Oxford | MS | 38655 | no | no |
| | 317 | 22 | M | H | Providence | RI | 02904 | no | no |
| **2054** | 318 | 19 | M | C | Elmira | NY | 14901 | no | no |
| | 319 | 31 | M | B | Washington | DC | 20090 | no | no |
| | 320 | 18 | M | C | Augusta | GA | 30903 | no | no |
| | 321 | 19 | M | C | Dearborn | MI | 48120 | no | no |
| | 322 | 20 | M | C | Canton | OH | 44711 | no | **yes** |
| | 323 | 23 | M | C | Ramney | WV | 25912 | no | no |
| | 324 | 20 | M | C | Port Allen | LA | 70767 | no | no |
| | 325 | 18 | M | C | Carville | LA | 70721 | no | no |
| | 326 | 20 | M | H | Forest Park | GA | 30297 | no | no |
| | 327 | 20 | M | C | Asbury | WV | 24916 | no | no |
| | 328 | 26 | M | C | Knoxville | TN | 37950 | no | no |

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 329 | 22 | M | C | Harwinton | CT | 06791 | no | no |
| | 330 | 19 | M | C | Queensbury | NY | 12801 | no | no |
| | 331 | 29 | M | C | Buffalo | NY | 14240 | no | no |
| | 332 | 22 | M | C | Lawman | NY | 14861 | yes | no |
| | 333 | 17 | M | C | Sellersville | PA | 18960 | no | no |
| | 334 | 21 | M | M | Hudson | FL | 34667 | no | no |
| | 335 | 20 | M | C | St Albans | VT | 05478 | no | no |
| | 336 | 18 | M | H | Philadelphia | PA | 19104 | no | no |
| | 337 | 19 | M | C | Elizabethtown | PA | 17022 | no | no |
| | 338 | 21 | M | C | Boca Raton | FL | 33431 | no | no |
| | 339 | 19 | M | C | Bronx | NY | 10451 | no | no |
| | 340 | 19 | M | H | Tampa | FL | 33601 | no | no |
| | 341 | 19 | M | H | Queens | NY | 11431 | no | no |
| | 342 | 18 | M | C | Brandon | MS | 39042 | no | no |
| | 343 | 18 | M | C | Stockbridge | GA | 30281 | no | no |
| | 344 | 19 | M | B | Savannah | GA | 31402 | no | no |
| | 345 | 21 | M | C | Aedsley | PA | 18703 | no | no |
| | 346 | 19 | M | C | Hampton | VA | 23670 | no | no |
| | 347 | 19 | M | C | Miamisburg | OH | 45343 | no | no |
| | 348 | 21 | M | C | Miami | FL | 33101 | no | no |
| | 349 | 19 | M | H | Isabela | PR | 00662 | no | no |
| | 350 | 21 | M | C | Ypsilanti | MI | 48197 | no | no |
| | 351 | 20 | M | M | Tampa | FL | 33601 | no | no |
| | 352 | 18 | M | C | Columbus | OH | 43216 | no | no |
| | 353 | 17 | M | C | Hartsgrove | OH | 44084 | no | no |
| | 354 | 20 | M | C | Thompson | CT | 6277 | no | no |
| | 355 | 18 | M | C | Williamsport | PA | 17701 | no | no |
| | 356 | 19 | M | C | Springfield | TN | 37172 | no | no |
| | 357 | 19 | M | C | Richmond Hill | GA | 31324 | no | no |
| | 358 | 21 | M | B | Ann Arbor | MI | 48106 | no | no |
| | 359 | 18 | M | C | Diberville | MS | 39530 | yes | no |
| | 360 | 19 | M | C | Slidell | LA | 70458 | no | no |
| | 361 | 20 | M | M | Fairfax | VA | 22030 | no | no |
| | 362 | 24 | M | C | Gauntier | MS | 39553 | no | yes |

| PLATOON | RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | ZIP CODE | MRSA POSITIVE | PRIOR HOSPITALIZATION |
|---|---|---|---|---|---|---|---|---|---|
| | 363 | 25 | M | B | Savannah | GA | 31402 | no | no |
| | 364 | 18 | M | C | Jay | FL | 32565 | no | no |
| | 365 | 18 | M | C | Princeton | WV | 24740 | no | no |
| | 366 | 24 | M | C | Alderson | WV | 24910 | no | no |
| | 367 | 18 | M | C | Pemberville | OH | 43450 | no | no |

**Table 4.7**
**Results for Pre- and Post-Crucible Female Recruits (June 2002)**

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 3 | 20 | F | C | Groveland | FL | no | no |
| 4 | 18 | F | C | Mechanicsville | VA | no | no |
| 5 | 21 | F | B | Havelock | NC | no | no |
| 6 | 19 | F | C | Richfield | MN | no | no |
| 7 | 20 | F | C | Buzzards Bay | MA | no | no |
| 8 | 21 | F | H | Oklahoma City | OK | no | no |
| 9 | 19 | F | C | Fayetteville | AR | no | no |
| 10 | 24 | F | C | Waco | TX | no | yes |
| 11 | 22 | F | C | Baldwin | NY | no | no |
| 12 | 18 | F | B | Carney's Point | NJ | no | no |
| 13 | 23 | F | H | Bronx | NY | no | no |
| 14 | 17 | F | A | Port St Lucie | FL | no | no |
| 16 | 20 | F | B | Triangle | VA | no | no |
| 17 | 17 | F | M | Burton | MI | no | no |
| 18 | 23 | F | C | Gilbert | PA | no | no |

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 21 | 18 | F | M | Charlotte | NC | no | no |
| 24 | 18 | F | C | New Orleans | LA | no | no |
| 25 | 21 | F | M | Albany | GA | no | no |
| 28 | 22 | F | C | Wauwatosa | WI | no | no |
| 30 | 19 | F | C | Limington | ME | no | no |
| 32 | 19 | F | C | Allenstown | NH | no | no |
| 33 | 22 | F | H | Orlando | FL | no | no |
| 35 | 19 | F | O | Burke | VA | no | no |
| 36 | 19 | F | H | Aurora | CO | no | no |
| 37 | 18 | F | H | Miami | FL | no | no |
| 38 | 21 | F | AI | Twin Lakes | MN | no | no |
| 40 | 18 | F | B | Davisboro | GA | no | no |
| 42 | 17 | F | C | Royston | GA | no | no |
| 44 | 21 | F | C | Lafayette | LA | no | no |
| 45 | 19 | F | H | Brentwood | CA | no | no |
| 46 | 23 | F | C | Buffalo | NY | no | no |
| 47 | 20 | F | M | Huntley | IL | no | no |
| 49 | 17 | F | C | Brenham | TX | no | no |
| 50 | 18 | F | M | National City | CA | no | no |
| 51 | 19 | F | M | Westminster | CA | no | no |
| 52 | 18 | F | A | Garden Grove | CA | no | yes |
| 53 | 24 | F | C | Raleigh | NC | no | no |
| 55 | 20 | F | M | Oxnard | CA | no | no |
| 56 | 22 | F | C | Gladstone | IL | no | no |
| 57 | 18 | F | C | Modesto | CA | no | no |
| 59 | 19 | F | H | Santa Rosa | CA | no | no |
| 60 | 17 | F | C | Anderson | CA | no | no |
| 61 | 20 | F | H | San Angelo | TX | no | no |
| 65 | 26 | F | C | Medina | OH | no | no |
| 67 | 19 | F | H | Modesto | CA | no | no |
| 68 | 20 | F | C | Afton | NY | no | no |
| 69 | 18 | F | C | Chicago | IL | no | no |
| 70 | 19 | F | C | Bellevue | WA | no | no |

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 71 | 17 | F | C | Brenham | TX | no | no |
| 72 | 18 | F | H | Sacramento | CA | no | no |
| 73 | 18 | F | C | Ellensburg | WA | no | no |
| 74 | 23 | F | C | LaGrangeville | NY | no | no |
| 75 | 18 | F | C | McHenry | IL | no | no |
| 77 | 17 | F | C | Port Angeles | WA | no | no |
| 78 | 18 | F | C | Cranston | RI | no | no |
| 80 | 21 | F | H | Houston | TX | no | no |
| 81 | 19 | F | B | Waterloo | IA | no | no |
| 82 | 18 | F | H | Santa Ana | CA | no | no |
| 86 | 19 | F | C | Salem | OR | no | no |
| 87 | 20 | F | C | Salt Lake City | UT | no | no |
| 90 | 21 | F | B | St Louis | MO | no | no |
| 93 | 18 | F | H | Tieton | WA | no | no |
| 94 | 18 | F | B | Gilbert | AZ | no | no |
| 368 | 22 | F | O | Edgartown | MA | no | no |
| 369 | 18 | F | C | Redding | CA | no | yes |
| 370 | 20 | F | B | Macon | GA | no | no |
| 371 | 18 | F | C | Stafford | VA | no | no |
| 372 | 19 | F | C | Los Angeles | CA | no | no |

**Table 4.8**
**Results for Pre- and Post-Crucible Male Recruits (June 2002)**

| RECRUIT | AGE | SEX | RACE | CITY ORIGIN | STATE ORIGIN | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 95 | 20 | M | C | Madisonville | TN | no | no |
| 96 | 27 | M | C | Ringgold | GA | no | no |
| 97 | 20 | M | B | Tallahassee | FL | no | no |
| 98 | 19 | M | C | Metter | GA | no | yes |
| 99 | 18 | M | C | Tampa | FL | no | yes |
| 101 | 23 | M | C | Hiram | GA | no | no |
| 102 | 20 | M | C | Kennesaw | GA | no | no |
| 103 | 19 | M | C | Candler | NC | no | no |
| 106 | 27 | M | C | Winston-Salem | NC | no | no |
| 107 | 26 | M | C | Lanexa | VA | no | no |
| 108 | 27 | M | C | Plant City | FL | no | no |
| 109 | 21 | M | H | Kissimmee | FL | no | no |
| 110 | 25 | M | H | Orlando | FL | no | no |
| 111 | 17 | M | C | Bethera | SC | no | no |
| 112 | 20 | M | C | Columbia | SC | no | no |
| 113 | 19 | M | H | Orlando | FL | no | no |
| 114 | 19 | M | AI | Mobile | AL | no | no |
| 115 | 19 | M | C | Tenille | GA | no | no |
| 117 | 21 | M | C | Stuarts Draft | VA | no | yes |
| 118 | 20 | M | C | Charleston | SC | no | yes |
| 122 | 19 | M | C | Poquoson | VA | no | no |
| 125 | 21 | M | C | Friendsville | TN | yes | no |
| 126 | 20 | M | C | Oak Ridge | TN | no | no |
| 127 | 20 | M | AI | Locust Grove | OK | no | no |
| 128 | 19 | M | AI | Cherokee | NC | no | no |
| 133 | 19 | M | B | Aiken | SC | no | no |
| 134 | 22 | M | C | Alabama | WV | no | yes |
| 135 | 21 | M | C | Murphy | NC | no | no |
| 137 | 20 | M | C | Waynesville | GA | no | no |

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 139 | 24 | M | H | Orlando | FL | no | no |
| 140 | 19 | M | C | Morrisville | NY | no | no |
| 142 | 18 | M | C | Howell | NJ | no | no |
| 143 | 19 | M | C | Salem | MA | no | no |
| 144 | 25 | M | H | Bayamon | PR | no | no |
| 145 | 18 | M | H | Kearny | NJ | no | no |
| 146 | 21 | M | C | Manchester | NJ | no | no |
| 147 | 19 | M | C | Windham | CT | no | no |
| 148 | 21 | M | C | Clayton | NJ | no | no |
| 150 | 18 | M | H | Jersey City | NJ | no | no |
| 151 | 18 | M | H | Philadelphia | PA | no | no |
| 152 | 20 | M | C | Rochester | NY | no | no |
| 153 | 19 | M | C | Unity | NH | no | no |
| 154 | 19 | M | C | Hamburg | NY | no | no |
| 155 | 20 | M | C | Merrimac | MA | no | no |
| 156 | 18 | M | C | Mount Sterling | KY | no | no |
| 157 | 21 | M | C | Monroe | NJ | no | no |
| 158 | 19 | M | C | Troy | MI | no | no |
| 160 | 21 | M | C | Brookline | NH | no | no |
| 161 | 19 | M | C | Hanover | IN | no | no |
| 162 | 19 | M | C | Manville | NJ | no | no |
| 163 | 26 | M | C | Towaco | NJ | no | no |
| 164 | 20 | M | C | Tauton | MA | no | no |
| 165 | 19 | M | A | Flushing | NY | no | no |
| 166 | 20 | M | C | Laconia | NH | no | no |
| 168 | 19 | M | C | Vineland | NJ | no | no |
| 169 | 19 | M | C | Indianapolis | IN | no | no |
| 170 | 19 | M | C | London | KY | no | no |
| 171 | 19 | M | C | Pepperell | MA | no | no |
| 172 | 20 | M | C | Lowell | MA | no | no |
| 173 | 20 | M | C | Middletown | OH | no | no |
| 174 | 22 | M | C | Long Branch | NJ | no | no |
| 176 | 21 | M | C | Winchendon | MA | no | no |

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 177 | 18 | M | M | Cincinatti | OH | no | no |
| 178 | 19 | M | H | Keansburg | NJ | no | no |
| 179 | 19 | M | C | Nashville | TN | no | no |
| 180 | 26 | M | C | Buffalo | NY | no | no |
| 181 | 18 | M | C | Wilmington | NC | no | no |
| 182 | 24 | M | H | Matawan | NJ | no | no |
| 183 | 22 | M | C | Saugus | MA | no | no |
| 185 | 20 | M | H | Miami Lakes | FL | no | no |
| 186 | 22 | M | M | Merritt Island | FL | no | no |
| 188 | 18 | M | C | Spartanburg | SC | no | yes |
| 190 | 19 | M | C | Bryant Pond | ME | no | no |
| 191 | 21 | M | C | Hoschton | GA | no | no |
| 192 | 18 | M | A | Centreville | VA | no | no |
| 193 | 22 | M | C | Dothan | AL | no | no |
| 194 | 17 | M | C | Enon Valley | PA | no | no |
| 195 | 20 | M | C | Greensboro | NC | no | no |
| 196 | 23 | M | H | Harrison | NJ | no | no |
| 197 | 18 | M | C | Annapolis | MD | no | no |
| 199 | 23 | M | C | New York | NY | no | no |
| 200 | 19 | M | H | Tampa | FL | no | no |
| 201 | 20 | M | C | Cocoa Beach | FL | no | no |
| 202 | 21 | M | C | Thomasville | GA | no | no |
| 203 | 22 | M | C | Birmingham | AL | no | no |
| 204 | 21 | M | C | Atlanta | GA | no | no |
| 206 | 24 | M | C | Covington | LA | no | no |
| 207 | 26 | M | H | Kissimmee | FL | no | no |
| 208 | 23 | M | C | Rye | NY | no | yes |
| 209 | 20 | M | M | Woodhaven | NY | no | no |
| 210 | 23 | M | C | Guilderland | NY | no | no |
| 211 | 18 | M | B | Greenville | SC | no | yes |
| 213 | 18 | M | O | Cheektowaga | NY | no | no |
| 214 | 19 | M | C | Queensland | Australia | no | no |
| 215 | 18 | M | H | Brooklyn | NY | no | no |

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 216 | 22 | M | H | Ft Lauderdale | FL | no | no |
| 217 | 23 | M | C | Riverdale | GA | no | no |
| 218 | 19 | M | C | New York | NY | no | no |
| 219 | 19 | M | C | Annandale | VA | no | yes |
| 221 | 18 | M | B | St Petersburg | FL | no | no |
| 222 | 20 | M | M | Miami | FL | no | no |
| 223 | 19 | M | H | Burke | VA | no | no |
| 224 | 19 | M | B | Detroit | MI | no | no |
| 225 | 19 | M | C | Anderson | SC | no | no |
| 226 | 24 | M | C | Nashua | NH | no | no |
| 227 | 18 | M | C | Birmingham | AL | no | no |
| 229 | 19 | M | C | Monroe | LA | no | no |
| 230 | 24 | M | C | St Clair Shores | MI | no | no |
| 231 | 21 | M | C | Unionville | TN | no | no |
| 232 | 22 | M | C | Dearborn Heights | MI | no | no |
| 233 | 20 | M | C | Columbus | OH | no | no |
| 234 | 22 | M | C | Sterling Heights | MI | no | no |
| 235 | 27 | M | C | Memphis | TN | yes | |
| 236 | 23 | M | C | Johnstown | PA | no | yes |
| 237 | 18 | M | C | Ridge | NY | no | no |
| 238 | 24 | M | B | Herndon | VA | no | no |
| 239 | 21 | M | B | Linden | NJ | no | yes |
| 240 | 19 | M | H | Miami | FL | no | no |
| 242 | 23 | M | M | Smithtown | NY | no | no |
| 243 | 19 | M | C | Gaithersburg | MD | no | no |
| 245 | 21 | m | C | Linden | TN | no | no |
| 247 | 18 | M | C | Westerville | OH | no | no |
| 250 | 23 | M | H | Miami | FL | no | no |
| 251 | 18 | m | C | Honesdale | PA | no | no |
| 252 | 22 | M | C | Long Island | NY | no | no |
| 254 | 18 | M | C | Clinton | MI | no | no |
| 255 | 19 | M | C | Newport | PA | yes | yes |
| 256 | 22 | M | C | Old Forge | PA | no | no |

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| **259** | **23** | **M** | **M** | **Lockport** | **NY** | no | **yes** |
| 260 | 21 | M | A | Northbergen | NJ | no | no |
| 261 | 19 | M | C | Cuba | OH | no | no |
| 262 | 21 | M | H | Buffalo | NY | no | no |
| 263 | 22 | M | C | Joppa | MD | no | no |
| 266 | 19 | M | B | West Orange | NJ | no | no |
| **268** | **27** | **M** | **C** | **Kew Gardens** | **NY** | no | **yes** |
| 270 | 19 | M | C | Jeanette | PA | no | no |
| 271 | 20 | M | C | Randolph | NJ | no | no |
| 272 | 19 | M | C | West Palm Beach | FL | no | no |
| **273** | **22** | **M** | **B** | **Flowood** | **MS** | no | yes |
| **274** | **19** | **M** | **C** | **Cranston** | **RI** | no | yes |
| **275** | **19** | **M** | **C** | **Seven Hills** | **OH** | **yes** | **yes** |
| **276** | **21** | **M** | **C** | **New Canaan** | **CT** | no | yes |
| 277 | 21 | M | C | Lower Barrel | PA | no | no |
| 278 | 18 | M | H | Barceloneta | PR | no | no |
| 279 | 19 | M | H | Jackson Heights | NY | no | no |
| 280 | 22 | M | C | Bellingham | MA | no | no |
| 281 | 19 | M | B | Miami | FL | no | no |
| 282 | 21 | M | C | Foster | RI | no | no |
| 284 | 19 | M | H | Miami | FL | no | no |
| 285 | 21 | M | C | Shelbyville | TN | no | no |
| 287 | 18 | M | C | Clarksville | TN | no | no |
| 289 | 20 | M | C | Erie | PA | no | no |
| 290 | 23 | M | B | Virginia Beach | VA | no | no |
| **291** | **17** | **M** | **C** | **Marietta** | **PA** | no | **yes** |
| 292 | 21 | M | C | Stockport | OH | no | no |
| 294 | 20 | M | A | Cranston | RI | no | no |
| 295 | 17 | M | C | Avon | CT | no | no |
| 296 | 20 | M | C | Syracuse | NY | no | no |
| 297 | 20 | M | C | Parma | OH | no | no |
| 298 | 20 | M | C | Stockport | OH | no | no |
| 299 | 20 | M | B | Miami | FL | no | no |

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 300 | 19 | M | C | Pittsburgh | PA | no | yes |
| 301 | 20 | M | B | Portsmouth | VA | no | no |
| 302 | 20 | M | C | Clinton | MA | no | no |
| 303 | 25 | M | B | Brooklyn | NY | no | no |
| 304 | 27 | M | H | Miramar | FL | no | no |
| 306 | 19 | M | C | Warwick | RI | no | no |
| 307 | 27 | M | C | Alpharetta | GA | no | no |
| 309 | 19 | M | C | Moon Township | PA | no | yes |
| 310 | 22 | M | C | New Milford | CT | no | no |
| 313 | 20 | M | C | Louisville | KY | no | no |
| 314 | 20 | M | H | Weston | FL | no | no |
| 315 | 21 | M | C | Plainfield | CT | no | no |
| 316 | 24 | M | C | Oxford | MS | no | no |
| 318 | 19 | M | C | Elmira | NY | no | no |
| 319 | 31 | M | B | Washington | DC | no | yes |
| 320 | 18 | M | C | Augusta | GA | no | no |
| 321 | 19 | M | C | Dearborn | MI | no | no |
| 323 | 23 | M | C | Ramney | WV | no | no |
| 324 | 20 | M | C | Port Allen | LA | no | no |
| 326 | 20 | M | H | Forest Park | GA | no | no |
| 327 | 20 | M | C | Asbury | WV | no | no |
| 328 | 26 | M | C | Knoxville | TN | no | no |
| 329 | 22 | M | C | Harwinton | CT | no | no |
| 330 | 19 | M | C | Queensbury | NY | no | no |
| 331 | 29 | M | C | Buffalo | NY | no | no |
| 332 | 22 | M | C | Lawman | NY | no | yes |
| 334 | 21 | M | M | Hudson | FL | no | no |
| 337 | 19 | M | C | Elizabethtown | PA | no | yes |
| 338 | 21 | M | C | Boca Raton | FL | no | yes |
| 339 | 19 | M | C | Bronx | NY | no | no |
| 340 | 19 | M | H | Tampa | FL | no | no |
| 341 | 19 | M | H | Queens | NY | no | no |
| 342 | 18 | M | C | Brandon | MS | yes | no |

| RECRUIT | AGE | SEX | RACE | ORIGIN CITY | ORIGIN STATE | MRSA POSITIVE PRE-CRUCIBLE | MRSA POSITIVE POST-CRUCIBLE |
|---|---|---|---|---|---|---|---|
| 343 | 18 | M | C | Stockbridge | GA | no | yes |
| 344 | 19 | M | B | Savannah | GA | no | yes |
| 345 | 21 | M | C | Aedsley | PA | no | no |
| 346 | 19 | M | C | Hampton | VA | no | no |
| 349 | 19 | M | H | Isabela | PR | no | no |
| 350 | 21 | M | C | Ypsilanti | MI | no | no |
| 352 | 18 | M | C | Columbus | OH | no | no |
| 353 | 17 | M | C | Hartsgrove | OH | no | no |
| 355 | 18 | M | C | Williamsport | PA | no | no |
| 356 | 19 | M | C | Springfield | TN | no | no |
| 357 | 19 | M | C | Richmond Hill | GA | no | no |
| 358 | 21 | M | B | Ann Arbor | MI | no | no |
| 359 | 18 | M | C | Diberville | MS | no | no |
| 360 | 19 | M | C | Slidell | LA | no | no |
| 361 | 20 | M | M | Fairfax | VA | no | no |
| 362 | 24 | M | C | Gauntier | MS | no | yes |
| 363 | 25 | M | B | Savannah | GA | no | no |
| 364 | 18 | M | C | Jay | FL | no | no |
| 365 | 18 | M | C | Princeton | WV | yes | no |
| 366 | 24 | M | C | Alderson | WV | no | no |
| 367 | 18 | M | C | Pemberville | OH | no | no |
| 373 | 19 | M | C | Jasper | AL | no | no |
| 374 | 23 | M | C | Wendell | NC | no | no |
| 375 | 19 | M | B | Norwalk | CT | no | no |
| 376 | 20 | M | B | Atlanta | GA | no | no |
| 377 | 20 | M | O | Westminster | MD | no | no |
| 378 | 20 | M | O | Woodhaven | NY | no | no |
| 379 | 23 | M | C | Athens | GA | no | no |

### 1. Geographical Distribution

ArcView® GIS is a software program developed by Environmental Systems Research Institute, Inc., and can be utilized to perform geographical analysis of data. The program is useful for understanding geographic relationships, solving complex problems, and gaining awareness on possible solutions. (ESRI, 1996)

This program was utilized in this report to illustrate the geographic distribution of Marine Corps recruits entering basic training. The significance of this distribution was to determine any trends in prevalence of MRSA colonization among recruits from their city and state of origin, and to illustrate the geographic distribution of previous hospitalization.

The program procedures included obtaining the zip codes for each recruit from the data provided in Figure 3.2 and geocoding the data based on five digit zip codes. Geocoding is the process of adding point locations defined by five digit Zip postal codes to the map. ArcView® GIS supports the following address formats: US street address with zone, US street address without zone, Zip+4 postal codes, five digit Zip postal codes, and single field identifiers, such as land parcel numbers and school district codes. The geocoding process involved loading the database (excel format) as a table. Once the database was loaded, the program matched the five digit Zip codes to the most likely candidates and yielded a match score. Candidates with scores between 75 and 100% were considered good matches, and scores below 75% were considered less reliable. (ESRI, 1996)

Figures 4.5, 4.6, and 4.7 illustrate the geographic distributions of recruits upon entry into basic training, the distribution of initial MRSA colonized recruits, and the

recruits who were hospitalized within the last year utilizing the ArcView® GIS program with a match score of 97%.

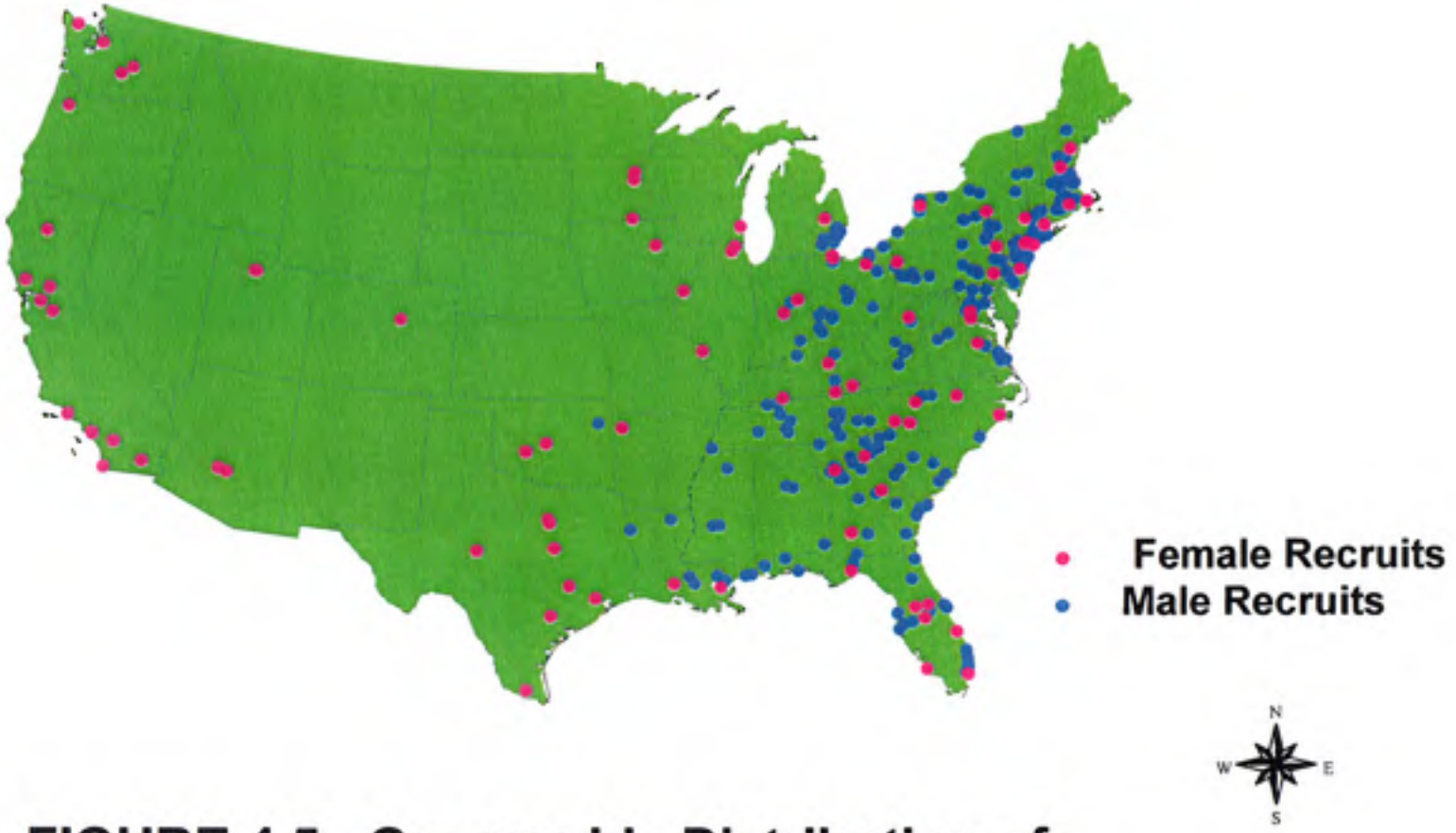



**FIGURE 4.5 - Geographic Distribution of Recruits Upon Entry into BasicTraining**

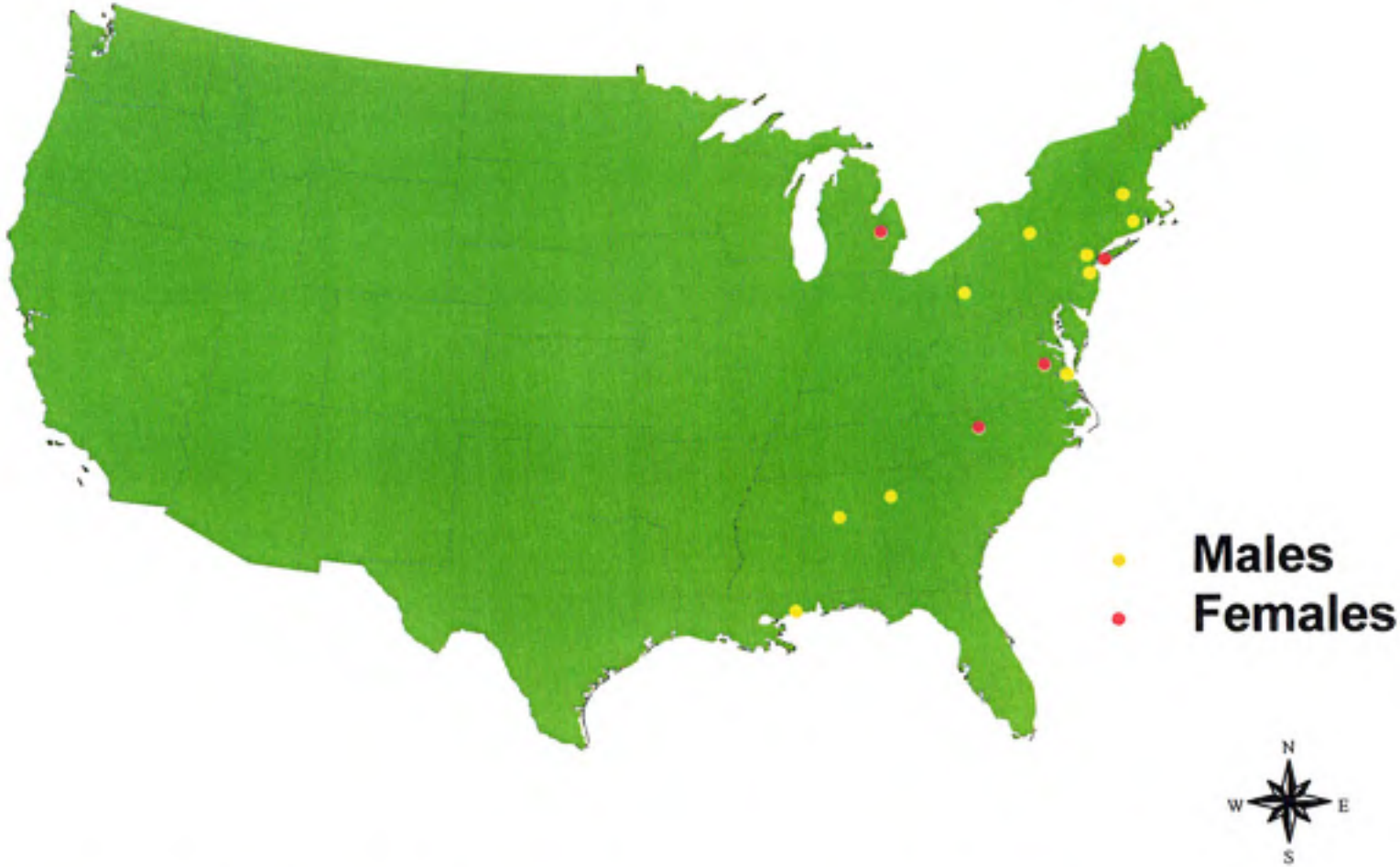



**Figure 4.6 - Distribution of Initial MRSA Colonized Recruits**

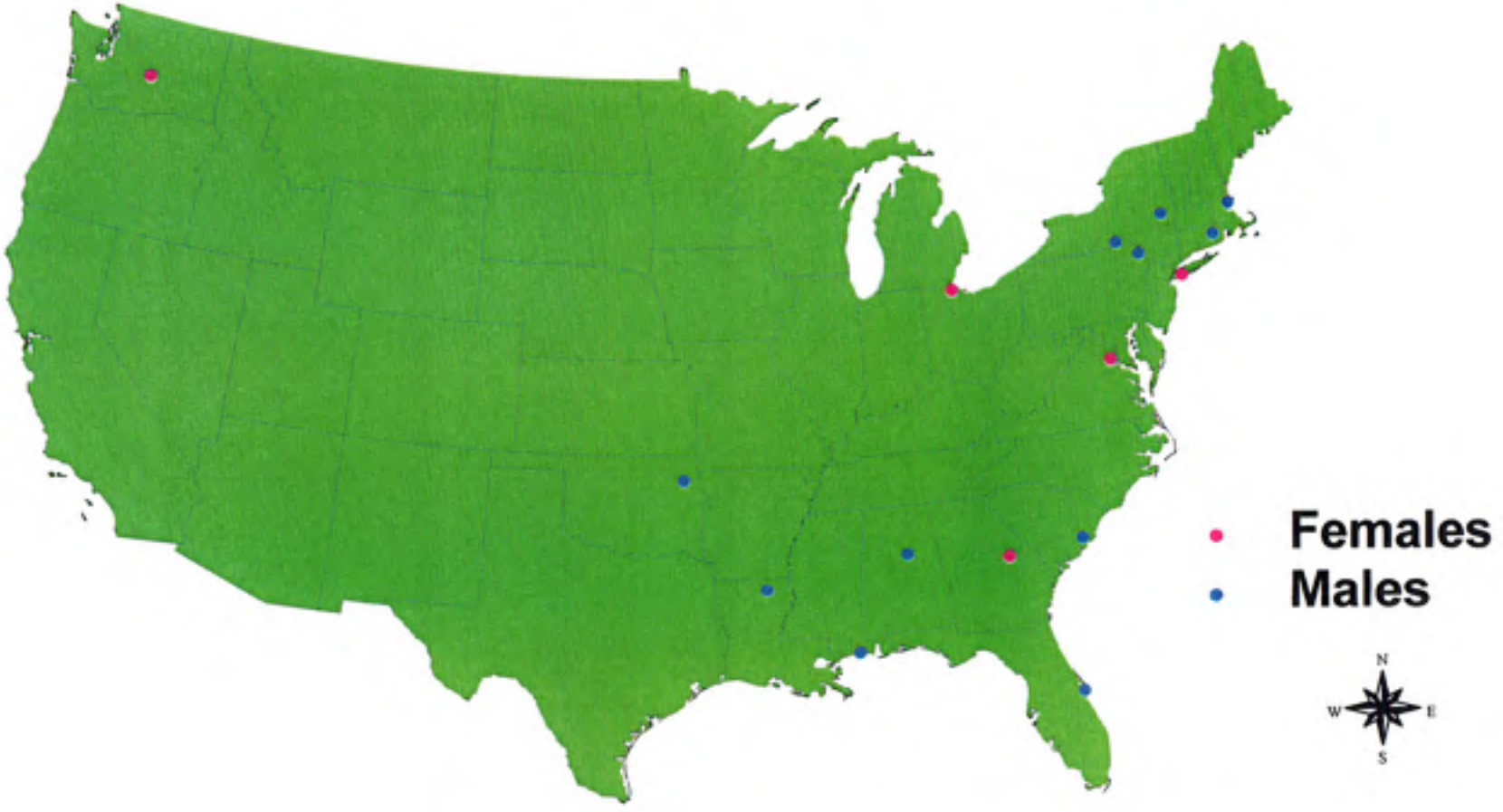



Figure 4.7 - Geographic Distribution of Initial Recruits Hospitalized within the Last Year

## V. DISCUSSION OF RESULTS

The main purpose of this investigation was to assess the prevalence of MRSA colonization among 367 Marine Corps recruits during basic training. Three samples were acquired from recruits as detailed earlier in III. D. Figure 5.1 illustrates the MRSA colonization prevalence during the twelve-week training period.

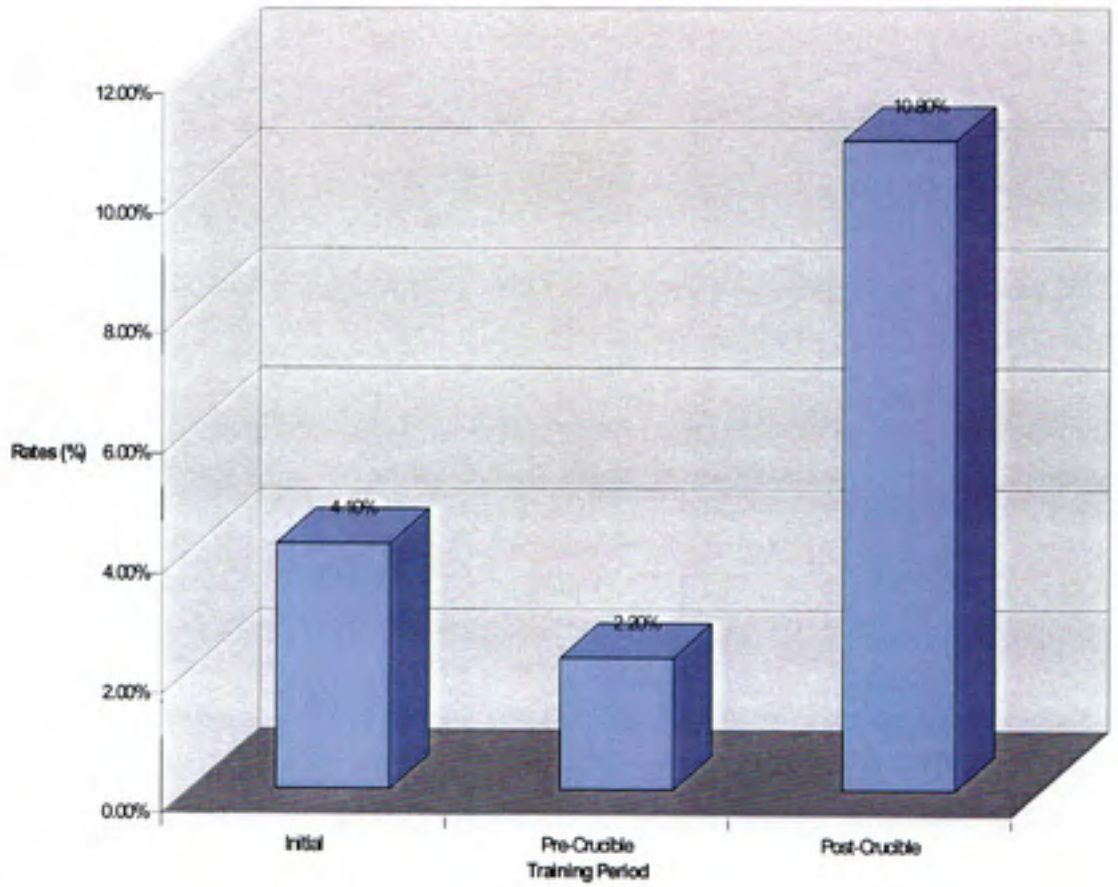



Figure 5.1 – MRSA Colonization Prevalence Rates of Recruits During Basic Training

The decrease in prevalence for pre-crucible samples may be attributed to sampling errors mentioned in III. B., personal hygiene awareness from the knowledge of the investigation, or an anomaly.

The pre- and post-crucible prevalence rates were based on 278 Marine Corps recruits that remained in training from the initial 367 recruits at the beginning of the investigation. Eighty-nine (89) recruits were lost to follow-up due to separation from active duty, medical hold, or setback in training (58 males, 31 females). Twelve recruits were gained during training (7 males, 5 females), but they were not utilized in calculating prevalence or statistical analysis due to inability to assess their initial MRSA colonization status. The initial recruit prevalence rate was calculated utilizing the initial recruit population of 367.

Environmental samples, with a prevalence rate of 2.1% (2 out of 94 samples were MRSA positive), and staff samples, with a prevalence rate of 1.5% (1 out of 67 samples were MRSA positive), were not tested beyond the initial sample collected. This decision was made the NEPMU-2 physician epidemiologist due to low prevalence rates and stability in their geographic location. Additionally, statistical analysis was not conducted on these samples due to insignificant low rates.

## A. Statistical Analysis

The MRSA risk factors of age, sex, race, and hospitalization within the last year were not analyzed in this investigation due to small sub-sample sizes, which would render hypothesis testing insignificant. Therefore, presentation of all data should be interpreted with caution.

The statistical analysis utilized for this investigation was the McNemar chi-squared ($\chi^2$) test for before-after measurements. This test is a marginal homogeneity of proportions, which determines whether the proportion responding under two conditions is the same. Adjustments are made for the fact that the data involve pairs (each pair is one observation under one condition and one observation under the other condition). The McNemar chi-squared ($\chi^2$) test formula including Table 5.1, which illustrates the cell categories comparing two criterion of classification that the test formula is based on, follows:

$$\chi^2 = (b\text{-}c)^2 / b + c$$

for

**Table 5.1**
**2 x 2 Contingency Table**

| | |
|---|---|
| a | b |
| c | d |

Statistical analysis was performed on the initial, pre-crucible, and post-crucible prevalence rates to determine if there was a similar significance between the initial prevalence rates and pre/post-crucible prevalence rates. Tables 5.2 and 5.3 are the contingency tables of initial by pre-crucible rates and initial by post-crucible rates. Each table is followed by the McNemar chi-squared ($\chi^2$) test, which is compared to the critical $\chi^2$ with one degree of freedom at the 0.05 significance level (95% confidence). One degree of freedom is based on the number of rows minus one multiplied by the number of columns minus one [(r-1)(c-1)] rule for finding degrees of freedom to a 2 x 2 contingency table. (Daniel, 1999)

**Table 5.2**
**Initial Prevalence Rates by Pre-Crucible Prevalence Rates**

| Pre-Crucible Prevalence Rates | | | | |
|---|---|---|---|---|
| Initial Prevalence Rates | | + | - | Total Recruits |
| | + | 0 | 15 | 15 |
| | - | 6 | 257 | 263 |
| | Total Recruits | 6 | 272 | 278 |

McNemar $\chi^2 = (15-6)^2 / 15 + 6 = 3.86$

Critical $\chi^2$ (1 df) at 0.05 significance level = 3.84

McNemar $\chi^2$ (3.86) > Critical $\chi^2$ (3.84), so reject $H_0$

**Table 5.3**
**Initial Prevalence Rates by Post-Crucible Prevalence Rates**

| Post-Crucible Prevalence Rates | | | | |
|---|---|---|---|---|
| Initial Prevalence Rates | | + | - | Total Recruits |
| | + | 2 | 13 | 15 |
| | - | 28 | 235 | 263 |
| | Total Recruits | 30 | 248 | 278 |

McNemar $\chi^2 = (13-28)^2 / 13 + 28 = 5.48$

Critical $\chi^2$ (1 df) at 0.05 significance level = 3.84

McNemar $\chi^2$ (5.48) > Critical $\chi^2$ (3.84), so reject $H_0$

Based on the McNemar chi-squared ($\chi^2$) test on the initial by pre-crucible rates and the initial by post-crucible rates, the rates are significantly different. This means that the initial prevalence rate of MRSA positives differs from the pre-and post-crucible prevalence rates of MRSA positives.

## VI. CONCLUSION

This investigation was initiated to assess MRSA colonization among Marine Corps recruits due to an increase in MRSA cases witnessed by a physician at the MCRD Naval Medical Clinic. NEPMU-2 developed and conducted the investigation plan in March and June 2002. Three hundred and sixty-seven (367) recruits were initially selected and 278 of those initial recruits were available for two follow-up samples. The inferences made herein may not reflect the actual assessment of MRSA colonization of recruits at MCRD, Parris Island, because the investigation population was not randomly sampled from the entire population of recruits. Also, recruits who were lost to follow-up (dropouts, setbacks in training, medical hold) did not have additional information collected on their MRSA colonization status during this investigation. Additionally, this investigation occurred during the off-peak recruiting months (October through May), so recruit populations were significantly lower than peak recruiting months (June through September).

The purposes of this investigation were to determine if MRSA colonization was a result of recruit basic training and if an intervention strategy needs to be implemented to decrease the transmission of MRSA during recruit basic training. Based on the statistical analysis of initial prevalence rates by pre- and post-crucible prevalence rates, the rates of MRSA positives were significantly different between the initial and pre-/ post-crucible samples. The most significant difference was the drop in prevalence rate from the initial to pre-crucible samples. The investigation brief (Figure 3.1) presented

to participating recruits by NEPMU-2 may have affected recruits attention to personal hygiene throughout training, and ultimately affected the pre-crucible prevalence rates. In addition to personal hygiene awareness, sampling technique error, colonized recruits becoming infected and dropping out of training, possible antibiotic treatment during the time period between the initial sample and pre-crucible sample, or an anomaly may have attributed to the drop in prevalence rates from the initial samples to the pre-crucible samples. All of these factors, acting alone or in combination, may explain the difference in rates. Future studies considering these factors may reveal definitive conclusions.

The results of the environmental and staff samples indicate a low prevalence rate, but MRSA transmission from these sources cannot be ruled out due to the scope of the investigation. Colonization can occur anytime from numerous sources, so the risk of transmission will remain, especially in close quarters of recruit training. Due to known colonization of MRSA within MCRD, Parris Island, intervention strategies should be implemented that emphasize thorough personal hygiene practices by recruits and education of recruits, drill instructors, and medical staff members on prevention and transmission of MRSA. NEPMU-2 will be responsible for making appropriate recommendations to the medical department chain-of-command on intervention strategies when the complete investigation is concluded.

Although statistical analysis revealed a significant difference in prevalence rates between initial samples and pre-/post-crucible samples, this investigation did disclose an increase in MRSA colonization following the crucible. If the low prevalence rate of the pre-crucible samples is valid, the comparatively high prevalence rate of post-

crucible samples may be indicative of factors during the crucible affecting MRSA colonization. Future efforts, such as investigations or studies, should focus on the risk factors of MRSA transmission involved in the crucible-training period. Further analysis of recruit populations should also focus on the total population during peak recruitment months to obtain a true assessment of MRSA colonization.

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