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COVER: CAPT Dale M. Molé, MC, Director of Undersea Medicine and Radiation Health at BUMED, conducts a medical evaluation of a Quecreek mine disaster survivor. Story on page 18. Photo by PHAN Samuel Price, USN.

Re-Emerging Malaria on Java

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The East Asian economic crisis of 1997 precipitated tumultuous social and political events in Indonesia. Already marginal budgets for health care and disease control withered and even today have only slightly recovered. The economic crisis rendered many millions of people vulnerable to endemic infectious diseases, especially to those that had been under control. The re-emergence of endemic malaria on Java is an example and represents an important new threat to public health in Indonesia. The Naval Medical Research Unit 2 (NAMRU-2) engages this problem with partners from the Indonesian Ministry of Health (MOH), U.S. Agency for International Development (USAID), and the World Health Organization (WHO). This engagement illustrates the humanitarian, technical, and diplomatic facets inherent in the mission of a DOD OCONUS laboratory, and how accomplishing that mission sometimes addresses critical infectious disease issues in developing host nations.

Over 120 million people live on the island of Java in the Indonesian archipelago of Southeast Asia (Fig. 1). Indonesia is the world's fourth most populous nation, and over half of all Indonesians live on Java. Rich volcanic soil and a tropical climate support the most densely populated large area anywhere, with about 950 people per square kilometer. Most of the 600-mile length of Java is forested hills, terraced rice paddies, and plantations of coffee, tea, rubber, clove, teak, vanilla, and quinine. This rich habitat also supports an abundance of potential vectors of human disease, including the anopheline mosquito vectors of malaria.

Endemic malaria thrived on Java until the 1950s. Among the several thousand Dutch newcomers to Batavia (now Jakarta, in western Java) each year in the 1700s, less than half survived their first year.(*1*) As recently as the 1920s a survey at several sites across the island found more than 80 percent of people with enlarged spleens(*2*) (a sign of chronic exposure to malaria). Examinations of blood films from people in rural areas of Java before World War II usually revealed more than 75 percent to be carrying the parasites that cause malaria. However, in a span of just 6 years, beginning in 1952, an island-wide DDT spraying campaign essentially eradicated malaria from East and West Java and narrowed it to a few foci in Central Java.(*3,4*) Between 1960 and 1995 the reported annual incidence of malaria on Java rarely exceeded 0.1 cases per 1,000 residents.(*5*) Two generations of Javanese grew up without knowing malaria.

Today the risk of malaria on Java spirals upward. Outbreaks, once a rare event occurring every few years in isolated areas with limited impact, now occur at least several times per year, involve more heavily populated areas, and tend to persist. The Thousand Islands, an archipelago of many small islands just north of Jakarta, were known to be free of malaria in the late 1980s. Surveys conducted by NAMRU-2 last year revealed endemic malaria on several of the islands, including an island just 2 km from Jakarta with over half of the residents having malaria [Maguire JD, unpublished].

In Purworejo District in Central Java the number of slide-confirmed

cases had remained stable up to 1995 at around 5,000 per year.(*5,6*) In 2000 over 37,000 cases were confirmed among the approximately 750,000 residents.(*5*) Confirmed cases represent probably less than half of actual cases. Among the hardest hit areas within Purworejo, the annual parasite incidence (API, cases/1,000 residents/yr) increased from consistently less than 30 to over 300. Similar outbreaks occurred in the districts of Kulon Progo, Banjarnegara, and Cilacap. In Central Java as a whole, the API increased from 0.1 in 1995 to over 1.8 in 2000 (see Fig. 2). On Java as a whole, the API increased from less than 0.1 in 1995 to over 0.8 in 2000. Where the API ceiling may rest on Java is not clear, but in other areas of Indonesia the API exceeds several hundred cases per 1,000 residents per year. On the basis of past risk of malaria on Java, the potential for considerably higher incidence may be considered great.

Figure 1: Map of Southeast Asia shows location of Java among the major islands in the Indonesian archipelago. Arrow indicates location of Jakarta, where NAMRU-2 is located.

NAMRU-2 Responds: Emergency Intervention

NAMRU-2 responded to this potential crisis on Java, joining forces with the handful of resident institutions with expertise in control of malaria. NAMRU-2 and its hosts within the National Health Research Center of the MOH bring the only full capability for conducting definitive studies of mosquito vector biology and susceptibility to insecticides, and parasite susceptibility to therapeutic agents in direct support of operational strategies to bring malaria under control. These vital resources at NAMRU-2, supported within the framework of the U.S. Military Infectious Diseases Research Program (MIDRP) and the DOD Global Emerging Infections Surveillance (GEIS) Program, are being brought to bear against the emerging malaria problem on Java.

During the year 2000 NAMRU-2 initiated clinical studies to ascertain the therapeutic response to available antimalarial drugs at Purworejo in the Menoreh Hills of Central Java. This work led to recognition of a high rate of resistance to available therapies (60 percent for chloroquine and 30 percent pyrimethamine/sulfadoxine, the first- and second-line therapies), and revealed a rapidly deteriorating malaria situation in that region. NAMRU-2 alerted authorities in the MOH, and simultaneously approached the WHO in Geneva and USAID in Jakarta and Washington for assistance. This consortium met over a period of several months in early 2001 and formulated an emergency intervention for the Menoreh Hills. USAID provided the $500,000 needed to execute it. The intervention brought rapid diagnostics, an effective new therapy, and a campaign of residual indoor insecticide spraying into the hardest-hit areas. A total of 62 villages, home to 170,000 people, were targeted for intervention. The activity identified and treated over 12,000 cases of malaria. At several sentinel villages, NAMRU-2 documented a broad decrease in the prevalence of malaria between 2000 and 2002: among the 5,524 blood films screened (same villages in same month), the overall prevalence of malaria fell from 33 percent and 37 percent in 2000 and 2001 to 14 percent in 2002.

In 2000 NAMRU-2 also established a permanent entomological research station at Purworejo. This facility continues conducting longitudinal studies of the mosquitoes responsible for the epidemic, documenting essential facts on feeding and breeding behaviors that guide critical

decisions on vector control strategies. The emergency intervention in the Menoreh Hills enters its final phase of further active case detection and application of indoor residual insecticides during July and August 2002.

Providing a Platform for Capacity Building in Malaria Control

Though modest successes were achieved with the intervention, the strategy was not sustainable or intended as such. It was as an emergency measure to diminish expediently risk of infection as much as possible, like using a fire extinguisher before the firemen arrive. In the long term, the intervention would have minimal impact without follow-up, bringing sustainable malaria control capabilities to the region. NAMRU-2 again stepped up to a key role in developing a long-term strategy in partnership with MOH, USAID, and WHO. Indonesia lacked an organization committed to bringing available donor resources to bear on the malaria problem on Java. Such an organization had not been needed because the problem had been essentially absent for over 40 years. NAMRU-2 conceived a consortium of institutions within Indonesia expressly for identifying strategic objectives in malaria control in Central Java, and then applying donor resources to specific technical tasks to meet those objectives. The MOH supported the concept and USAID was approached with a proposal for the "Koalisi Antimalaria Indonesia" (KAMI, or the Indonesian Coalition Against Malaria). USAID agreed to fund KAMI with $4 million over 4 years through a Participating Agency Service Agreement (PASA) with NAMRU-2. This agreement, approaching signature stage as of this writing in June 2002, poises NAMRU-2 to move immediately to hire dedicated KAMI personnel positioned in office spaces provided by the MOH Sub-Directorate for Malaria Control located near NAMRU-2 in Jakarta.

KAMI, supported by USAID funds channeled through NAMRU-2, represents a short-term strategy to achieve a long-term objective. In essence, NAMRU-2 provides a temporary platform upon which an organization capable of competing for donor funds aimed at capacity building in malaria control is established. NAMRU-2 intends to construct a KAMI having the administrative and fiscal wherewithal to receive and disburse resources to the satisfaction of international government and non-government donor agencies. The successful transfer of accounting, purchasing, and contracting procedures play a key role in KAMI ultimately standing as an independent entity funded directly by USAID and other donor agencies. More importantly, KAMI must achieve a track record of successful application of donor resources to achieve and sustain malaria control on the ground in Central Java. The resident expertise in malaria control at NAMRU-2 and at the MOH represents the key to these successes.

What KAMI ultimately aims to achieve is overhaul of the malaria control strategy in Indonesia, and on Java in particular. As the re-emerging malaria problem on Java testifies, the malaria control strategy in Indonesia urgently needs restructuring. Current strategy was based on a powerful central government distributing effective and affordable therapies, along with a highly cost-effective DDT spraying strategy. This landscape has changed radically: Government power has been abruptly decentralized, available therapies are no longer effective, and DDT was banned in Indonesia in 1990. KAMI aims to constitute what amounts to region-specific tool boxes for malaria control for use by the local authorities that now carry the responsibility for executing malaria control.

The Malaria Control Tool Box

As a partner and host institution of KAMI, NAMRU-2 will participate in the process of identifying specific malaria control tools and developing specific guidelines for their application by local health authorities. KAMI seeks to buttress what may be considered the five pillars of malaria control—diagnosis, treatment, vector control, surveillance, and community action. The broad technical objectives for these may be summarized as follows:

Diagnosis – a functional microscope and certified microscopist for the diagnosis of malaria in every clinic serving areas of risk.

Treatment – availability of effective therapy for malaria in every clinic serving areas of high risk.

Vector control – availability of high quality insecticide-treated bed nets at affordable prices to informed residents of high-risk areas.

Surveillance – a functional surveillance system that provides real-time estimates of risk of infection linked to geographical information

systems in every local malaria control office.

Community action – communities in areas of high risk understand their exposure and the means at their disposal for minimizing that risk, e.g., seeking treatment, compliance to prescribed therapy, use of bed nets, etc.

The responsibility for implementing malaria control strategies ultimately rests on the MOH and local health authorities. The role of NAMRU-2 has been to facilitate restructuring the strategies for accomplishing the control of malaria in an environment of broad social, economic, and political changes that resulted in sharp slippage of control. NAMRU-2 created and will incubate the development of KAMI as an independent vehicle for achieving malaria control. The DOD OCONUS laboratories thus provide the means of not only conducting research on the infectious diseases that threaten U.S. military personnel as the core mission, but also catalyze local efforts to control these diseases. In a broad sense, this approach also minimizes risk to deployed forces by addressing the reservoir of infection among residents. Moreover, conducting work of direct and tangible benefit to the public health of host nations buttresses the nation-to-nation relationship that allows the U.S. DOD laboratory to carry out its core research mission.

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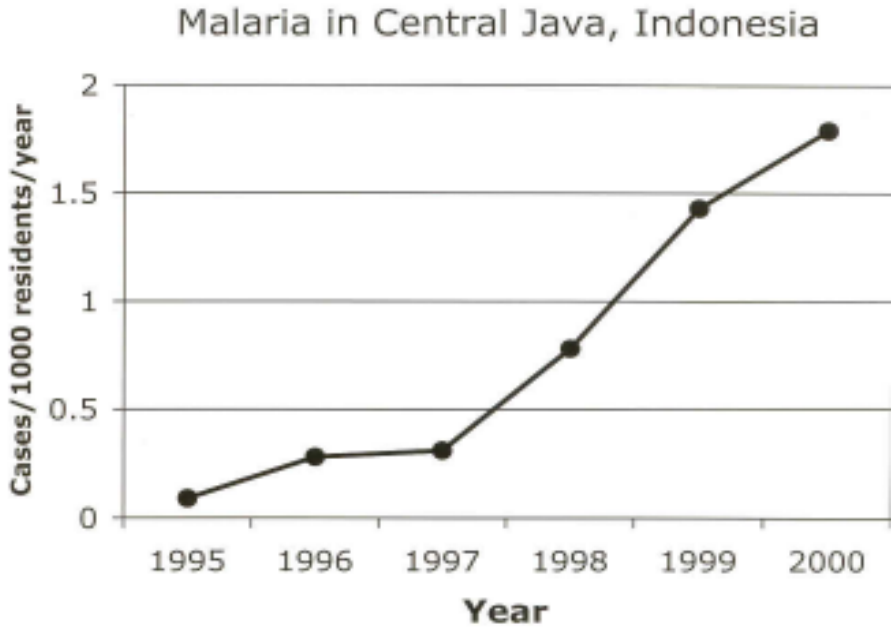

Figure 2: Graph illustrates the increasing incidence of malaria in the province of Central Java.

Evaluating the Long-Term Health Impact of Military Service

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Does military service, in particular operational deployment, result in a higher risk of chronic illness among military personnel and veterans? The Millennium Cohort Study, the largest Department of Defense prospective study ever conducted, will attempt to answer this question.(*1*)

Legacy of the Gulf War

The 1999 Institute of Medicine report, *Measuring Health*,(*2*) recommended the Department of Defense (DOD) begin systematically collecting population-based data to evaluate the health of service personnel throughout their military careers and after separation from military service. DOD, in its report to Congress titled *Effectiveness of Medical Research Initiatives Regarding Gulf War Illnesses,*(*3*) also identified the need for a coordinated effort to determine whether deployment-related exposures are associated with post-deployment health outcomes. The Millennium Cohort Study was developed in response to these recommendations.

Soon after fighting ended in Operation Desert Storm, numerous Gulf War veterans began reporting various medical symptoms. Many of these veterans attributed their illnesses to deployment-related exposures in the Gulf War. At that time, DOD had little systematically collected pre-deployment health data to compare with post-deployment health assessments. In addition, all analyses of Gulf War veterans were retrospective in design. Epidemiologically, a prospective, or forward-looking design is considered much stronger. The Millennium Cohort Study takes an important step in support of force health protection by providing longitudinal health data, previously lacking, on a large cohort of military service personnel over a 21-year period. These essential data will assist researchers and military leaders in understanding the health impact of military deployments more completely than in the past. In turn, this better understanding may affect deployment policies as well as prevention and treatment programs.

Development of the Project

A multi-service and multi-agency team was assembled to create a comprehensive study encompassing all branches of military service, including Reserve and National Guard personnel. The first task accomplished by this collaborative team was articulating the objectives of the study. The primary objective is to determine if risk factors related to military service, such as service occupational specialty, deployment history, service type, and other exposures, are associated with the development of chronic disease. Secondary objectives include examining characteristics of military service associated with common clinician-diagnosed diseases and with functional status, as measured by scores on several standardized self-reported health inventories. To meet these

objectives, a survey was created that will be distributed every 3 years for the next 21 years.

The initial survey instrument includes information on basic demographics; the 36-item Short Form for Veterans of the Medical Outcomes Survey (SF-36V)(*4*) physical and functional status score; the Patient Health Questionnaire (PHQ)(*5*) to provide a psychosocial assessment; medical conditions diagnosed by a clinician; self-reported symptoms; the Patient Checklist (PCL-17)(*6*) to screen for post-traumatic stress disorder; alcohol use;(*7*) tobacco use; alternative medicine use; occupational classification; life events and occupational exposures; sleep and nutrition; and various contact information questions. In addition, the survey instrument affords respondents an opportunity to list any concerns not otherwise solicited. The standardized instruments (SF-36V, PHQ, and PCL-17) were selected because of published data on their reliability and validity, and their use in previous veterans' studies.(*8*)

Because surveying all military personnel is not feasible, a study population was generated as a statistical sample of all regular active duty, National Guard, and Reserve military personnel of the Army, Navy, Air Force, and Marine Corps, so as to be representative of the entire military force. The initially enrolled cohort is stratified to include 30,000 study participants who have been deployed to Southwest Asia, Bosnia, and Kosovo, and 70,000 study participants who have never been deployed to these areas. Reserve, National Guard, and female service personnel will be over-sampled (see Fig. 1) so that adequate numbers of these groups will be available for meaningful statistical analyses. Service members' data were provided by the Defense Manpower Data Center, Monterey Bay, CA. This strategy should generate a probability-based sample of 100,000 study participants who were in service as of 1 October 2000, representing approximately 3.7 percent of the 2.7 million persons in uniform. Figure 1 reflects the expected number of potential participants that must be targeted to enroll the initial 100,000 individuals. In 2004, and again in 2007, additional probability-based samples of 20,000 U.S. active duty, National Guard, and Reserve military personnel will be added to the study (see Fig. 2). These personnel will have at least 1 year and not more than 2 years of service at the time of recruitment into the study, and will provide representation of newer military members who were not represented at initial enrollment.

Methodology

The Millennium Cohort Study questionnaire is distributed using standard postal survey techniques.(*9,10*) These techniques consist of sending introductory and reminder postcards, alternating with postal surveys, for several iterations. A tracking service and several address locator databases are used to find correct addresses for undelivered mail. This process will be repeated with participants every 3 years. Email messages may also be sent to encourage participation.

In conjunction with the mailed survey, the Millennium Cohort Study research staff also created an Internet site. The website (www.MillenniumCohort.org) serves as an inexpensive means to receive data, as well as an efficient system to disseminate information to study participants and the general public. The website provides participants with the option to complete an online questionnaire in place of the mailed paper version. The use of a "digital signature"(*11,12*) (the subject identification number along with the last four digits of the social security number) prevents individuals other than study subjects from completing the survey. The format of the online questionnaire is identical to the paper version, but it is less time-consuming to complete. After the participant completes and submits the questionnaire, the data are transmitted via very secure electronic means to the Naval Health Research Center, San Diego, CA, and incorporated into the study database.

An added benefit of the website is that it provides a nearly instantaneous method of communication between subjects and investigators. Subjects may provide mailing address changes and/or their email addresses to receive periodic study communications. Additionally, the website text can be easily modified to provide up-to-the-minute study progress reports and findings to participants. Participants are able to easily contact the study coordinator via email to ask questions or offer suggestions. Thus, the website serves as a continuous and relatively inexpensive means for keeping study participants involved and interested throughout the course of the study. Recognizing the cost and speed advantages of online participation, the Millennium Cohort Study research staff is working hard to maximize participation through this route.

After candidates have consented to participate and respond to the survey, 1 percent of them will be asked to complete a similar but shorter survey instrument to assess the reliability of selected questions. Additionally, self-reported hospital-

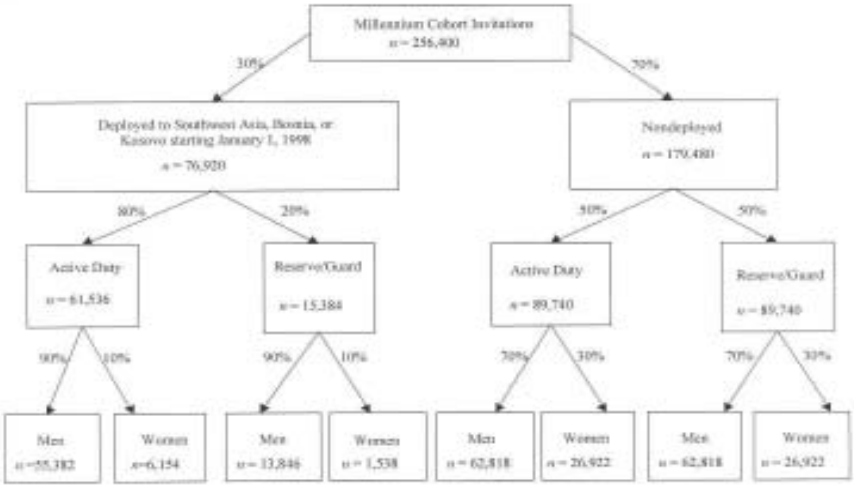

Figure 1: Sampling Strategy.
An initial sample of 256,400 service men and women was drawn from regular active duty, Reserve and National Guard rosters as of 1 October 2000, in an attempt to achieve the 100,000 target population size. Thirty percent of this population was deployed to Southwest Asia, Bosnia, or Kosovo after 1 January 1998, and 70 percent was not deployed to these areas. Women and Reserve/National Guard personnel were oversampled.

ization data will be validated by linkage to the Department of Defense's electronic hospitalization databases. Similarly, various Department of Veterans Affairs databases will be examined for healthcare utilization. These electronic records archive clinical diagnoses in the International Classification of Diseases, 9th Revision, Clinical Modification format.(*13*)

The DOD Center for Deployment Health Research directly manages or has access to numerous established military data sets.(*14-17*) These data sources will be linked to survey data and enhance the ability to conduct comprehensive evaluations of the medical outcomes of interest. In addition, the Department of Veterans Affairs has agreed to provide mortality and other healthcare utilization and disability compensation data that will augment the investigators' capacity to capture health outcomes in longitudinal follow-up.(*18-20*) Self-reported and objective electronic data will be examined for health outcomes of interest by demographic and deployment subgroups. Demographic covariates available for multivariable modeling will include age, gender, race/ethnicity, marital status, education level, rank/rate, occupation, service branch, and length of service. In addition, health habits, healthcare utilization history, immunization history, and deployment history will be available from the survey and other sources to uniquely describe exposures of military concern. Outcomes of interest are expected to be extensive, and will include common chronic diseases, such as diabetes, heart disease, and cancer. Other outcomes that may be uniquely accessible from the periodic surveys include chronic, multi-symptom illnesses and more subtle changes in functional status. Interest in these diagnostically challenging outcomes continues to grow more than a decade after the Persian Gulf War experience.(*2,3*)

A major challenge in conducting cohort studies is maximizing participation, both initial enrollment of study subjects and prevention of losses to follow-up.(*21*) To promote a sense of unity among study participants and encourage a higher response rate, study investigators developed a Millennium Cohort Study logo that appears on all correspondence, questionnaires, and incentives. Millennium Cohort Study staff members have actively sought the support of military and veterans service organizations to further instill a sense of unity and duty. In August 2000, a special study briefing was given to Washington, DC, area military and Veterans Service Organization representatives. A number of these organizations have subsequently agreed to endorse and help publicize the study, and each of these endorsements appears on the website. Most recently, the Deputy Secretary of Defense, Paul Wolfowitz, provided a letter of endorsement to the Millennium Cohort Study, that was mailed to subjects and placed on the website. Other methods of maintaining contact with participants and keeping them involved in the study are continuously explored.

Why Create a "Cohort"?

The longitudinal cohort study design method is a natural choice for a study of this importance and magnitude. The cohort study offers

several advantages over other study designs. In particular, cohort studies are valuable when the exposure or exposures being examined are rare.(*22*) This advantage is especially relevant to the unique roles and duties presented by the military population. Cohort studies also allow for the examination of "multiple effects of a single exposure." The ability to examine the relationship between exposure and the time before disease presents itself is an important strength of the cohort study as well. Prospective cohort studies reduce the chance of participant recall bias inherent in most retrospective study designs. Further, cohort studies that examine data sources such as medical and deployment records supplemented with participant questionnaires, like the Millennium Cohort Study, provide a more complete method of collecting information on exposures. The cohort design method allows investigators to periodically resurvey the study population, providing flexibility in assessments based on newly discovered scientific advancements.(*22*) As noted previously, the Millennium Cohort Study takes advantage of these design features by surveying the selected cohort every 3 years, for a total of seven questionnaires within the 21-year study period.

The nature of the cohort study, providing the most direct measurement of the risk of disease development by prospectively collecting and studying exposure and outcome data over time, has been responsible for numerous public health advancements. The Millennium Cohort Study has the potential to contribute new and important information to the field of preventive medicine and public health, benefiting both military and civilian populations alike just as other landmark cohort studies have done. Two seminal longitudinal prospective cohort studies, the Framingham Heart Study(*24*) and the Nurses' Cohort Study,(*23*) have been able to provide valuable insight with regard to the identification of risk factors for diseases of public health importance. The Framingham Heart Study, through its tracking of a cohort of 5,127 men and women living in a single community, identified risk factors for cardiovascular disease that greatly enhanced our scientific understanding of the association between lifestyle factors and the occurrence of adverse outcomes due to coronary artery disease. The Nurses' Cohort Study was initiated to examine the health effects of the use of contraception among women. By leveraging the cohort design, this study has since provided invaluable information on reproductive system cancers and other women's health issues. In a similar manner, the Millennium Cohort Study has the potential to uncover unanticipated exposure-disease associations in a relatively young, healthy, screened population that might otherwise remain unrecognized. It is likely that this information will not only benefit the military, but the civilian populations as well, just as the Framingham and Nurses' Cohort studies benefited more than just their respective study populations. Most members of the Millennium Cohort Study population will become civilians during the course of follow-up, further highlighting the applicability of study findings in both military and civilian sectors.

Conclusion

Millennium Cohort Study data will likely serve as a foundation for other epidemiological studies, just as other landmark cohort studies have done before. While military research teams will manage many of these efforts, civilian research teams will likely be interested in the Millennium Cohort Study results as well. Because of its potential impact on preventive medicine practice, the Millennium Cohort Study is an important and exciting project for the new millennium. The study's successful implementation is critical, and its results may resonate in public health for years to come.

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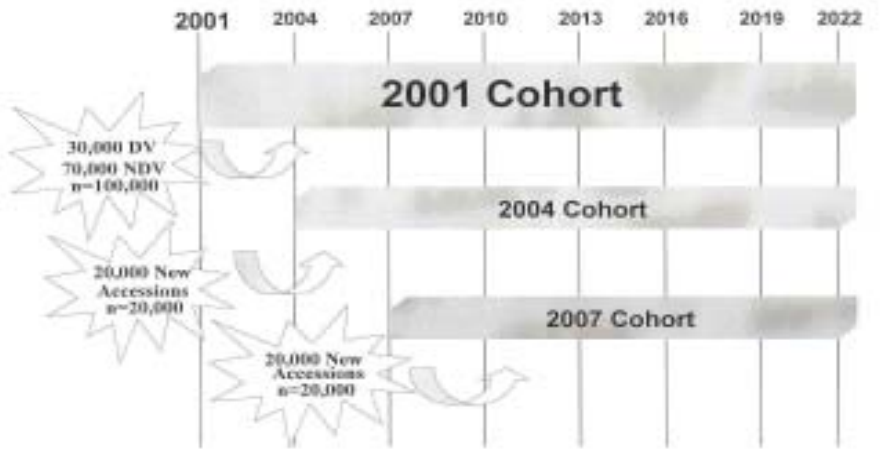
Figure 2: The Millennium Cohort Study Timeline



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DOD-Global Emerging Infections Surveillance and Response System

CDR Randall Culpepper, MC, USN
COL Patrick Kelley, MC, USA

Since the introduction of antibiotics in the 1930s, the medical community began to imagine a world free of infectious diseases. In the 1980s, following the successful global eradication of smallpox and the widespread use of vaccines for childhood preventable diseases, our nation became complacent about the threat of emerging infections and, consequently, federal funding for infectious disease control either decreased or shifted to other priorities. Unfortunately, it was this complacency and, ironically, the ubiquitous use of antibiotics and pesticides leading to increased antibiotic resistance that has contributed to the emergence and re-emergence of infectious diseases. (See Table 1)

Emergence of infectious diseases occur for many reasons and are usually classified as due to the "introduction of a new agent, to the recognition of an existing disease that has gone undetected, or to a change in the environment and/or human behavior (e.g., HIV) that provides an epidemiological bridge. Re-emergence refers to the reappearance of a known disease after a decline in incidence."(*1*)

In May 1989, the National Institutes of Allergy and Infectious Diseases (NIAID), Rockefeller University, and the Fogarty International Center sponsored a conference to focus on the emergence of viral diseases, of which Human Immunodeficiency Virus (HIV) was already becoming a looming global threat. Subsequently, in 1991, the Institute of Medicine (IOM), as an advisor to the federal government under the auspices of the National Academy of Sciences, convened the Committee on Emerging Microbial Threats to Health "to identify significant emerging infectious diseases, determine what might be done with them, and recommend how similar future threats might be confronted to lessen their impact on public health.(2) The report from the IOM was a reminder that in the complex relationship between humans and microbes, the struggle for survival is ongoing and that the microbes can still win.(3)

In 1994, the Centers for Disease Control and Prevention (CDC), World Health Organization (WHO) in Geneva, and NIAID each published strategic planning documents on emerging infectious diseases calling for strengthening our emerging infectious disease (EID) surveillance and response capabilities. The Department of Defense (DOD) was noted in each of these plans to be a major player in the global efforts against EID, particularly through our unique network of overseas (OCONUS) tropical medicine research facilities.

In June 1996, President Clinton issued PDD NSTC-7 (Presidential Decision Directive, National Science and Technology Committee) establishing national policy and implementing actions to address the threat of emerging infectious diseases by improving surveillance, prevention, and response measures. In particular, PDD-7 directs the DOD to "expand our mission to include support of global surveillance, training, research, and response to EID threats and to strengthen our global disease reduction efforts through: centralized coordination, improved

preventive health programs and epidemiological capabilities, and enhanced involvement with military treatment facilities and U.S. and overseas laboratories."(*4*)

In early 1997, the Assistant Secretary of Defense for Health Affairs (ASD(HA)) and the three Surgeons General approved the formation of the DOD-Global Emerging Infections Surveillance and Response System (DOD-GEIS), a tri-service organization formed to implement the PDD-7 through an international, coordinated, joint service program. DOD-GEIS is focused on timely recognition and control of EID threats through systematic surveillance for action, research, response, training, and capacity building. The program executes its mission through three primary settings: the overseas research laboratory network, the Military Health System (MHS), and the Unified Command's Humanitarian Assistance Programs.

Navy medicine provides an extremely important contribution to the overwhelming success of DOD-GEIS primarily through the Naval Health Research Center in San Diego and our three Navy OCONUS research facilities: Naval Medical Research Unit No. 2 (NAMRU-2) in Jakarta, Indonesia; Naval Medical Research Unit No. 3 (NAMRU-3) in Cairo, Egypt; and the Naval Medical Research Center Detachment (NMRCD) in Lima, Peru. In addition, the Navy has assigned two preventive medicine officers to support GEIS: one to the WHO in Geneva as the Civil-Military Liaison and the second to the DOD-GEIS Central Hub located at the Walter Reed Army Institute of Research (WRAIR) in Silver Spring, MD. The Army also substantially supports the DOD-GEIS through their two overseas medical research units: the Armed Forces Research Institute of the Medical Sciences in Bangkok (AFRIMS) and the Army Medical Research Unit - Kenya (USAMRU-K), as well as the Army Medical Research Institute of Infectious Diseases (USAMRIID) located in Ft. Detrick, MD.

Naval Health Research Center, San Diego (NHRC)

NHRC is designated as the Navy GEIS Hub and provides the DOD-GEIS Central Hub information on activities related to emerging disease surveillance at the Navy Environmental Health Center (NEHC), Naval Medical Center, San Diego, and the four Navy Environmental and Preventive Medicine Units (NEPMU) at Norfolk, San Diego, Pearl Harbor, and Sigonella, Italy. NHRC uses specialized laboratory capabilities to conduct active surveillance, pathogen isolation and identification for several acute respiratory diseases including adenovirus, influenza viruses A and B, parainfluenza, *Streptococcus pyogenes*, and invasive *Streptococcus pneumoniae* for tri-service high-risk military populations (e.g., recruit training centers).(*5,6*) NHRC also conducts surveillance for emerging respiratory illnesses caused by pathogens such as *Mycoplasma pneumoniae, Chlamydia pneumoniae,* and *Bordatella pertussis*.

Of particular importance is NHRC's work leading to an increased effort to find a manufacturing partner to produce the adenovirus vaccine unavailable to DOD since 1998. Additionally, NHRC has been a leader in evaluating rapid diagnostic tests for influenza and adenovirus as well as conducting the largest ever DOD clinical trial evaluating the effectiveness of the 23-valent pneumococcal polysaccharide vaccine among 191,000 military personnel in a multi-centered double blind/placebo controlled study.(*6*)

DOD Overseas Medical Research Units

The three Navy and two Army OCONUS infectious disease research laboratories are the most broadly-based state-of-the-art international facilities supported by the U.S. and provide a unique network of forward-based facilities to carry out the mission of DOD-GEIS. The five laboratories are uniquely capable research platforms and operate over three continents: Africa (NAMRU-3 in Egypt, USAMRU-K in Kenya), Asia (AFRIMS in Thailand, NAMRU-2 in Indonesia), and South America (NMRCD in Peru). All the research units have engaged in substantial collaborations with public health and scientific institutions in over 34 countries around the world.

Currently, the overseas GEIS mission is primarily centered on three goals: surveillance for action, response, and host-nation training, and capacity building. The core pillars of surveillance focus on drug-resistant malaria, drug-resistant enteric organisms, unexplained febrile illnesses, and influenza. Each DOD laboratory leverages their host region capacity through laboratory and epidemiology training.

"These GEIS mission target areas are intended to address a balance of emerging infectious diseases that are potentially threats to DOD force health protection, the U.S. population, and our national security, and the international community."(*5*)

Naval Medical Research Unit No. 2

NAMRU-2 in Jakarta, Indonesia actively collaborates across an expansive archipelago in Southeast Asia with over 17,000 islands extending over 3,000 miles from east

to west with primary GEIS interests in Laos, Malaysia, Nepal, Vietnam, Cambodia, Brunei, Indonesia, Thailand, Singapore, and the Philippines. They have recently been recognized for Outstanding Performance as a WHO Collaborating Center for Emerging and Re-emerging Diseases with approval for redesignation for another 4 years. This designation serves to emphasize NAMRU-2's contribution to global EID surveillance.

NAMRU-2 GEIS has successfully implemented and expanded two internationally recognized model programs for establishing a global disease surveillance and response system, based on regional hubs and linked by modern communications. These are (1) EWORS (Early Warning Outbreak and Response System), a syndromic, near real-time surveillance tool, and (2) ASEAN-Outbreak.Net, the Association of Southeast Asian Nations (ASEAN) web-based outbreak response network.

EWORS represents the first U.S.-Indonesian patented software system and is currently deployed in over 20 sites throughout Indonesia, Cambodia, Laos, and Vietnam. Over 500,000 cases from some of the most remote and economically depressed areas of the region have been entered into the EWORS database making available standardized trend analyses. This computer-based tool has resulted in the timely recognition and appropriate response of at least four large infectious disease outbreaks in Indonesia.

ASEAN-Outbreak.Net was developed by NAMRU-2 and the Indonesian Ministry of Health and is the officially adopted web-based platform of the 10 countries of the ASEAN for the reporting and tracking of infectious disease outbreaks between countries and the WHO Regional Offices. The website will also help identify sources of regional expertise, including laboratory diagnostic capabilities and will foster better public health communication within the region.

NAMRU-2 GEIS surveillance activities have led to many important contributions to the region, including (1) the recognition of leptospirosis as a significant cause of febrile disease in Indonesia, Cambodia, Laos, and Vietnam, (2) the decline in incidence of *Vibrio cholerae*, the rise of *Shigella flexneri*, and the re-emergence of *Shigella dysenteriae* after a 15-year absence in Indonesia, (3) the first-ever finding in the world of chloroquine resistance to *Plasmodium malariae* in South Sumatra and the re-emergence of malaria in a coastal tourist area close to the megatropolis of Jakarta after an absence of disease for over 25 years. As described in a companion article by Drs. Baird and Beecham in this issue of *Navy Medicine*, NAMRU-2 has designed an Indonesian Ministry of Health-adopted intervention strategy to combat this epidemic malaria in Central Java.

NAMRU-2 actively engages in building regional public health capacity by conducting 10-day Outbreak Response Training Workshops throughout Southeast Asia. These 10-day workshops are conducted by U.S. and local experts with the text and all training materials translated into the host-national language. Over seven workshops have been conducted in Indonesia, Laos, Cambodia, and Vietnam. NAMRU-2 also supports regional capacity building by transferring diagnostic testing capabilities to host-nation lab facilities in Indonesia, Laos, Vietnam, and through the joint NAMRU-2/National Institute of Public Health field laboratory in Cambodia.

Naval Medical Research Unit No. 3

NAMRU-3 , located in Cairo, Egypt, is adjacent to the 1,500-bed Abbassia Fever Hospital and has operated continuously since 1942. As the largest DOD overseas laboratory (68,000 ft. lab space, 25,000 ft. office space, and 2,750 ft. BSL-3 bio-containment space), NAMRU-3 has established an impressive GEIS program that focuses on supporting infectious disease operational research and surveillance in Egypt and throughout the western Mediterranean region. As in other DOD OCONUS laboratories, NAMRU-3 benefits by the assignment of a senior Public Health Service officer and by maintaining a robust, dedicated, and professional foreign service national (FSN) staff that provides project continuity and fosters collaborations with partner agencies in their region.

NAMRU-3's extensive surveillance activities have resulted in many notable achievements: (1) documented *Haemophilus influenzae* serotype b (Hib) as the major cause of childhood meningitis and the emergence of brucellosis (previously misdiagnosed as *Salmonella Typhi* - typhoid fever) as a cause of acute fever in Egypt (WATTS), (2) identified and mapped areas of risk for Rift Valley Fever (RVF) in Saudi Arabia prior to a joint exercise between the U.S. and Saudi Arabian militaries, (3) engaged in extensive laboratory and epidemiology training throughout the region in over 12 countries in Africa, the Middle East, and Central Asia, and (4) in cooperative agreements with the WHO Eastern Mediterranean Regional Office (EMRO) and the Field Epidemiology Training Program-Egypt, rapidly responded to several infectious disease outbreaks including RVF in

Table 1. Representative emerging and re-emerging pathogens over the past 20 years.	
PATHOGEN/DISEASE	**CAUSE FOR EMERGENCE**
Borrelia burgdorferi **(Lyme Disease)**	**Increase deer/human population in wooded areas.**
Esherichia col**i 0157:h7 (Hemorrhagic colitis Thrombolytic HUS)**	**Probably new pathogen.**
Helicobacter pylori **(Gastritis, peptic ulcer)**	**Increased recognition.**
M. tuberculosis **(TB)**	**Re-emergence secondary to antibiotic resistance due to immunosuppression and treatment failure.**
Streptococcus pyogenes	**Changing virulence, poor mutation.**
Bovine Spongiform Encephalopathy (BSE)	**Change in rendering process.**
Congo-Crimean Hemorrhagic Fever	**Ecological changes increasing human exposure to ticks and sheep.**
Hantavirus	**Human invasion of virus ecological niche.**
Hepatitis E	**Newly recognized.**
HIV-1	**Urbanization, change in lifestyle, increased IV use, international travel.**
Japanese Encephalitis	**Changing agricultural practices.**
West Nile Virus (USA)	**Changing geographical pattern.**
Yellow Fever	**Re-emergence secondary to lack of effective mosquito control and widespread vaccination; urbanization in tropics; increased air travel.**

Yemen and Saudi Arabia, waterborne salmonellosis in the Nile Delta, and newborn sepsis in a hospital in Egypt associated with improper intravenous fluid preparation.

NAMRU-3's GEIS program is an integrated effort through well-established partnerships with other agencies in the area to include USAID, Department of State, CDC-FETP, CDC-WHO, and the Egyptian Ministry of Health and Population. One area of significant achievement involves the development of the Egyptian National Guidelines for Communicable Disease Surveillance and the subsequent development of a solid quality assurance laboratory assessment and training program to improve the performance of laboratory personnel at the Government Common Laboratories and all fever hospitals.

An exciting area of expansion for NAMRU-3 is the recent movement into Central Asia to conduct GEIS surveillance for influenza and Crimean-Congo Hemorrhagic Fever (CCHF) in Kazakhstan; CCHF, meningitis and acute febrile illnesses in Uzbekistan; and hemorrhagic fever and encephalitic viruses (Hantaan, Russia Spring Summer Encephalitis, CCCHF, and Omsk) in the Crimean and Western Ukraine. These recent efforts are critical to developing a more clear understanding of emerging infections in this potentially significant region that may affect our global security.

Naval Medical Research Center Detachment - Peru

The NMRCD in Lima, Peru, was established in 1983 and operates a vital field site in Iquitos, the capital of the Peruvian Department of Loreto along the Amazon River. NMRCD has strong affiliations with the CDC, the University of Texas Medical Branch, Galveston, and the USAMRIID to enhance the lab's ability to identify new or emerging pathogens that may require the highest level of biocontainment. NMRCD GEIS has enjoyed a period of rapid expansion and is filling in the gaps in national surveillance that faltered in the early 1990s during the period of terrorism by the Shining Path and Tupac Amaru.

NMRCD has established strong collaborations with public health personnel at all levels throughout South America and contributes to the WHO regional influenza surveillance network. In FY01, NRCD conducted influenza surveillance in six sites in Peru, three sites in Ecuador, and one in Argentina. This past year, emphasis has been placed on expanding influenza surveillance efforts into the non-immune, young military personnel to assess the relevance of acute respiratory diseases in military populations in South America.

A particularly remarkable contribution from the NMRCD GEIS Program resulted from their studies finding varying levels of widespread resistance of *Plasmodium falciparum* to chloroquine (CQ), sulfadoxine/

pyrimethamine (SP), and/or mefloquine (MQ) along the northern coast and the Amazon Basin of Peru. Based on these and other studies, Peru became the first country in South America to recommend SP-artesunate combination therapy that varies by region and the first country in the world to recommend different combination therapeutic regimes for different parts of the same country (SP-artesunate along the north coast, MQ-artesunate in the Amazon Basin region) for uncomplicated *Plasmodium falciparum* infections. Training of host-nation malaria control staff in Bolivia to conduct *in-vivo* anti-malarial resistance studies has also resulted in that country ready to change its anti-malarial therapeutic recommendations.

Mosquito surveillance in the Amazon Basin region of Iquitos, Peru, has been an active and crucial GEIS activity to document emerging arboviral threats and appropriate control measures. When surveillance began in 1996, only 25 species of mosquitoes were known in this region. By the beginning of 2002, over 100 species had been catalogued by the Smithsonian Institution in Washington, DC. Viral isolates identified with support by USAMRIID and the University of Texas, Galveston, have yielded over 16 different viruses including Eastern Equine Encephalitis. Comparing mosquito viral patterns and human sera is yielding a more accurate picture of arboviral threats in the region.

Finally, NMRCD has been a leader in surveillance for antibiotic resistant enteric organisms in Peru and Bolivia. Continued multi-drug resistance in *Shigella*, increasing Ciprofloxacin resistance in *Campylobacter*, and emerging multi-drug resistance of *Salmonella* and *Escherichia coli* have been documented. NMRCD and the Bolivian Technologic Food Institute in Sucre, Bolivia, co-sponsored a landmark drug resistance symposium highlighting these enteric resistance patterns bringing to the forefront the attention needed to act responsibly to make future changes.

Summary

DOD-GEIS will begin its 6th year in FY03 and has already made enormous contributions to the understanding of global emerging infectious disease threats. In a recently completed extensive program review by the Institute of Medicine, it was noted that DOD-GEIS and the overseas laboratories have made substantial progress despite the relatively small investment and that continued success of GEIS is predicated on the continuing availability of resources. When the first IOM report was written in 1992, there were seven overseas military infectious disease research laboratories. Today, there are only five. The IOM expressed concern for this trend and emphasized the importance of increasing the capacity within the existing laboratories and the introduction of additional new DOD laboratories, particularly in areas of high biodiversity and other locations where the potential for the emergence of infectious diseases is high.(*5*)

As we move forward, Navy medicine will continue to develop significant research and surveillance initiatives that not only will benefit the U.S. military but will enhance our national and global security.

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Feature

Korea 50 Years Later

CDR Nancy J. Crosby, NC, USN (Ret.)

Photos courtesy of the author

CDR Crosby and Harry Smart.

This story really begins 50 years ago when a young Marine, Harry Smart, was critically injured by mortar fire. After being treated at a front-line aid station, he was flown by helicopter to the hospital ship USS *Haven* (AH-12).

Smart remained unconscious until hospital corpsmen placed him on a stretcher 5 days later to return him to surgery. At that point he awakened and learned his right leg was about to be amputated, and adamantly refused to go. I approached the agitated patient and decided to intervene. After I assessed his mental status, I ordered that he be returned to the ward, where corpsmen and I worked hard to save his badly injured and infected leg. Ultimately, Harry and a shipload of injured troops were taken to the Naval Hospital in Yokosuka, Japan, where he and I lost contact. He eventually returned home by medevac aircraft and our ship headed back to Inchon, Korea. Harry never forgot that the other nurses had called me "Bing" and had tried to find me and express his appreciation.

Two years ago he attended an annual meeting of Korean War veterans. There he met CDR Frances Omori, who had written a book about the role Navy nurses had played during the Korean War. She had interviewed me and after reviewing her notes, realized that I was the "Bing" Harry Smart had been seeking all these years. She immediately called him at his home in Texas, and he wrote to me at once. We met shortly thereafter and the meeting was profoundly moving for both of us. Neither of us could contain the tears as memories of that experience so long ago flooded back.

Last spring, Harry called to tell me of a trip being planned by Mr. Won Pae Pak, a former Korean soldier who had been drafted by the Korean Army at age 14 to carry munitions and supplies to the front lines. And so a half century after it all began, the story continued when we all met in Texas.

In June 1950 North Korea invaded South Korea. The United Nations immediately responded to this aggression by sending combat troops from 16 nations. Five other nations provided non-combat personnel to the Korean theater.

Ultimately, in 1953 the fighting ended with the border between the two Koreas re-established near the 38th Parallel, pretty much where it had been when the war began.

Day One, 17 April 2002: Five U.S. Marines, four U.S. Army troops, four wives, a Navy nurse, and Mr. Won Pae Pak (our guide) returned to South Korea. We landed at the large, modern Seoul-Inchon Airport and, after passing through customs, boarded a bus. The bus and its driver were to remain with us throughout our stay.

Immediately evident were modern apartment and office buildings, and superhighways. New cars crowded the highway. Nevertheless, people drove politely, stayed in their lanes, and no one seemed to be exceeding the speed limit.

We passed areas where Marines and Army personnel had landed at Inchon in September 1950, when GEN Douglas MacArthur had executed the brilliant amphibious operation that landed our troops behind enemy lines and turned the tide of the war. Before heading north to Seoul, we toured General MacArthur Freedom Park.

When we drove by "Ascom City," I was shocked. In 1952 this area housed the Marine Corps reserve area which consisted of several tents, two outhouses, one small wooden building, and a tiny airstrip. Today, the former Ascom City contains modern apartment buildings about 40 stories high in groups of about five or six, side by side, and stretching for miles.

Occasionally, we saw a small farm or industrial park. Most Korean farms grew vegetables and some rice, but most of this staple is now imported. Except for the occasional farm or factory, Inchon and Seoul seem to run together.

We passed over the Han River and entered Seoul, its skyline punctuated by tall apartment buildings and offices.

I was truly shocked by what I saw. The Seoul I recalled in 1952 consisted of the Emperor's Palace, some low shell-pocked apartments and office buildings, and a Catholic church on a hill.

Our group finally checked in at the Itaewon Holiday Hotel. After a 17-hour flight and tour I was bushed.

Day Two, 18 April: After a pathetically early breakfast in a little Chinese restaurant at the hotel, we began our morning. We left Inchon and headed north to visit Camp Casey where we watched an Army training film and afterward lunched at the USO.

Our day continued at the truce village of Panmunjom where we had a "Demilitarized Zone Tour." Security personnel warned us what not to do. There were buildings on both sides of the DMZ and we were allowed to enter the one where UN and communist negotiators signed the armistice in 1953. I stood for a moment beside a North Korean soldier who stood "at ease." We were warned not to touch him because he was highly trained in karate!

We then returned to Seoul to attend a formal banquet/dinner hosted by the Korean Veterans Association and the presentation of the official proclamation "Ambassador for Peace" certificate and medal.

Day Three, 19 April: This was certainly a day to remember. The 8th Army held "Veterans Appreciation Day." We departed the hotel at 0630 and drove to Youngsan, a nearby town. Upon arrival, each of us received a military escort. We then had breakfast in the mess hall with the troops, each of whom, it appeared, had been fully briefed on the Korean War. We met a general and before long the story got around that we were there, for we heard that reporters were looking for us.

After breakfast we joined other veterans who had fought in the Korea. They were from Korea, England, Scotland, Canada, and Australia. We formed up by country and paraded onto Knights Field as the 8th Army Band played in our honor.

The men, 150 strong, resembled troops in their dark blazers while two colorful Navy nurses—I and Marilyn Affleck—marched among them. She had served at Naval Hospital Yokosuka during the war.

All of us vets then faced left, passing in review before two generals, American and Korean, and countless guests filling a large grandstand.

After finally breaking ranks, we sat beneath covered tents. Then the 8th Army troops passed in review, followed by a lone uniformed Scottish bagpiper slowly marching the length of the field while playing "Amazing Grace." There was not a single dry eye in our group.

The American general then spoke, recounting how United Nations troops had saved South Korea. The Korean general followed with words of gratitude. Several wreaths were then placed representing each country there that day.

After the ceremony we spoke with GEN Thomas A. Schwartz and his wife prior to being escorted to the reception hall. Harry and I had trouble eating because representatives from several military newspapers wanted interviews and pictures. An independent reporter from the *Time/Newsweek* group then appeared for an interview and pictures.

After lunch, we were taken to a field where we inspected modern weapons and helicopters. The men who use them were there to explain the hardware. By then we were tired and returned to the hotel.

Day Four, 20 April: We traveled to Chipyong-ni where the commanding general of the 2nd Infantry Division and his staff, 8th Army representatives, the commanding general of the 20th Division, Republic of Korea (ROK), the 20th Division ROK Army Band, and the 2nd Infantry Division Honor Guard were gathered to pay tribute to fallen comrades. We then visited the battle area.

Afterward, we went to Camp Red Cloud and received a VIP briefing in the "War Room" held in headquarters and conducted by G-3 Operations. The colonel told us how our military and all the Korean people thought of us Korean War vets, and that we could

CDR Crosby and GEN Thomas A. Schwartz.

expect genuine appreciation everywhere we went.

The briefing included a slide show. One slide was most dramatic. It showed a startling satellite view of both North and South Korea at night. South of the DMZ, there were brightly lighted cities. North of the DMZ, a few tiny lights appeared, a metaphor for the political realities of our time. As was the case 50 years ago, the people of North Korea are severely controlled and reportedly very hungry.

Day Five, 21 April: We traveled to Suwon to visit the Yi Dynasty's "500-year history of Folk Life Village." Later we saw what was allegedly the world's first ironclad warships of Asan. Then we headed East to Taegu. My room in the luxury Taegu Park Hotel overlooked a miniature golf course, and flowers surrounded the remainder of the grounds.

We dressed for the evening meal given by the Honorable Taegu City Mayor and city officials. This was followed by a "Traditional Korean Folk Show." Our meal was Korean food so each table had a young Korean who identified the type of food served. Most Americans gave up using chopsticks to use knife and fork. We sampled meat that was sweet and edible, raw salmon (tasty), large prawns with heads still attached, and unappealing, kimche, and fried octopus, too hot for my taste. Kimche is raw cabbage (fermented), and served with almost every meal. I did enjoy the fruit for desert.

Day Six, 22 April: Today we traveled to the "Bowling Alley/Naktong River Combat Area" at Chilgok Gun, Waegwan to participate in a memorial ceremony at the "Largest Monument of the Korean War" honoring the United Nations Korean War veterans.

We then went to Changwon City, the most beautiful city in Korea with wide streets lined by flowers, trees, manicured lawns, and wide walkways. There we saw a portion of the "Military Defense Industrial Park" (not opened to the public).

After checking in at a hotel we attended a reception, dinner, and briefing by the Honorable Mr. Kong Min Bae, Mayor of Changwon City.

Day Seven, 23 April: Today we visited Kyongju to meet the 1,000-year history of the Shilla Dynasty, and the Keri Institute, a scientific laboratory. We lunched with the employees and were treated to a delightful Korean meal. Typical was rice, eel, raw fish, broccoli, beef, seaweed, mushrooms, pumpkin, kimche, sesame, soy, pepper powder, sushi, bean sprouts, onion soup, and watermelon washed down with tea.

That evening we attended a dinner reception and briefing hosted by the Honorable Kap Young Lee, the mayor. He spoke about the "World Peace Park," which memorializes the sacrifices of the United Nations soldiers who fought and died defending South Korea.

Day Eight, 24 April: This day we entered a stadium where a band played. We were seated behind several Korean dignitaries and Mr. Pak. Apparently, we were the "guests of honor." Tea was served, bouquets pinned on, and hats presented. Groups of about 50 children each began to enter the stadium. Each group had distinct, colorful costumes. They carried drums, symbols, etc., and enjoyed making lots of noise. The officials bowed to each group walking by the grandstand. Some groups released gas-filled balloons and some larger balloons were attached to ropes. A band played the Korean National Anthem, and several Korean officials gave speeches—all in Korean!

On the way back to Seoul, we saw many more farms and an occasional town. The highway was relatively straight despite the mountains. Even though Korea is underlain with solid rock formations, Korean engineers have built tunnels or simply shaved off the sides of mountains.

Traveling Korean roads was a pleasure. We witnessed no accidents, and billboards were conspicuously absent. Most available spaces were filled with flowers. Roads were free of trash and drivers were polite to one another.

Day Nine, 26 April: This was our "free" day spent shopping and packing.

Day Ten, 27 April: We departed from Inchon Airport for the long flight home. As we reflected on the trip, we could not get over the level of gratitude felt and expressed by the Korean people everywhere we went. They went out of their way to bid us welcome and express their feelings. We learned that all young children are taught about the Korean War in detail, and all visit the War Museum in large groups from their schools. Periodic visits to the museum leave them well grounded in the military history of Korea, and the effects of this exposure are evident by the welcome we Korean War veterans received. The people of Korea are so appreciative of what we did.

As a Korean War veteran, I'm often asked whether our sacrifice was worth it. After what I experienced on this trip, I can honestly say, of course it was. And I'm sure my patient, Harry Smart, who, by the way still has both legs, would agree. ❑

CDR Crosby resides in Winter Springs, FL. Her photographs of the "forgotten war" appeared in the March-April issue of *Navy Medicine*.

Photo by PHAN Samuel Price, USN

Snatched from the jaws of death, a miner briefly reflects upon his ordeal while still in the rescue basket.

Steaming to Assist at the Quecreek Mine Disaster

CAPT Dale M. Molé, MC, USN

Photo by PHAN Samuel Price, USN

After days in darkness, a miner is dazzled by the bright lights and commotion surrounding the rescue site.

At 8:50 pm, on 24 July 2002 miners on the night shift of the Quecreek Mine in Somerset, PA, dig through the wall of abandoned Saxman No. 2 mine, and 50 million to 60 million gallons of groundwater begin pouring into Quecreek.

At 9:00 pm, members from a team of nine miners a mile inside Quecreek use a mine phone to alert another team of nine miners to evacuate.

At 9:30 pm, the second team the miners alerted by phone leave the mine.

At 9:53 pm, aware that one team is not out, mine officials call 911 with a report of miners suffering water-related injuries.

11:30 to midnight, the call goes out to find a large drill, big enough for a hole to raise men from the mine.

Midnight, workers start boring a 6-to-9 inch hole to where the miners are trapped.

3:30 am, the drill reaches the area where the miners are. Rescuers hear banging on the drill they say are signals from the miners.

11:30 am, the last signals are heard. Navy medicine enters the arena.

The scene at rescue hole No. 1. The drill rig to the right drilled the first 6-inch hole into the mine and is supplying compressed air to the survivors.

Photo by PHAN Samuel Price, USN

Thursday: 25 Jul 02: By 4:30 am I was halfway to work, looking forward to a full, uninterrupted day in the office clearing away some of the stacks of paperwork that chronically occupy space on my desk. While catching up on overnight events via the radio, one report caught my attention. Around 9:30 pm the previous evening, coal miners in Pennsylvania inadvertently breached a wall separating them from an adjacent water-filled mine. The result—"uncontrolled flooding," a term that evokes a strong emotional response in the heart of every submariner. It is the reason submarines sink, never to surface again. Nine miners were missing. This was a story I needed to follow later in the day.

After several hours of work, it was time to check the web for further developments in the mine disaster story. Amazingly, news reports indicated there were survivors! I could only imagine what it must be like, having survived the initial terrifying event, to be trapped hundreds of feet below ground in a flooded mine, wondering if you will ever see your loved ones, smell fresh air, or see the sunshine again. These were familiar thoughts, similar to the ones I had upon hearing there were survivors trapped on the Russian submarine *Kursk*, which sank almost 2 years ago to the day.

I soon received a phone call from the "front office," telling me to check my email immediately. There I found a message from the Office of the Surgeon General marked urgent. LCDR Nick Colovos, a Navy reserve emergency medicine physician on the Pennsylvania Special Medical Response Team, was concerned about the possibility of fatal decompression sickness occurring if the miners were rescued. I immediately called him and we discussed the situation.

The sudden onslaught of water compressed the air in the pocket containing the miners. They were now exposed to a pressure equal to that of a diver at a depth of 40 feet of seawater (FSW). In essence, the miners had just become divers. Unlike most divers, however, they would not be returning to normal surface pressure after a few minutes submerged.

Since air is one-fifth oxygen and four-fifths nitrogen, prolonged exposure could cause serious problems. Oxygen is consumed by normal metabolism, but nitrogen is considered to be inert, i.e., metabolically inactive. Over a period of 24 hours, blood and tissue absorb the extra nitrogen in compressed air like a sponge. Similar to a carbonated beverage, where carbon dioxide instead of nitrogen is dissolved in the liquid, if the pressure is released too quickly many gas bubbles form. While desirable in soft drinks or champagne, in blood or tissue they can cause decompression sickness resulting in death or permanent disability.

Photo by PHAN Samuel Price, USN

LCDR Paul Fleischman, on-scene Navy OIC, inspects the rescue basket.

We would rescue the miners, but they might die or be paralyzed from decompression sickness.

On another rescue mission more than a decade ago, I was confronted with a similar situation. A Peruvian submarine sank after being struck by a fishing trawler while returning to port. There was uncontrolled flooding and the survivors inside were exposed to a pressure equivalent to about 50 FSW for a number of hours. Because of deteriorating conditions, they were forced to escape before we arrived. One died and several suffered permanent disabilities. I did not want to see that happen here.

Navy medicine has been working on submarine escape and rescue issues for over 70 years. In this particular situation, the survival challenges of the miners as compared to survivors on a sunken submarine were readily apparent. Since flooding is a part of every submarine sinking, threats to survival include elevated atmospheric pressure within the submarine, wet or damp clothing, hypothermia, diminished or absent light, little food or potable water, and minimal communication with the outside world. An additional problem, if a rescue is successful, is serious decompression sickness developing in any submariners exposed to elevated pressures for more than a few hours.

To address decompression sickness concerns, the Navy has portable, multi-person recompression chambers we could deploy to the rescue site. Most of the chambers are the same ones used by Naval Special Warfare (SEAL), Explosive Ordnance Disposal, Underwater Construction Team, and Fleet divers. In addition, we have several small, collapsible one-person fabric chambers called a "Hyperlite," which fit in a helicopter and can transport a patient under pressure. This allows for the safe air evacuation of patients suffering from decompression sickness, as well as other pressure related problems.

CDR William Orr at OPNAV N77, is the Navy's action officer for submarine escape and rescue issues. Since this was similar in many ways to a submarine rescue operation, I dialed his number and prayed that he was at his desk. To my great relief, a familiar voice answered the phone after two rings. After a brief conversation, we arranged a four-way conference call between LCDR Colovos, (on his cell phone at the rescue site), CDR Orr (OPNAV), CAPT Henry Schwartz, MC (Naval Sea Systems Command), and me (BUMED). Underlying the discussion was the issue of time; it was running out for both us and the miners. If we were going to provide assistance, we had to act quickly.

CDR Orr has a well deserved reputation for quickly cutting through red tape. He recognized the correct course of action and proceeded full speed ahead. He contacted diving

Part of the largest collection of recompression chambers ever assembled. A chamber is just visible in the truck outside the "medical treatment facility."

Photo by the author

commands along the East Coast and expeditiously mobilized their recompression chambers and people. After hurried preparations, a small team of rescue personnel from Naval District Washington (CAPT Schwartz, LCDR Paul Fleischman, Tom Galloway, NAVSEA Submarine Rescue System Technical Director, BM2(DV) Warren Dempsey, USNR, and me), were assembled. We managed to shoehorn ourselves into a rented SUV, with a Hyperlite in the luggage area, and our personal gear strapped to the roof. In less than 3 hours after making the decision to go, we were on our way to Somerset, PA. Within 18 hours there would be nine multi-place recompression chambers, five Hyperlite chambers, and 60 Navy personnel from eight different commands on-site, in a barn on the Arnold family farm, set up and ready to receive patients. The multi-person chambers would allow us to treat injured miners while they were being decompressed.

The long drive provided time for reflection. There are many unsung heroes in America; coal miners are among them, risking their lives every day to provide America the energy she needs to be the largest economy in the world. Supplying power to make the tools for defense, they are as essential to our national security as the men and women in uniform. Much of our electricity comes from coal-fired power plants. The expectation the lights will come on when we flick the wall switch depends upon men willing to risk their lives, men just like the miners we were on our way to help rescue.

It was well after sundown when we arrived. The scene was like something out of a science fiction movie. Banks of bright portable lights contrasted surrealistically with the darkness of the surrounding rural countryside. The flashing red and blue lights of the Pennsylvania State Police cars told us we had arrived at our destination. The roadblock was to prevent the curious and the news media from interfering with the race against time.

After a short explanation, "We are with the U.S. Navy" and a quick perusal of ID cards, the patrolman nodded and waved us through with a gesture of his hand. We drove down a short access road that led to a small rectangular field. At one end of the field, floodlights illuminated a drilling rig that soared more than 60 feet into the dark, overcast sky. Nearby, sparks cascaded from the torches of two welders who were diligently working on a 40-foot-long dark cylinder, whose purpose I would later understand.

It seemed hard to believe 245 feet below where I stood nine coal miners were fighting for their lives. It had been 24 hours since one of the miners breached a wall separating the Quecreek mine from the abandoned, water-filled Saxon mine. Through the breach, 150 million gallons of water gushed into the Quecreek mine,

Photo by the author

The decontamination tent is the first stop for the rescued miners. The Navy truck to the right contains a recompression chamber. The "medical treatment facility" (barn) is in the background.

sweeping men off their feet and trapping half of the 18-man crew working the evening shift. Thanks to a warning from one of the trapped miners, nine managed to scramble to safety. The other nine, the ones we came to rescue, struggled to keep their faces above water as they sought the highest spot in the mine.

A small cluster of mostly women and children were off to one side of the field. I discovered they were family members of the trapped men. Upon seeing the wives and children, the miners were no longer anonymous, faceless strangers who toiled in the coal mines to supply energy for America; they were husbands, fathers, brothers, and sons. Failure was not an option. We had to do whatever it took to get the miners out, and to get them out alive!

Dr. Colovos, dressed in his blue Special Medical Response Team jumpsuit, greeted us with a broad smile and a warm handshake. He was glad Navy medicine had arrived, as were the rest of the rescue workers and family members. I told him our role was to provide assistance and support to the local effort. We were here to help, not take over.

We were quickly introduced to Jeffery Stanchek from the Bureau of Deep Mine Safety who gave us an update on the current situation. Jeff has over 20 years of experience as a mine safety instructor and technical expert, including eight previous mine rescue operations. None had been successful. We were hoping to change the track record.

Earlier in the morning, mining engineers had determined the most likely location in the mine for survivors. Using a combination of three-dimensional seismic maps (produced by shooting sound waves down in the earth) and global positioning system satellites (put into space by the military for navigational purposes), they determined the best place to drill a 6-inch hole to pierce a central section of the mine shaft. The hole would funnel fresh, warm air down to the miners, as well as increase the air pressure and help prevent the water from rising further or at least slow it down.

After almost 2 hours of drilling, they broke through into the mineshaft. A blast of air shot out around the drill. A quick analysis showed the oxygen content was lower than normal. When the drill was shut down, the rescue workers tapped on the pipe. Minutes went by while they waited. Then, unbelievably, they heard what sounded like tapping on the other end of the pipe. Nine taps were sent from topside; nine taps were returned from below. Amazingly, all nine miners were alive. High-pressure air was pumped down through the drill rig. The shaft was sealed by volunteer firefighters who stuffed air bags around the drill, air bags normally used to lift vehicles off of crash victims. The loud noise of the air compressors would fill our consciousness for the next 72 hours. High volume water

Photo by the author

Seamless integration of Navy and civilian medical personnel. In the foreground, Dr. Richard Kunkle, senior member of the Special Medical Response Team, questions a miner while Navy corpsmen assist in the evaluation and treatment.

pumps were placed at the mine entrance over 1-1/2 miles away to pump water out of the mine. Jeff said it would take weeks to pump the mine dry.

He took us over to the drilling rig. A massive 32-inch, 1,500 pound drill bit had already burrowed over 100 feet down into the ground. The drill shaft turned slowly and moved imperceptibly lower with each revolution. Too fast and the reactive torque from the huge bit would break the rig; too slow and we would not reach the miners in time.

Next we closely examined the rescue basket, a cylindrical yellow steel cage that would lift our precious human cargo one at a time from the mine that entombed them, up through the 245-foot rescue hole. The plan was to attach a remote video camera to the basket to determine conditions within the mine and look for signs of life. If the miners were incapacitated, a rescue team would be sent down to assist the miners into the basket. If there were no signs of life, it would be far too dangerous to send people down into the mine. Over the course of the next few weeks the mine would be pumped dry, and then a team would be sent in to recover the bodies. Since there was no time to line the rescue hole with sheathing, most of the hole was unsheathed and could collapse at any time. Also loose rock could fall down the hole and wedge between the rescue basket and the sidewall of the hole, jamming the basket and trapping the miner in the rescue hole. This meant certain death for whoever was in the basket, as well as blocking the exit for the remaining miners. For this reason, food, water, and blankets were loaded into the basket on the first trip below. We had to pray the hole would not collapse or the basket become jammed until the last miner was out.

To prevent rapid depressurization when the drill pierced the mine, a special cap for the rescue hole was designed and rapidly constructed onsite. This was the object the welders were so diligently constructing when I first arrived. Nicknamed the "iron maiden" after the medieval torture device, it acted as an airlock, allowing us to remove the miners one at a time while maintaining pressure in the mine. Once the miners were exposed to normal atmospheric pressure, we calculated we had about 15 minutes to transport them from the rescue hole, perform a quick medical examination and decontamination, place them in the recompression chambers, and pressurize them back to 40 FSW. Should we fail to do so within the allotted time, serious decompression symptoms could develop.

Once in the recompression chambers, we planned to use special decompression tables to return the miners gradually to normal atmospheric pressure. Doctors at the Navy

Photo by PHAN Samuel Price, USN

HM1(SW/DV) John Carlson, USN, checks breath sounds and directs the medical evaluation and care of a miner. HM2(SW/DV) Chris Walker, USN (left) obtains vital signs.

Experimental Diving Unit in Panama City, FL, developed these accelerated oxygen decompression tables for submarine rescue. One of these doctors, CAPT Ed Flynn, MC (retired), a world renowned expert on diving medicine who is now working at NAVSEA, continued to email updated decompression recommendations to us throughout the rescue effort.

Friday: 26 Jul 02: Given the current rate of drilling, it would be several hours before the drill reached the mineshaft. At about zero-dark-thirty, I decided it was time to get some sleep on one of the cots provided by the Salvation Army. After what seemed a couple of minutes of restless sleep, I awoke 2 hours later to discover the drill bit had broken into several pieces in the hole. Not only had little progress been made, but also now the drill bit fragments prevented further drilling. A special extraction device had to be designed and built to remove the broken pieces, before drilling could resume.

Not until 4:00 pm that afternoon when all the pieces were removed, could drilling resume on rescue hole No. 1. Several hours earlier, drilling was started on rescue hole No. 2 about 60 feet from the first hole. A different type of drill bit was used with the hope of more rapid progress. All seemed to go well until hard rock was encountered and drilling slowed dramatically. We were all beginning to wonder if we were ever going to drill our way into the mine.

Many of the miners' families seemed to gravitate toward the Sailors. Fit young men in uniforms, with sophisticated equipment, who went about their work very professionally, instilled confidence that everything humanly possible was being done. Over the hours and days, with much time to talk, a deep mutual respect developed. Interaction with the family members placed us on a similar emotional roller coaster, one minute hopeful, the next uncertain and frustrated.

The media showed up in force, although they were confined to the media center located in an abandoned supermarket 2 miles down the road. CAPT Henry "Hank" Schwartz, the other diving medical officer, had the honor of interacting with the media initially. After a quick shower and a shave, he was ready to take on the world. Performing superbly on live television at the afternoon press conference, he was later thanked by the governor for changing the tenor of the conference from doom to optimism as he explained what the Navy was doing so far from the ocean. He did several interviews for individual stations and networks before returning to the rescue site later in the evening.

While "Hollywood" Hank was wowing the press, we conducted

Divers from Underwater Construction Team One take a break from their duties to befriend some local inhabitants. Left (front to back) EACS(SCW/DV) Jeff Moxley, UT2(SCW/DV) Martin Stacy, CM2(SCW/DV) Ian Kepran. Right (front to back) EO2(SCW/SW) Nick Gegg, SW1(SCW/DV) Eric Biwer.

Photo by the author

medical drills to insure that patient transport from the rescue site to the medical treatment area and recompression chambers was flawless. We had to do this right the first time. Stretcher-bearers consisted of teams of six that were made up of local volunteer firemen, mine safety workers, and Sailors. We tried various routes and went through emergency procedures. We practiced communication with hand-held radios and headsets. We practiced until we were able to get transport time from the rescue hole to the treatment area down to 4 minutes.

Since the rescue effort was dragging out, it was decided to provide Navy coverage with port and starboard shifts, i.e., 12 hours on duty followed by 12 hours off duty. Those off duty would be recalled to the rescue site once we were close to breaking through into the mineshaft.

We obtained rooms at a nearby bed & breakfast, but had to "hot rack" (take turns sleeping in the same bed) since there were not enough beds to go around. I was dead on my feet and CAPT Schwartz graciously offered to take the night shift. I felt lucky to get clean sheets!

Saturday: 27 Jul 02: Got 6 solid hours of sleep, as well as a shower and a shave. I felt like a new man. With a little luck, today was going to be the day! The Red Cross had breakfast ready when I arrived at the site. I was optimistic the miners were still alive despite the fact we had not heard any more tapping since just before noon on Thursday. There were many reasons why we would not hear signals, only one of which was that the miners were dead.

Time for more drills. Civilian and military worked as a team. We were confident we were prepared for whatever might confront us once the miners were rescued. Because the pumps were lowering the water level in the mine, the air pressure inside the mine was declining. We calculated the rate of decline at about 1 foot of seawater per hour, a perfect air saturation decompression schedule. Since the pressure in the mine was becoming less, we now had the luxury of more time to examine the patients before worrying about symptoms of decompression sickness developing.

With CAPT Schwartz asleep, it was now my duty to face the media. My usual job is shuffling papers in a basement at BUMED headquarters, something I much prefer compared to what lay before me. Master Chief Ted Brown, from the CINCLANTFLT public affairs office, did an absolutely outstanding job shepherding me through the interview process. As an instructor for the media affairs course in Norfolk, he was the right person to help a novice like me and he made the whole ordeal fairly painless. By the time the day was over, I had done about 20

Photo by PHAN Samuel Price, USN

The strong arms of Sailors, firefighters, and mine safety personnel carry a miner to the decontamination tent.

interviews including a one-on-one, a one-on-one remote (where you talk to the camera and hear the interviewer through an earpiece), a press conference, and a talk show. Being on the other side of the lights and lenses, knowing you are representing the U.S. Navy can be very intimidating. Sensory overload is the term that comes to mind. I was very happy to leave the lights and cameras behind, returning to the rescue site, and getting back to what I do best, taking care of people.

At 10:00 pm we were just a few feet away from entering the mine on rescue hole No. 1, so we recalled all the Sailors. The tension in the air was palpable. Sleep-deprived and emotionally fatigued, we had waited a long time to get to this stage in the operation.

At a last-minute conference with the senior civilian physician, Dr. Kunkle, it was decided that at least some of the miners, if alive, would be evacuated via helicopter to a nearby trauma center. I decided to re-deploy one of the recompression chambers to the trauma center by truck. CAPT Schwartz would fly over to the hospital with the first patient and remain there to provide assistance. He would be the only physician on the flight. An internist, as well as an undersea medical officer, his expertise would be critical to insuring the proper diagnosis and treatment of decompression sickness should it arise. He would stay at the hospital for 24 hours, after which the risk of developing decompression sickness is negligible.

The rescue team had problems with their video equipment. The monitor and video recorder for the remote camera on the rescue basket was not working. They asked the team from Navy-Marine Corps News if they could help. Sent here to cover the rescue effort, they now became an essential part of it. They provided the first video images inside the mine. The Navy was also asked to photograph the evacuation and treatment for future training purposes.

At 10:15 pm the drill finally penetrated the mine. Hundreds of eyes were focused on rescue hole No. 1. The rescue basket was lowered and communication was established with the miners. All nine were alive! A cheer went up from the crowd. Prayers had been answered and hope fulfilled. One of the divers went to wake a family member who was sleeping in the medical treatment area near one of the recompression chambers, a place where she found comfort. We were all overjoyed and close to tears, but still hours away from returning the miners to their families.

Sunday: 28 Jul 02: At 12:50 am, the first miner reached the surface. Cheering and applause followed him

Inside tender, HMCS(SW/PJ/DV) Mark Cappock checks communication and other gear within one of the recompression chambers.

Photo by the author

as he was carried up the hillside to the decontamination tent. He arrived covered in coal dust from head to toe. The only white parts were his eyes. As his clothes were cut away with trauma shears, a brief medical history was obtained and cursory exam performed. He was quickly washed down with soap and warm water, then dried with soft towels from a local prison.

While talking to the first miner, I discovered how desperate their situation really was. "I was completely underwater several times," he said. "At least twice I thought I was going to die." For someone who had been trapped underground, he looked remarkably good. Much like the biblical Lazarus, who died and was resurrected after 3 days, this modern day Lazarus had been entombed for 3 days and now was back among the living. The miners also could not believe there were so many people and so much equipment assembled to rescue them. More than one exclaimed, "God bless America!"

Next stop, the medical treatment area. While the civilian emergency medical technicians started an IV on each patient, HM1(SW/DV) Jon Carlson performed a physical exam, including a rapid neurological assessment. He directed other Navy corpsmen to obtain vital signs, assisted in starting IVs, got more history, and assumed any task that seemed to be neglected. Like the water on which we sail, we flow to fill any voids in patient care, even including such things as patient privacy and comfort.

A case in point, just prior to the rescue, we were asked to form a human shield to provide privacy for the patients during the 70-foot journey from the decontamination tent to the medical treatment area. I discussed this with some divers from Underwater Construction Team One, the diving Seabees. One must be careful what is requested when working with Seabees. Not only will they build it, but include a patio, hot tub, and barbecue. In less than 15 minutes they erected a 12-foot-high barrier with tarps they "obtained" and had sewn together. It greatly exceeded every expectation and performed the job admirably.

After the initial examination, it was decided the first patient would be flown to the trauma center. CAPT Schwartz and the first survivor were soon on their way.

This basic process, including cheers and applause, was repeated eight more times, with the last miner being brought to the surface at 2:45 am. The elation I felt when the last miner was rescued will be something I savor until the day I die. At that moment, nothing else seemed to matter. We were victorious!

Photo by the author

Navy personnel perform final checks of the recompression equipment in preparation to receive patients.

At 4:00 am it was time for a well-deserved shower followed by rapid unconsciousness. I slept the sleep of the saved until 7:30 am when I awoke to a beautiful Sunday morning. What a great day to be alive! After a hearty breakfast (for which the townspeople would not allow us to pay) at a local diner, it was time to inquire about the miners. During the morning, one of the miners had developed worsening shoulder pain. CAPT Schwartz elected to try a "test of pressure," i.e., if symptoms improve when the patient is recompressed to 60 FSW, then a pressure induced illness is a more likely diagnosis. The patient's pain improved significantly. Therefore, a Navy treatment table six, involving oxygen breathing and gradual pressure reduction, was undertaken.

Following the treatment, the patient remained much improved. "Hollywood" Hank was asked to perform at yet another press conference and again represented Navy medicine superbly. He has a talent for explaining complicated physiological issues in a manner that any non-professional will understand.

It had been an amazing 3 days. I witnessed American spirit and ingenuity triumph over adversity. I saw complete strangers from many different walks of life join together to volunteer time, money, and expertise to save the lives of a few. I was touched by the outpouring of warmth and hospitality of the Arnold family, despite having their farm invaded by hundreds of people, as well as dozens of trucks and other heavy equipment. For a brief time all eyes were focused on the prize—the successful rescue of nine miners— no matter what was required.

During the drive back to Washington, I reflected on the events of the previous 72 hours. I decided I have one of the best jobs in the world, that of a physician in the United States Navy. Words cannot express the pride I feel for the truly outstanding work these Sailors did in a small town in Pennsylvania less than 15 miles from the 11 September United Airlines Flight 93 crash site. There is not a better example of the seamless integration of local, state, and federal agencies working together for a common good. There is not a better example of "steaming to assist." More than a motto of Navy medicine, it is the prime directive. ❑

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Designing Shipboard Medical and Dental Facilities for the Owners with the Owners

Ms. Tracy Ballagh
CAPT Kendall King, USN (Ret.)

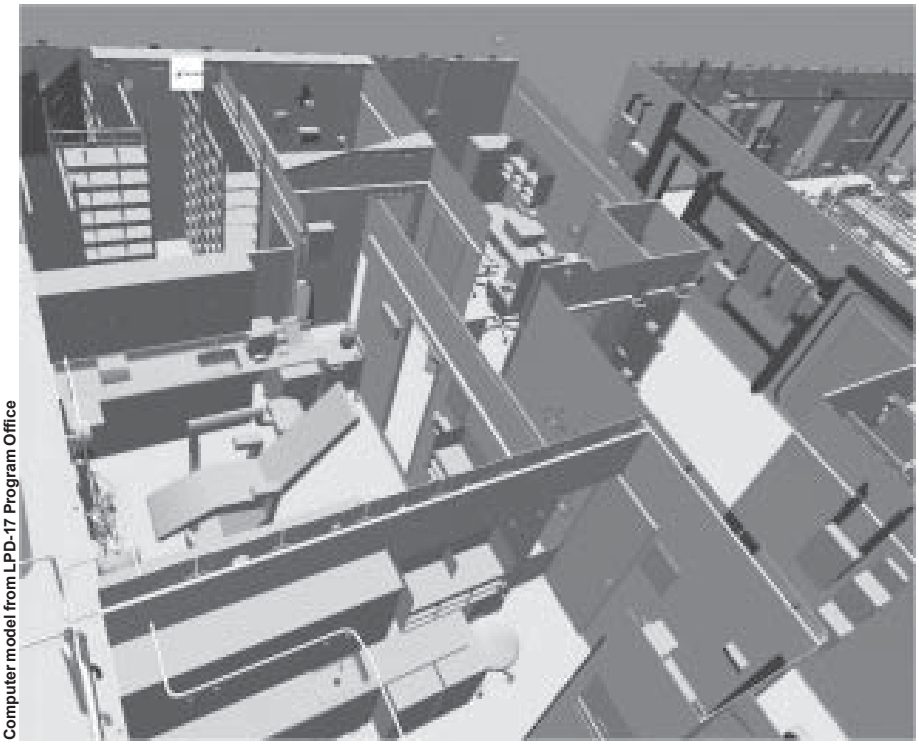
Computer model, PMS 317, LPD-17 Program Office

The LPD-17 Class will support the Expeditionary Warfare Mobility Triad of LCACs (Landing Craft Air Cushion), Marine Corps Advanced Amphibious Assault Vehicles (AAAVs), and the V-22 Osprey, vertical take off and landing aircraft to fully support expeditionary maneuver warfare.

An MV-22 *Osprey* lands on the flight deck of LPD-17 and begins to offload its cargo of wounded flown from the forward base, 300 miles inland. The first litter patient is carried gingerly from the flight deck toward triage, bypassing the unneeded Casualty Decontamination Station. Once in triage, they carry the wounded patient to a waiting bed, easily negotiating the turn, entry, and passage among other patients. Gently positioning their patient, the stretcher team heads back to the flight deck for another patient while the triage team begins to check the new arrival's vital signs.

These patients are far more likely to survive their wounds than were their comrades of previous conflicts. The enhanced chances of survival and full recovery are not by luck, however. The medical capabilities of the USS *San Antonio* (LPD-17) Class of amphibious transport dock ships reflect the influence of fleet and Marine Corps healthcare professionals more than any warship built to date. Healthcare personnel were intimately involved in validating the design of the USS *San Antonio*'s triage well before commencement of the ship's construction.

The enhanced survivability rate of casualties is the result of advanced planning by medical personnel using state-of-the-art tools to provide input to the design, layout, and equipping of spaces throughout the ship. Using a computer design simulation to demonstrate the effective form, fit, and function of moving a patient into a triage, fleet medical personnel and the ship's design team labored tirelessly to ensure mistakes of the past were not repeated. Medical subject matter experts from coast-to-coast, the eventual "owners" of LPD-17's medical facilities, concurrently viewed and reviewed the evolution to ensure adequate clearance measurements and routes for stretcher-bearers to move the litter to the ship's main battle dressing station. They laboriously reviewed three-dimensional space layouts to ensure efficient use and equipping of the medical and dental spaces. The



Computer model from LPD-17 Program Office

San Antonio Dental spaces include two operating rooms, two dental storerooms, a dental sterilization room, dental apparatus room, and a dental records office. Fleet dental personnel contributed recommendations that led to over 25 design and outfitting changes in these spaces.

result is a ship with medical and dental facilities that meet 21st century afloat medical requirements.

LPD-17 Capabilities

USS *San Antonio*, the first 21st century expeditionary warship, is well under construction with a scheduled delivery in 2004. LPD-17 and its sister ships will form an integral part of future Amphibious Ready Groups (ARGs) and expeditionary forces throughout the first half of the century. Each will have the capability to support or perform the full gamut of amphibious and Special Operations Capable (SOC) missions throughout the world's littorals. Moreover, this ship class will have the capability to accomplish independent missions separate from the ARG or other forces, such as conducting non-combatant evacuations (NEO) or advanced force operations. The design of LPD-17's medical and dental spaces is critical to the success of these types of missions. For this reason, the LPD-17 design team collaborated through all stages of the ship design with the fleet medical and dental experts who will staff, operate, and maintain these spaces.

Just as in the LPD-4 Class of amphibious transport dock ships that it replaces, the mission of the *San Antonio* Class is to embark, transport, and land elements of a landing force. It is the first class of amphibious ship designed to support the Marine Corps' "Mobility Triad" of Advanced Amphibious Assault Vehicles (AAAVs), Landing Craft Air Cushioned (LCAC), and aircraft to include the vertical take-off and landing MV-22. Collectively, the LPD-17s crew of 361 and up to 800 embarked troops of a Marine Expeditionary Unit (MEU) can support a variety of operational scenarios. Moreover, the Mobility Triad provides ARG and MEU commanders a much greater degree of flexibility to plan and support missions.

First, the design of LPD-17's flight deck accommodates the launch and recovery of a variety of helicopters plus the MV-22. Four of these aircraft can fit on the LPD-17 flight deck (plus one in the hangar) and, when launched, can transport landing forces and equipment hundreds of miles. The AAAVs are true amphibians, able to splash from the ship's well deck, swim ashore from over-the-horizon, and carry their embarked troops ashore. Moreover, LPD-17 will be able to carry 14 AAAVs and 2 LCAC simultaneously.

The LPD-17 Class brings other attributes to the fleet. Quality of life improvements include more efficient food service spaces that employ a flexible, consolidated galley to serve officers and enlisted alike. Berthing areas incorporate the sit-up berth that increases storage space by 40 percent while providing ample room for sleeping or sitting up to read or write. Moreover, berthing spaces are identical for ship's crew or embarked troops and each berthing area has an adjacent sanitary facility and lounge.

While not flagship configured, the LPD-17 has ample command and control facilities to support temporarily embarked commanders and a full communications suite to interact with the ARG flagship or higher authority. This

also provides the capability for ship's medical personnel to interact and consult with counterparts on board larger ships and at shore-based medical facilities further enhancing on board medical care.

Self-defense and survivability in the littoral, where the ship will operate, are crucial elements that drove ship design. The LPD-17's profile is especially distinctive because of the streamlined look of its two enclosed masts, the Advanced Enclosed Mast Sensor, which surround its communications and radar antennas. This distinctive design reduces radar signature, which in turn enhances survivability in a hostile environment. Survivability enhancements also include improved weaponry, the MK 2 Ship Self Defense System, and improved damage control and overall ship design features.

Considerable advanced planning ensured incorporation of the capabilities to provide forward resuscitative healthcare in a myriad of potential operational scenarios. The ship's design encompasses an overall capability heretofore only found on large-deck amphibious ships. For example, the ship will have a morgue, an Operating Room, and convertible Main Battle Dressing Station. Other features include a scrub room, a gowning room, a pharmacy, a lab, Navy and Marine medical records rooms, a sterilization room, and two consulting rooms. The 6-bed Intensive Care Unit (ICU) and 18-bed ward includes a nursing station with an adjacent quiet room. The LPD-17 will utilize computed radiography to process x-rays in lieu of the traditional wet processing.

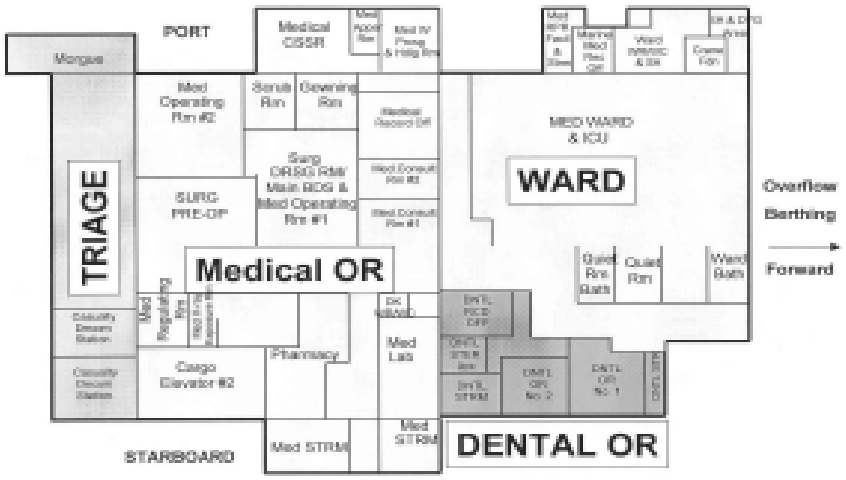
Fleet planners did not overlook manning requirements in this planning process either. Current manning requirements call for a medical staff of a medical officer and 12 corpsmen. When dictated by operational requirements, Fleet Surgical Teams from the ARG flagship (an LHA/LHD) or ashore medical facilities augment ship's company medical personnel. In addition, two dental operating rooms, with associated records room and lab and manned by the ship's dental officer and three dental technicians, round out the ship's extensive healthcare facilities.

LPD-17 Design Process

The LPD-17 design process was as revolutionary as the ship itself. During the 1990s, Naval expeditionary warfare commanders reported growing requirements experienced during forward presence operations. Increasingly, real world events often caused an ARG/MEU to split, as circumstances required presence in varying locations. For instance, an LPD might cover a non-combatant evacuation operation off the West African Coast while the remainder of the ARG supports missions inside the Mediterranean Sea. Incorporating this feedback, the 1995 LPD-17 Class' Operations Requirements Document emphasized a need for the ship to be able to perform its mission independently or as part of a group or force.

The LPD-17 program used a number of initiatives to ensure that their design met naval medical and dental requirements. Since 1997, a Medical Service Corps officer has been co-located with the design team in Avondale, LA. This individual maintained a dialog with medical and dental subject matter experts, seeking to resolve design questions and serving as a conduit for new technologies or policy initiatives. One of these officers even proposed a rearrangement of the consulting room – an arrangement later validated by the fleet and implemented into LPD-17's design.

During a series of conferences, the LPD-17 Team directly solicited suggestions and recommendations from the owners. As early as 1996, the fleet recommended increasing the enlisted corpsman manning from 10 to 12. At a follow-up conference in 1998, attendees ensured that the Preliminary Ship's Manning Document reflected this change. A 1998 LPD-17 Medical/Dental Workshop brought together the owners with the designers to review two-dimensional space drawings



Computer model from LPD-17 Program Office

LPD-17 Class Medical and Dental Complex. These spaces will enable *San Antonio* to support first response health care by ship's personnel and when augmented, casualty receiving and treatment to include forward resuscitative surgery.

of each medical compartment and to provide recommendations to OPNAV's Required Operational Capabilities document. Participants ranged from hospital corpsmen and dental technicians to anesthesiologists and the force dental officer. As noted by CAPT Edward Wyatt of OP 931 and the Surgeon General's office, "the teaming of PMS 317 and the key medical and dental activities bring exactly the right expertise together to positively impact LPD-17." The workshop's recommendations led to the incorporation of dozens of proposals into the design.

In 1999 and 2000, design team coordination with the owners moved into a new phase known as the virtual crew. The design team projected three-dimensional models of specific medical and dental spaces from their Avondale design facility to fleet representatives located in the LPD-17 War Room at Little Creek, VA, and at COMPHIBGRU Three in San Diego, CA. These electronic "walk throughs" enabled the "virtual crew members," up to 25 fleet subject matter experts at a time, to verify accessibility of ICU beds, visibility from the nursing station, and the placement of the dental chairs. In the ward and ICU alone, the owners recommended modifying a ward cabinet, replacing a flaked ice machine with a cubed ice machine, and changing the type of portable ventilator. They also recommended the deletion of the surgical scrub sink and addition of two-hand washing sinks for ward personnel in addition to changing the model of adjustable hospital beds. Also validated were the locations of oxygen bottle brackets, emergency lighting, electrical outlets, and other services in the Ward.

During virtual crew sessions, designers demonstrated distances in order to validate clearance around equipment. The use of computer-generated Sailors and Marines, anthropomorphically sized between the 5th and 95th percentile, ensured that humans could fit in the designed spaces. After the space review and validation, these 3-D space models became the final detailed design to drive the steel cutting machines and actual construction.

Examples of LPD-17 Design Accomplishments

In addition to the triage example mentioned at the beginning of this article, two other examples highlight the value of the "ownership" and design team interaction. While reviewing the two-dimensional drawings of the Central Sterilization Supply Room (CSSR) in 1998, medical experts traced the process flow for sterilizing instruments based upon equipment position. They discovered that clean and dirty instruments crossed through the same areas and recommended physical separation into "dirty" and "clean" sides. The design team asked for assistance in rearranging the CSSR, and Fleet Surgical Team Six responded. The Surgical Team's recommendations to relocate equipment led to a revised traffic pattern that facilitated infection control practices. This is is reflected in the current, revised design.

The dental operating room also received scrutiny. In addition to validating equipment and instrument selection, the owners helped improve space arrangement. Through their interaction, the design team moved or reoriented a dental dresser, an eye wash station, two wall cabinets, two heaters, and an x-ray machine. The resultant operating rooms will have better access and accessible storage space.

Conclusion

The overall results of this effort not only ensured LPD-17's medical capabilities meet fleet requirements of the 21st century, but also reduced costs. By incorporating recommendations more than two years before construction started, the LPD-17 Program avoided costly engineering changes. Overall, the LPD-17 medical and dental space design reflects over 130 adopted change recommendations, total validation of equipment selection, and even modernization of allowance lists and consumables. This team effort ensured that the USS *San Antonio* Class will meet the needs of expeditionary warfare healthcare professionals throughout the first half of the 21st century.

From triage to operating room to central sterilization and supply room, USS *San Antonio*'s medical and dental spaces exemplify a design for the owners with the owners. Perhaps the best description of the overall effort is by SURFLANT's Force Master Chief Corpsman Raymond Bailey, a participant in LPD-17 design events beginning in 1996 when assigned to COMPHIBGRU Two. He noted, "Never before have designers so involved the healthcare communities in warship design. At every step of the process we were asked for our input and then had an opportunity to validate the results. When medical and dental personnel step aboard USS *San Antonio* in 2004, they will benefit from a design that has been refined from the efforts of dozens of owners and designers." ❑

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Book Review

Two Moons by Thomas Mallon. Pantheon Books. New York, 2000. 310 pages.

In *Two Moons,* Thomas Mallon weaves an unconventional love story together with the scientific and political atmosphere of Washington DC, in 1877. Set mainly at the Naval Observatory in Foggy Bottom, the current location of the Bureau of Medicine and Surgery, *Two Moons* includes not only fictional characters, but also real historic figures, such as New York politician Roscoe Conkling and astronomers Simon Newcomb and Asaph Hall. This novel, while not destined to be a classic, is nonetheless an enlightening, unique, and enjoyable read.

Cynthia May, the book's main protagonist is a 35-year-old widow. Despite what many would call a tragic and difficult life, Cynthia is an independent and emotionally strong individual. Her life has been dramatically marked by the Civil War, in which she lost her husband and brother. She has no friends and lives in a boarding house run by a nosy woman and inhabited by shallow boarders who are her intellectual inferiors. Her life, however, seems to be on an upswing when she is hired as a "computer," a person who does the mathematical calculations and charts for the astronomers at the Naval Observatory.

It is at the Observatory that Cynthia meets not only the famous astronomers Simon Newcomb and Asaph Hall, but also the astronomer Hugh Allison. Hugh, who is younger than Cynthia, is handsome and intelligent. Yet, despite his education, Hugh seems unmotivated by his work at the observatory and unable to come up with his own experiments. Cynthia is drawn to Hugh from the first time she sees him. Hugh, likewise, is attracted to Cynthia's intelligence and practicality. Not withstanding their age and social class differences, the two fall in love.

Careful not to let the novel become simply another love story, Mallon is equally interested in the political unrest of the time. By 1877 Reconstruction was over and a controversial election had put Rutherford B. Hayes into the presidency. However, the man wielding much of the political power was not the President, but the charming yet devious Republican Senator, Roscoe Conkling. Conkling was a womanizer, known for his rhetorical skills.

On a chance encounter, Conkling catches a glimpse of Cynthia and is instantly enamored of her. Used to getting what he wants, her denials of his advances only serve to excite him further. However, as Cynthia slowly becomes closer to Hugh and learns of his ultimate goal, she realizes that she will need Conkling's power to help the man she loves fulfill his dreams. Playing games with a powerful man, who is by no means a fool, is a dangerous affair, and Cynthia's problem is compounded by the fact that she cannot hurt Hugh by telling him about her involvement with Conkling.

The scientific life at the observatory is no less interesting than the love story with which it is intimately involved. The recent death of the Superintendent, due to malaria contracted at the observatory, has heightened the concern of the astronomers who are unsatisfied with the observatory's riverfront location. Furthermore, Foggy Bottom, as its name implies, lives up to its name, making viewing conditions far from ideal for astronomers. The only way to secure the hundreds of thousands of dollars needed to move the observatory away from these adverse conditions is for one of the astronomers to make a great scientific discovery, and, thereby prove the observatory's worth to Congress. Thus, while Cynthia walks a thin line with a powerful senator, the astronomers with whom she works feverishly search the night skies for something profound.

With all these fascinating plot twists and turns, *Two Moons* is never dull and can be appealing to readers of vastly different interests. Mallon is a clever author, and nothing in *Two Moons* is quite what one would expect. ❑

—Sarah Tronic is a summer intern for M09H, Bureau of Medicine and Surgery, Washington, DC, and a student at the College of William and Mary, Williamsburg, VA.

A History of Medicine in the Early U.S. Navy by Harold D. Langley. The Johns Hopkins University Press. Baltimore, MD, 1995. 435 pages.

Chronicling half a century of history in a comprehendible, yet thorough fashion is no easy task. In *A History of Medicine in the Early U.S. Navy*, Harold Langley is able to accomplish both. The book traces not only the evolution of Navy medicine, common ailments, and treatment practice prior to the creation of the Bureau of Medicine and Surgery, but also focuses on political and social developments that affected both the treatment rendered to patients and the treatment of Navy doctors by their peers.

In 1795, Langley explains, the need for a U.S. Navy and, thus, for a Navy medical corps became apparent as hostilities with France escalated. This was known as the Quasi-War.

Dr. George Gillasspy, an Army physician from New York, became the first Navy surgeon when he was assigned to the frigate *United States* to prepare her medical chest. Although Dr. Gillasspy did not remain in the Navy long, he paved the way for a new group of naval professionals.

The end of the Quasi-War did not mark the end of hostilities for the burgeoning nation. Soon thereafter, Barbary pirates began interfering in American commerce. When Tripoli finally declared war on the United States, the Barbary Wars began. These hostilities created new medical experiences for Navy surgeons, who had to contend with unique conditions in the Mediterranean.

The Embargo Act, and then the War of 1812, put a damper on American commerce which in turn resulted in new challenges for medical officers of the Navy. In 1811 Congress passed a provision that allowed for the creation of a naval hospital at Washington, but the War of 1812 temporarily suspended the project. Throughout the country, naval hospitals were understaffed and in poor condition. The fight for better pay and better working conditions for Navy surgeons subsequent to the War of 1812 lead to the eventual creation of the Bureau of Medicine and Surgery in 1842.

To illustrate the plight of Navy surgeons and surgeons' mates, Langley examines the monetary and professional struggles of individual officers and mates. At the end of the War of 1812, Army surgeons received 60 dollars a month and could draw three rations a day. Their Navy counterparts were paid only 50 dollars a month and received just two rations a day. Furthermore, Navy surgeons were required to serve aboard ships and often had to be away from home for long periods.

In his examination of individual officers, Langley is able to demonstrate the importance these men placed in the treatment of their patients and the integrity of their profession. It is obvious that being a Navy surgeon or surgeon's mate was a grueling and often financially unrewarding career. Many Navy men left the service due to disagreements with line officers, unpleasant assignments, and unsatisfactory working environments.

However, it is clear from Langley's work that, despite all aforementioned obstacles, medical men were proud to serve in the Navy. In the 1820s the list of men applying for positions as surgeons or surgeons' mates was so long that many had no realistic chance for entry. In 1824 a system of rigorous exams was created to help determine qualifications for entering surgeons' mates and for advancement of those men already in the Navy. Furthermore, Navy surgeons also contributed greatly to medical knowledge of the time by often publishing their findings.

Despite the sometimes overwhelming amount of information thrown at the reader, Langley's work is an impressive overview of medicine in the early Navy. His discussion of real people and their particular ailments or problems make the work more approachable on a human level. Yet Langley is equally interested in scientific practices and discoveries at the time, such as the early use of a vaccination for smallpox. He approaches all aspects of his work with skill and knowledge. ❑

—Sarah Tronic is a summer intern for M09H, Bureau of Medicine and Surgery, Washington, DC, and a student at the College of William and Mary, Williamsburg, VA.

NEWS RELEASE

The Society of Civil War Surgeons, the largest organization of its kind dedicated to the study of Civil War surgery and medicine, will hold its 10th National Convention on 28-30 March 2003 at the Crowne Plaza Union Station Hotel in Indianapolis, IN. The convention fee includes all lectures on Friday and Saturday, Friday night hospitality reception, dinner with Keynote Speaker on Saturday evening, breaks on Friday and Saturday, and a tour of selected Civil War sites in the Indianapolis area, including the Lilly Museum. Leading authorities in the field will speak on various topics and will be the mainstay of the convention. Our after dinner Keynote Speaker is Sophia Hammond, great granddaughter of Union Army Surgeon General William A. Hammond. A pre-conference workshop, for an additional fee, will feature Alvan St. Jacques, renowned expert and teacher in moulage techniques. We are offering special student rates, with appropriate school ID, for 1-day attendance.

For information on the Society and/or registration packet contact: Peter J. D'Onofrio, Ph.D., President, Society of Civil War Surgeons, 539 Bristol Drive, S.W., Reynoldsburg, OH 43068. Email: PjdSOCWS@aol.com or visit our website at: www.civilwarsurgeons.org

Please note that in the July-August 2002 issue of *Navy Medicine* that CAPT Edward G. Reeg, DC, USN, Executive Officer of the National Naval Dental Center, was also a contributing author to the article *Navy Dental Corps: 90 Years Marching Forward*.

CALL FOR PAPERS

The tenth National Convention of the Society of Civil War Surgeons, Inc., will be held in Indianapolis, IN, at the Crowne Plaza Union Station Hotel 28-30 March 2003. Anyone interested in presenting a paper is invited to submit an abstract (one original and two copies) to Peter J. D'Onofrio, Ph.D., President, Society of Civil War Surgeons, Inc., 539 Bristol Drive, S.W., Reynoldsburg, OH 43068. Electronic submission (WordPerfect or Microsoft Word) is also acceptable for submission (please submit one "hard" copy with disk).

Any subject relating to the medical or surgical aspects of the American Civil War, treatment of the sick and wounded, or relating to any of the medical personalities of the era is suitable for presentation, but the paper must represent original work not already published or in press. We would also be interested in papers that would compare medicine in the Civil War with modern day treatment. Presentations, if selected, shall be limited to 45-minutes, followed by a 5-minute question and answer period. Abstracts must by typed, single-spaced, and not to exceed two typewritten pages in length. Abstracts should embody not merely a statement of a research question, but findings and conclusions sufficient to allow assessment by a selection committee. Speakers selected to present a talk will be encouraged to submit, at the time of presentation, a manuscript of their talk for possible publication in the Society's quarterly publication, *The Journal of Civil War Medicine*, after a peer review.

The following author biographical information is also required: name, title (occupation), preferred mailing address, work and home telephone numbers, fax number (if applicable), email address (if applicable), present institutional affiliation (if applicable), and academic degrees (if applicable). Abstracts must be received by 15 September 2002. We will also need to know if you require any audio/visual equipment as part of your presentation. Presentations will be audiotaped to make them available to our members at a reasonable cost. If you are selected for presentation, you will also receive a release form.

Submission of an abstract does not guarantee presentation at the convention.

Navy Medicine 1939

BUMED Archives

U.S. Naval Hospital, Newport, RI, 1939 showing the newly completed 2nd floor in the south wing.