Gene D. Arcy
Human Factors in QAS
Topic: *Ergonomic Considerations While Working In A Mobile Military Laboratory And Wearing A Chemical Suit Ensemble*
01 APR 03

INTRODUCTION

In any major military conflict, medical personnel have always been there to support troops in the field. In particular, American forces have seen the evolution of medical capabilities that parallel military innovation - the Revolutionary War, to the Civil War, and upwards to Vietnam and Operation Iraqi Freedom – innovation through technology has allowed for better life-saving treatments. In the field, medical processes must be as sound as possible so that the best possible care can be given. In theater Medical Treatment Facilities is the first stage in real-world medical care. One might recall the show “MASH” where visions of crude surgical and patient tents abound. A Medical Treatment Facility is similar and, nowadays, much more advanced, and may have a variety of names depending on the branch of service. Such facilities usually have a need for basic medical laboratory support.

WORKING ENVIRONMENT

One area of interest within the sphere of the Medical Treatment Facility is the mobile clinical laboratory. Such a laboratory can provide for a multitude of testing, which includes, but is not limited to, chemistry panels, blood operations, basic hematology, and basic microbiology. One operation is consistently seen: the transfusion service (blood operations). The mobile laboratory’s outer exterior is made of metal, which are pieced together from paneling. A cooling system is needed to keep the laboratory in an ideal environment, usually 22°C. Laboratory equipment is packed and shipped using a pallet system. Such a system can be delivered via air and land. Other set-ups exist as new approaches to in-theater medical support are realized.

The equipment used in automated and manual testing procedures can be very intricate and a good eye-hand coordination. For example, blood must be tested using the tube-slide method. Such testing is used to verify patient and donor blood types, and patient antibodies. This method involves multiple test-tubes and reagents. Given that these tests can be done in batches at one time, it is quite reasonable to have a test-tube rack of fifty plus tubes. One must understand that a mistake in this kind of testing can result in the death of the recipient, thus this is one stressor of the many to follow. Another intricate test is the manual blood differential using a microscope and stained slides. Such testing may involve blood counts of red blood cells and white blood cells. Such slide readings may be numerous, even more so when combined with microbiological slides. Although automated methods appear ideal, one must consider that instrumentations require constant monitoring and, at times, unexpected and periodic maintenance. Quality Control failures must be resolved. Storage capabilities need to accommodate strict room temperature, freezing, and refrigerated requirements for blood and blood products; reagents; calibrators and standard; etc.

Although laboratories which are in country may vary based on need, one such laboratory exists exclusively for receiving, storing and distributing blood within the theater of operations; such a laboratory is known as a Blood Supply Unit. The Blood Supply Unit may be incorporated into other forms of laboratory operations, or operate independently. This kind of laboratory must provide a five day storage supply of blood products based on the support requirements of the Medical Treatment Facility, and blood reports. The Blood Supply Unit can support up to twelve Medical Treatment Facilities. Such support can be very taxing to laboratory staff should a high rate of injuries be encountered by troops and the like.

In the mobile laboratory itself, incandescent bulbs hang from the ceiling. The walls are white. The dimensions can and do vary, but usually approximate to roughly a 20ft by 10ft box. Laboratory benches are very basic, and provide for the bare essentials as do the seating arrangements – comfort is not an option. Staffing for any given shift might see a maximum of three persons, depending on emergency requirements; however, night shifts may only need one person to monitor operations should there be only be a need for basic laboratory support. Since such medical support is seen during drastic times, working hours probably exceed 12 hours per shift. The staff themselves may vary in experience and qualifications, and stand a good chance of not knowing each other as medical services from all branches are commonly brought together under a medical 'umbrella.' So, different philosophies may be seen with Navy, Army, and Air Force personnel; so too with qualifications and training. The ages of such personnel do not usually exceed beyond 35 years. Performing one's duties in the same position and performing repetitive steps is very common.

CHEMICAL SUIT ENSEMBLE

Chemical suit ensembles have been used for many years now in one form or another. Through technology the have gradually become more tolerable to use and wear. The current system is known as Joint Lightweight Integrated Suite Technology. See Figure #1 and 2 for an illustration. The suite itself consists of a two-piece heavy, air permeable overgarmet worn over the duty uniform. When worn properly, it will protect in-theater military personnel biological, radiological, and chemical agents.

The system also consists of one MCU-2A/P gas mask; a hood which is tightened around the mask exposing a filter, voice emitter, drinking apparatus, and intercom adapter; identification markings are worn on front and rear of the hood, the right breast garment pocket has an abbreviated rank and last taped to it; butyl gloves are worn over cotton inserts while the sleeve is over the part of the glove with Velcro secured; a front draw string connects to a rear draw string, both of which should be firmly tied and remain on the out side of the suit; vinyl boots fit over combat foot wear, and have secure buckles to ensure proper protection before overlapping with pant legs; Velcro straps are tightened around vinyl over boots; a gas mask bag is

strapped to the side; and usually a web belt is worn which has canteens, flashlights, and miscellaneous materials attached to it. The belt itself is designed to cross over the shoulders and attach, front and rear, to a belt worn around the waist. As one can begin to see, working within such a suit could make performing one's job very difficult, especially in hot and high tempo situations. It should be noted that not all of the components of the suit need be worn should the military alert system guiding its use should indicate, for instance, that only the top and lower garments be worn with web belt and gas mask bag with gas mask stored inside. However, during such times military members must have the rest of their ensemble packed in a bag and placed next to the member for ease of access, should the other suit components be needed.

Figure 1 & 2. [http://www.fas.org/man/dod-101/sys/land/jslist.htm]

HUMAN FACTORS PROBLEMS

In looking at both the mobile laboratory system and the Joint Lightweight Integrated Suit Technology one may, at first, see a combination of ergonomic concerns arising should the two be needed. Generally, one can see that stress arises from the situation itself, that of being put into a wartime situation where lives are at stake. Of course, stress factors can be broken down even more specifically by understanding what is expected from laboratory tasks and work routines while negotiating the limitations of the suit. Here, we will see that mental fatigue can become the primary concern.

As I have indicated, laboratory tasks are very technical in nature; high quantities of work are realized; scheduling complements medical wartime need; the task

environment is based on precision and accuracy of laboratory tests and/or blood production; and the conditions under which personnel must work are less than accommodating, both ergonomically and aesthetically. However, military members are driven by a sense of mission, sacrifice, and camaraderie, thus leading to a better attitude towards what needs to get done. This kind of attitude alone could significantly counterbalance the 'bad,' thereby giving an emotional edge. One might add that the purity of the tasks themselves and corresponding environment add to better clarity of mind in that they leave little in the way for added 'polish;' just the essentials. However, we should look closely into such tasks and consider the chemical suit ensemble.

Simple reaction times are expected to increase while wearing the ensemble; this would include movements, hearing, and visual. Of these, the visual aspect is probably the most important as testing must be accurate and precise; thus choice reaction time is affected, especially when dealing with fifty tubes which are lined up in a rack and one is wearing a gas mask. Wearing the ensemble also adds to the difficulty of the noncritical components of any one task - now, one must be accountable for the care his or her own suit, and also the task at hand. Secondary tasks are realized; tracking is a large practice within the laboratory - labels, bar codes, and all testing steps are identified; short term memory is used to execute test protocols, e.g., general placement of samples and reagents within a particular testing step.

Certain physical positions may be used for long periods of time. Certain tasks may require repetitive and constant motions. Wearing the ensemble adds to heat strain. Although the mobile laboratory is kept at a constant room temperature, working actively, combined with the suite, can and does add to constant sweating, increased heart rate, and increased core temperature. The humidifying effect of wearing the gas mask increases such effects. Dehydration can also be a problem.

Tasks aside, sleep depravity is very common and a very real concern, especially when dealing with a complex laboratory environment in a war time situation. Having to sleep in just the top and bottom of the suit can make things very uncomfortable if in a dry and hot, or humid, climate; that combined with long shifts over a long period of time can make for a bunch of irate laboratory technicians.

POSSIBLE SOLUTIONS

So, one sees that there is the potential for mental fatigue over time; that is, one sees high demands in the nature of the tasks themselves, working conditions, and overall physical effects of the suit.

Performing laboratory tasks is cumbersome while wearing any part of this suit. To make things easier, staff should attempt to combine their efforts whenever possible and work on different components of the same task where previously only one person was needed. Tasks should be set up for the least amount of movement. Rotation of tasks should be done every few hours. Personnel should double check

each other's work, no matter how trivial, thereby spreading laboratory responsibility and effort. Non-specific laboratory tasks, such as supplies and general QC checks and other support duties, should be rotated. Such rotation might be seen as a 'break' from the stress. Personal check-lists should be used so that a routine can be established when possible, thereby reducing the reliance on memory; this would include writing down minor details during testing. During 'down times' personnel should break out from their routines and relax. If allowed, tasks should be modified for ease of use. For example, setting up test tubes in three racks instead of one might allow for ease of task completion in that the tubes are not clustered together, which allows for one to better distinguish between tubes and better handle the load.

To counteract the effects of the suit, water must be consumed constantly. Times should be established where two canteens are consumed, say, every hour, depending on the climate. The officer in charge could enforce this and make it a way of doing business in the suit. Where breaks in work are seen, personnel should be allowed to lie on the floor or a make-shift cot. That way, sleep, or rest, is obtainable.