TOPIC I) Does the HMF as currently planned provide the capabilities needed for your specialty? What would you add or delete and why?

Group 1
Speaker: Joe Boyce

Regarding the capabilities which the HMF provides, we tried to break it down into four categories. Categories I, II, and III covered minor, moderate, and major illness and everybody agreed that we had covered all the minor illness very well. There is no problem with that issue. In Class II, we saw the majority of problems being covered very well. There are very few exceptions to that and, certainly for up to a 10 day period, we will be able to cover that. Even with all the considerations (we went back and forth on whether we're going to have an EMT who has been trained for the first six months versus a physician), we still see the majority being covered, especially when you consider the telemedicine considerations. In Class III illnesses, as we designed the HMF from the start, we don't see being able to cover all those major problems and catastrophic illnesses from the list. Let me let each one of you address the specifics as how we compare to your specialty in another setting and in the wilderness medicine environment.

Group 1
Speaker: James Wurgler

I have been asked to comment about equipment and supplies. There are more supplies in some areas than I have available to me now in my environment, so I think that there are some excesses, but I'm not prepared to ask people to give up some of the things that they think are necessary for some of their specialty practices. The thing that I keep focusing back on is what is the purpose of the HMF and what are we trying to do, and I see it from the perspective of family practice which is to look at the common things and to see what can be done for common things; it's the common problems that would interfere with the ability of the mission. The question is, "What is the HMF supposed to do; is it supposed to provide tertiary care for the rare situation that might cause a single person to have a catastrophic event, or is it to keep the mission going?" And when you look at problems with keeping missions going, you are looking at basic, common problems. A person with a relatively simple eye problem is disabled or unable to perform the mission. People with dental or eye disorders (and neither of these things are probably in the remotest imagination life-threatening), but they are mission-threatening. The equipment and supplies that are available in the HMF, in my judgment, will allow me to take care of probably 90-95% of the complaints that might occur - even to the orthopedic issues. I know that this sounds archaic to say this, but the fact is that even if we have fractures that are not reduced to anatomic perfection, a person can still

function. In the space environment where you can't bring a person down and have somebody put some plates on, screws on, etc., you can still get by with basic splinting and holding things in position. So to make it very brief, I feel comfortable with, I think, 90-95% of the things that we talk about. It's just like it is at home - 5-10% we have to call for help from a specialist.

Group 1
Speaker: Kim Broadwell

This issue of the mission of the HMF is everything - is it all things to all people? The HMF covers a lot of the things that we've talked about as well as technology "stretchers", long reaching advances over terrestrial medical devices. The capabilities of the HMF are very ambitious. I've always felt that way. A lot of resources are available for things which have a small likelihood of happening, relatively speaking, but which would have a great impact if they did occur. The possibility of having a crew return vehicle, in some senses, increases your responsibility to do be able to do a bang-up job with brief resuscitation and support. The thought here would be, "Is this someone we can evacuate?" The opposite - no return crew vehicle, and you know that if someone is real sick, you can keep them alive for a day or two, but without definitive care, survival is not likely. I think the overall capability is certainly there to do a good job for most of the internal medicine issues. Major trauma and surgical issues are still in the Class III category; the patient will die.

Group 1
Speaker: Joe Boyce

Allow me to speak for Dr. Stetson in his absence and try to capture his inputs. There were several comments made in comparison to the submarine environment, i.e., how we compare to their environment. We thought we were more capable in terms of overall equipment than a submarine environment. Certainly, the training issue is one which is at variance with ours. When we said EMT, we meant a person that we could train for six months, what we could do in that time, that's how we define the EMT issue. Compared with the Navy independent duty corpsman you heard yesterday, there were several years of training involved and a lot of clinical hands-on training. There is a difference there in the two groups. Then we had more capability in equipment and that of EMT (as updated physician) CMO. On the subs, he noted, there are about 20 liters of fluid, half of that Ringers lactate. There is no defibrillation capability in most subs with the exception of when they do have a physician on-board. Physicians are only on board typically when they go on for training issues; they are not assigned to individual submarines. There is about a maximum of three weeks to rescue. They do have blood intercrew member transfusions, so they are the same as us in that regard. They are limited in certain capabilities, certainly no peritoneal lavage capability exists. The Navy has an equipment list equivalent and noted that it was received about every two years, and they go over that with a Navy board and have what they call their authorized medical allowances. They don't have a chemical analyzer on subs, but they can do limited microscopic exams, gram stains, etc. Dr. Stetson noted that some docs "sneak" equipment

onboard - the most common thing being the defibrillator although they rarely use it. That was the majority of comments in comparing subs to the HMF.

Group 5
Speaker: Bill Martin

Our group covered radiology, chemistry and pharmacy, and as far as the first question is concerned, about whether it provides capabilities, with regard to radiology, it would. It would provide hospital basic level radiography.

The chemistry laboratory was also found satisfactory with its coagulation instrument, blood gases, clinical chemistry and hematology.

Pharmacy is a problem so far because there are certain areas where it is insufficient. One area is the nutritional products. There also are areas where pharmacy is heavily impacted by the other groups which it supports. It depends a lot on whether or not you are going to keep a certain instrument or not, whether or not the pharmacy will be able to supply the necessary materials to support that particular instrument. So there's a feedback system here that goes up and down and you go up and down, and that has to have some flexibility depending upon the development in the other areas. The area that I could pick out is that there is no pharmaceutical supply for x-ray in case one wanted to do an IVP with some contrast agents, there were no provisions for contrast agents, and I guess I mentioned nutritional products there, so as far as the first question is concerned, our efficacy now is defined - "What would you add or delete, and why?"

In radiology, of course, there is the question as to whether or not imaging should be provided or not be provided. It is clear that you cannot add or delete various aspects of the imaging chain - you delete one, you delete them all. However, as the system is currently designed, it is much bulkier than it need be. I think there are much more efficient designs that could be employed, i.e., as currently designed it uses five imaging sets; I think that's unnecessary - you could probably get by with one with current state-of-the-art technology which was not available when this instrument was initially designed about five years ago. So there are issues where volume and weight can be cut back now with the advances in technology.

As far as chemistry is concerned and what could be cut out there, the discussion centered around the coagulation instrument which would be the first to go. That would be a savings of 8 lbs. and approximately one cubic foot of supply. The next thing that might be considered for scrub would be the clinical chemistry analyzer, and that would save approximately 16 lbs. and two cubic feet. And then in addition to that, there would no longer be a need for the centrifuge which would save an additional ten pounds and one cubic foot of supply. Those are the priorities we set in that area.

As far as pharmacy is concerned, there was a lot of talk about HESPAN and the volume and bulk that it takes up and whether or not that it should be eliminated. Of course, there is feedback with the pharmacy and it is at the

dependency of everybody else and what support they need to provide for them and their needs. So, I think that pretty well covers and summarizes our area.

COMMENT:

I don't have a question, but in our discussions, you had mentioned trying to set goals for the level of care, and I would like for you to comment on that.

Well, the concern that I see throughout the meeting is that there has been a lot of focus from many individuals to relate to their own experiences and try to take your own experiences and say, "How do these relate to space station?" What I haven't seen is a focus or cohesive effort to try to reach a decision about what exactly is the level of care which we are trying to do for the space station? I don't think the goal has been set or they haven't really defined objectives in terms of what is it that we are trying to achieve? What level of care is it? And nobody knows yet; that's still up in the air at this point. And not a lot of definitive discussion has taken place in regard to defining that level of care and what it is that we want to do. The impression that I get from the group is that the level of care that they want to provide from this study is a lot smaller than what it was initially intended to be from previous groups that have met on this problem. So I think there has been a lot of change in philosophy from what I've seen over the years that has evolved, and at this time, I'm up in the air as to what exactly it is that we're trying to achieve here in terms of the level of care and the needs of the group. That's why I emphasized yesterday that I think we should look at this as a Space Station project. I think that it is somewhat incorrect to take individual experiences and backgrounds (such as submarine or wilderness, etc.) and then apply that to space station. I think what we should do is say, "What is space station? Now how do we look at these individuals to treat various things that could occur on there?" And then go to them for their expertise and say to them, "How would we deal with this? What's your experience?" And that's the best way to use them. But I don't think you should define it in terms of any of those things. We're a totally different situation; we have different problems that we've got to address, and they are unique. They're different from all these other areas. I haven't seen that goal and that definition made at this point.

Group 3
Speaker: Charles Stiernberg

Just for clarification, we're just speaking to question number one. We spent a different amount of time on each of the six questions and not a lot of time on question one, and, perhaps, quite a lot of time on questions four and five, but I don't think I need my full amount of time to make this short report.

From an otolaryngology standpoint, the capabilities, as currently planned for SSF are more than adequate. I would not necessarily remove much. There are a few small things that could be thrown out that will probably never be used, i.e., a tuning fork. That might sit in the drawer for 30 years and never be used. However, on the other hand, I noticed a solution of cortisporin ear drops - I'm sure that everyone here has used these at one point in their life for the

treatment of swimmer's ear. As you well know, you always put a patient's head in the dependent position to drop the drops into the ear canal, provided the canal is patent and not swollen shut. It's not going to work in micro-G gravity, so to get around that we do need to add a very simple otic wick, which is a small, one centimeter miniature tampon, so to speak, put in the canal so it will soak up the drops.

With regards to x-ray equipment, all of us in our group do not have a critical, absolute need for x-ray equipment, although all of us see that in the future that if we look at this thing 15-20 years down the road we want to make the statement, "Yes, it may eventually be absolutely necessary should this Space Station become more and more developed." So we don't want to throw out x-ray equipment and say we will never use it. We may not use it initially, but somewhere down the road, it may become important.

From a dental standpoint, there were no particular changes. From an ophthalmology standpoint, several things were recommended. I will just briefly read these: such things as substitute tetrocaine with proparacaine, add a high irrigation solution, add some sort of method for rebreathing CO_2 such as a simple paper bag, a spud for removal of foreign bodies is absolutely essential. Some of these things we went over yesterday, I believe. Also add a keeler loop, a cult needle holder, 6.0 and 8.0 sutures are very important, a near vision test card - that's very simple and lightweight, penlight with cobalt filter. We do not recommend a fundus camera, although it is noted that such camera is on-board in the laboratory section of the experimental section of the Station, although that particular camera for an ophthalmologist is, as I understand it, not of real great value since it's only got one or two colors and has some other deficiencies. From an ophthalmology standpoint, x-ray equipment is not actually essential nor is ultrasound.

All of us here have seen patients that, if not psychotic, were in a state where they had to be restrained whether they be in an ICU, intubated, trying to pull a tube out, or whether they be just a psychotic patient. That's essential to restrain such a person.

That's all I have. Thank you.

Question:

Is there a hemostatic nasal canula currently provided?

No, but under question three -"What new technologies are developing, what methods or techniques would you consider adding," and under that I would say, "Yes, we would need it. An epistat or a nasostat - that's on the current orbiter and it's been requested (I'm sorry I didn't mention that) for nose bleeds. Although they have never occurred, we should be able to treat that.

Group 2
Speaker: Alfred Bové

We basically looked at a number of items for Hyperbarics, and I will say a brief word about that. If an urgent EVA, which lasts an hour or more, is needed without adequate oxygen prebreathing, there is a very high risk of decompression sickness. If that occurs, you have a disabled crewmember probably after one or two of these events. The hyperbaric chamber would resolve this disability. I think the hyperbaric chamber is a necessary component.

Within the medicine and surgery categories, I examined medicine to list critical and non-critical medicines. The question was raised about our goals. We have all been making assumptions about our level of care. I would make the comment that the level of care in a three month mission ought to be return the crewmember to full duty unless the illness is very serious. We should be able to practice medicine to return a crewmember to full duty unless it's a catastrophic illness or injury (at which time we have to save life first and stabilize the individual with possible return to duty). That would be the level of care we should approach. It's not truly the wilderness environment where you have a short-term emergency that you must stabilize and get back to civilization. This is a situation where you would really like to take someone who has an illness that's not catastrophic, fix it and go back to work. And, so when we look at non-critical issues i.e., the usual kinds of things which come up would be infections like pneumonias, gastroenteritis of various types including bacterial and viral, skin infections (I think these are going to be a problem from my experience in other closed crew environments such as saturation diving and submarines - not so much submarines, but saturation diving), at least a remote possibility of a CNS infection such as bacterial or viral, (meningitis or encephalitis). In addition, pyelonephritis, septic arthritis, cystitis, renal or gall stone problems, and asthma are likely. (I have some concern about breathing the particulates in the environment for three months. Somebody is likely to come down with asthma). Metabolic illnesses are unlikely; we're not likely to find a diabetic developing in spaceflight. Heat stress is possible.

The capabilities to treat these are quite good with the equipment and facilities which are presently planned. When we look at more critical types of things which might occur medically such as acute myocardial infarction or pulmonary embolism, those are events which are also treatable with the facilities that are on-board. The consensus was that the anti-coagulation or the coagulation parameter unit is probably not necessary. I wish to dissent on this. I would personally not like to treat a pulmonary embolism with anticoagulants, both acute and chronic anti-coagulation without having coagulation parameters available, nor would I like to use thrombolytic agents in acute myocardial infarction without having some measure of coagulation. It was mentioned that we could use leukocytes but leukocytes don't work for measuring prothrombin. So, I think our consensus was that the coagulation unit could be prioritized lower; my personal feeling is that if you experienced a pulmonary embolism or acute myocardial infarction, you would be very uncomfortable trying to manage the patient without it, but we prioritized it as a group a little bit lower.

In terms of the x-ray system, there was a variety of opinions. My own personal opinion is that if I were trying to manage an infarct with heart failure or a pneumonia, I would certainly like to have that x-ray. We did not have any radiologists in the group, but I think the consensus here again is that the x-ray would be a good thing to have; it probably doesn't have to be prioritized at the top of the list.

If we look at surgical items, we discussed trauma, and I don't want to talk a lot about trauma. There are, at present, adequate materials to mechanically ventilate the patient and provide a few days of care. Although something should be said about the nursing care of an intensive patient because the nursing care is the major issue. Intensive care will require one-on-one nursing care and none of us can imagine 14 days of one-on-one nursing care in that environment. A few days would probably exhaust the entire crew, so there should be an evacuation option. I think that was the ultimate conclusion from that.

In terms of treating burns, one of the questions raised was how do you handle stool and vomitus from a burn patient in terms of contamination and maintaining the products of the burned patient in a closed environment to avoid having it spread throughout the space station? The fluid needs for a burned patient are well beyond the planned storage capabilities of the IV fluids, and there should be some powdered materials kept on board to be mixed with water. Recycled water can be used for enteric nutrition and enteric fluid replacement rather than for parenteral fluid. There was some concern expressed for the filtration system and the condensate conversion particularly about the drinking water in terms of removing viruses. If the herpes virus was passed through the condensate system and spread around in the water and mixed through an IV solution, it might have some very serious effects.

There were a number of suggestions made as to how to treat burns in terms of specific agents. I don't think there is the time to discuss them, but there were concerns about the ability to debride a burn, to coat the burn and cover it with antibiotics and other materials. Antibiotics were also of some concern in terms of making sure they didn't have antibiotics that were being used in allergic subjects.

In terms of fractures, orthoplast was mentioned. It is a plastic material you can heat and it doesn't produce dust. You can cut it with a scissors before it's molded and it can be used to make splints for fractures. It was recommended by one of the surgeons.

So I think overall the facilities were adequate. We prioritized the coagulation machine low on the list, but we would prioritize x-ray near the top of the list, but not at the top. My personal feeling is that our goal for care of day-to-day illness in a closed environment such as this ought to be to cure the illness and return the individual to full duty.

Group 2
Speaker: Rob Fromm

We've pretty much covered the critical care aspects and transport aspects, but I will just reiterate them quickly. Critical care medicine really involves titrated care based on physiologic variables that are fed back to the operator. The feedback of physiologic variables is termed monitoring and proposed HMF monitoring capabilities are superb, perhaps more than one needs. We have a major problem with providing titrated physiologic support to patients. As many of you who have worked in an ICU realize, it is not a medical ICU, or a surgical intensive care unit, it's a nursing ICU. It is really the nursing interventions that are the therapeutic aspect in intensive care units. We feel that it is unreasonable to expect the Crew Medical Officer (CMO) with a geologic background and six months of training (functioning in a hallway of the hab patient module, having to serve as a pharmacist, housekeeper, and respiratory therapist) will be able to replicate the kind of efficiency we see in well-skilled, intensive care unit nurses. Therefore, it is unreasonable to expect what we call critical care medicine to be existent for more than 48 hours, in the HMF for the most critically ill patient. We do feel that monitoring capabilities for all categories of illnesses should be relatively easy to provide with currently allocated resources.

In addition to the personnel limitations of the HMF, there are some technological limitations that are of interest. Specifically, there is no provision for the management of patient with renal failure (dialysis or hemofiltration). It is possible that one could perform peritoneal dialysis using currently allocated resources. You might be able to get by with this.

Because of these factors, the critical care medicine group really feels that some consideration for other options for dealing with the most critically ill patient is warranted. The ACRV is probably the most palatable, and a second less palatable option is a recognition that some patients will die.

Group 4
Speaker: Daniel O'Neill

I'm speaking as a representative of the surgical group on the first question, and we feel that the HMF, as currently planned, provides capabilities needed for surgical sub-specialties. First of all, it must be recognized that surgical procedures performed will be of a very limited nature. I think we do all recognize that. Orthopedically, as originally planned, there is more present on the HMF than is needed, so we have deleted most of the splint and traction devices, added a few small things such as a thoracic extension, a few Philadelphia collars, we felt it imperative that heat and cold applications be available as well as serious consideration be given to electrical stimulation units for the treatment of overuse injuries. Specifically, I don't think there's any need for orthoplast splints. The heating that's necessary from all these splints introduces another problem, and the splints that are being serious consideration already (SAM splints) beat everything that an orthoplast splint can for most major injuries without that extra step.

Gynecology - There definitely is a need for D & C instrumentation. It is necessary to have the ability to position one in the lithotomy position and they have made a strong call for ultrasound because most of the pelvic diagnoses and treatments are going to rely on ultrasound. Again, gynecology integrated waste management is essential.

As far as general surgery, again, limited procedures can be performed with the current capabilities with the addition of some peritoneal lavage, catheters, and a few other items. In essence, the limitations of the HMF as far as surgical capabilities are those of the clinical capabilities of the Crew Medical Officer. And those are our comments.

Question:

Yes, I'd like to ask one question with regard to ultrasound. Is there any usefulness of ultrasound in cardiology?

Comment: Alfred Bové

For the most part, these people will be well-screened prior to going to their flight so there would be no intrinsic cardiac diseases that we would have to diagnose. The only time ultrasound would be useful if somebody had chest pain and non-specific electrocardiographic finds the ultrasonic analysis of left ventricular function sometimes can show an abnormality of motion of the left ventricle which indicates that there is an ischemic process going on. I would not consider that a very major need though. As I said, I would think that if we had in the pharmacy the appropriate drugs to treat an acute myocardial infarction and the electrocardiographic diagnosis, that would be adequate in this population although the ultrasound would be an nice embellishment if we had it. We would use it if, but I don't think we feel it is essential.