AIAA SPACE 2009 Conference & Exposition
14 - 17 September 2009, Pasadena, California

AIAA 2009-6539

Medical Astrosociology: Ethical Dilemmas in Space Environments

Jim Pass[1]
Astrosociology Research Institute, Huntington Beach, CA, 92647

[Abstract]. One of the key areas within the emerging subfield of medical astrosociology involves research concerning the ethical dilemmas that space travelers and settlers will face as humanity spreads itself out into the solar system. Those that touch on the medical domain can be especially difficult to reconcile, and they often result in disagreement and conflict. While it may seem premature to many to consider such ethical issues while human spaceflight still focuses on low Earth orbit, we must seriously initiate this dialog now so that humans will be better equipped to face difficult decisions in the future. These dilemmas occur on Earth, so they are sure to play out in space environments. Historical and contemporary lessons derived from analogous situations involving humans living and working in isolation on our own planet can serve as extremely valuable guides. Examples include polar and other types of expeditions, long-term residence at permanent polar stations, submarine and warship duty, and the voyages of explorers from the past. Humanity's experiences aboard space stations that include Skylab, Mir, and the ISS orbital stations have provided valuable data, though some aspects of the experiences of professional astronauts and cosmonauts more closely resemble military living arrangements than the typical social life experienced by civilians. Thus, it is important to distinguish between the two in settlements that establish themselves farther out in the solar system. Once again, however, we must remain cognizant of the medical ethics developed on Earth in "ordinary" situations as well as the special circumstances added for those living in isolated space environments. In a sense, all experiences on Earth involving medical decisions represent analogies for space environments. The bioethical issues that transcend beyond space medicine in terms of strictly involving biomedical matters require input from social scientists working together with physicians and others concerned with the multiple dimensions of health and safety. Medical astrosociology allows for a multidisciplinary approach to the study of the ethics related to space medicine that requires investigation *before* these issues exhibit life-and-death consequences for patients, family members, friends, and even entire populations living in space. The time has come to take advantage of existing knowledge regarding analogous situations, and the rich traditions of the social sciences, so we may institute humane and safe procedures involving bioethical situations in space.

I. Introduction

FUNDAMENTALLY, we must ask ourselves a series of questions that are relevant to space medicine and thus to medical astrosociology. What will the twenty-first century hold for humanity's exploration of space? Will we be content to collect more Moon rocks and then come straight back to Earth? Will we be content to send robotic probes into the solar system? Alternatively, do we crave something more aligned with *human* involvement in space? Is space the final frontier just for robots or for human beings as well? Will we be content to send robotic probes into the solar system and study the data from terrestrial control stations and laboratories? If our answers to these sorts of questions favor quick trips by elite astronauts and dependence on robotic probes to explore space, then we can probably continue to get by without the development of medical astrosociology because bioethics and biomedicine would not require a heavy influence from the social and behavioral sciences. On the other hand, human expansion into space makes medical astrosociology invaluable due to the larger numbers of humans that we must send to make

[1] Chief Executive Officer, Astrosociology Research Institute, P.O. Box 1129, full AIAA member. For orientation, the author holds a Ph.D. in sociology.

a space settlement both survivable and livable. Utilizing a broader perspective, it becomes clear that engineering concerns about the physical environment and concerns about human well-being become equally important. Most individuals in the space community tend to overlook this relationship due to its unfamiliarity to their current everyday occupational concerns. On the other hand, it seems that some change is occurring.

Many in both the social science and space communities have long recognized the need for social and behavioral scientists to contribute to engineering by expanding the area of human factors studies,[1,2] but it is not a widespread trend that encompasses the social and behavioral sciences. Likewise, many of those in space medicine and related areas do, in fact, recognize the importance of this expanded perspective. However, in general, medical practitioners and surgeons tend to overlook the consequences of their occupational advances. Moreover, both the medical and social science communities fail to prepare humanity for coping with future technological advancements not only in space, but on Earth as well.

> Some of the more important and obvious emerging technologies are human cloning, tissue engineering, genetic engineering, species prolongation (longevity), suspended animation, virtual humans (holomers), intelligent machines, nanotechnology, and surgery in space. Each of these will have enormous impact and create major shifts in the future of medicine, yet little attention has been paid to them by the medical community at large…Although all of the implications of the new technologies cannot be foreseen at this time, it is critical to identify the likely candidates which have the potential to disrupt our conventional thinking about medical care and investigate their social, behavioral, political, moral, and ethical implications. Many critics would argue that some of the technologies cannot be realized in the next two to three decades, yet the issues are so profound that even longer time spans may be inadequate to prepare for the consequences.[3]

Satava's last point is important because many critics, especially in the social/behavioral sciences, view long-duration space travel and settlement as decades away and thus not important to the contemporary "real world." All of the technologies mentioned above have strong implications for human space habitation, and thus the need to develop medical astrosociology *at this moment* is imperative.

Truly living in isolated space environments during long duration missions and in permanent settlements will require the study of all aspects of social groups. Those studying groups of people stationed aboard the International Space Station have come to realize that medical issues are many and can easily become life threatening.

> Increases in both duration of flight and distance from the Earth create different and more complex experiences and challenges. Behavioral health is at risk due to these challenges. Increments on the International Space Station have increased to 6 mo, and the behavioral health support that has been provided has been praised by crewmembers and their families. For exploration missions, behavioral health will constitute one of the most important risk areas, along with radiation, bone and muscle loss, and the potential for illness and injury.[4]

Maintaining behavioral health, or healthy behavioral conditions, is vital for survival and mission success during long-duration spaceflights.[5] What many still fail to recognize is the fact that space medicine involves issues in decision-making that include social-scientific considerations. The fact that humans are social animals totally removes the possibility of restricting biomedical decisions to strictly medical criteria.

The complexity of social life in space will only increase as we move from space crews, to small groups, to permanent bases, to communities, and ultimately to space societies (or settlements). Increases in social complexity result from population growth and increasingly transform the group identity from a Gemeinschaft (community) structure to a Gesellschaft (society) structure.[6] This also implies that medical decisions become less individual- or even group-based and more society-based. Critical decisions in a crisis involve weighing the best interests of the individual(s) to those of the mission, or group, or society as a whole. This is nothing new – in medical sociology, for example, or even in science fiction – but it may require a major shift in thinking within the space medicine community. Social and behavioral science criteria shape how people live whether they are on or off the Earth. We need to start paying serious attention to how the medical and nonmedical criteria relate and complicate one another when making critical decisions about illness, injury, and health care delivery in space environments. Otherwise, we risk missing essential elements of understanding.

A. Defining Astrosociology and Medical Astrosociology

Medical astrosociology is patterned after the existing fields of medical sociology and medical anthropology that currently exist within their respective social science disciplines. When applied to space medicine, additional issues arise that either never occur on Earth or at least rarely do so. This new subspecialty, while relevant today for the ISS, will prove even more valuable once human groups begin living in space beyond Earth orbit and for longer durations. Long duration spaceflights and especially permanent settlements will face issues that demand attention today so that we may prepare ourselves for the difficulties that will inevitably come to pass. For example, when missions increase in duration and distance from Earth, crews will need to respond to medical and other types of emergencies without the aid of terrestrial mission controllers.[7,8]Space societies will have the same difficulty. Problem solving in all areas

of social life will occur in the space environment in real time while controllers can only respond after the incident has begun or even ended.

The field of astrosociology has developed into a much more inclusive approach compared to its original conceptualization that was limited to a subfield of sociology. It is now a multidisciplinary field that purposely takes advantage of the best contributions from the various social/behavioral and humanities disciplines. This results in a field that takes a comprehensive approach from a wide-ranging social-scientific perspective.

The subfield of medical astrosociology seeks to incorporate the social sciences into strictly biomedical discussions to allow for a more all-inclusive approach to space medicine.

> Medical astrosociology [is] defined as the study of [behavioral,] social and cultural patterns (i.e., astrosocial phenomena) that affect medical issues in space environments. As will become clear, it an approach that combines issues related to space medicine with social-scientific concerns. It may be termed "the space variant of medical sociology" because it borrows concepts primarily related to sociology, psychology, and anthropology impact on medicine and medical practice. It combines space medicine and a social-scientific approach in many ways, many of which currently remain beyond our knowledge.[9]

Medical astrosociology therefore seeks to benefit from the input of contributors from the social/behavioral sciences and humanities. Beyond that, it seeks participation from those who study space psychology, behavioral health, space medicine, biomedicine, and related fields. Collaboration from multiple disciplines and fields from both the social sciences and space sciences can lead to modes of thought impossible from any single perspective. When combining both branches of science, the possibilities for unconventional forms of progress escalate beyond average levels. Suddenly, synergy exists between the two branches of science.

The call for the need to transform space medicine into a more highly collaborative discipline is not new as Nicogossian and Pober[10] exemplified in 2001, and they were not the first to do so. However, such restructuring plans tended to involve fields from the natural and physical sciences. The missing link is comprised of a substantial level of participation by social scientists in addition to psychologists. Medical astrosociology can bring about change in this area by organizing a larger group of social scientists from multiple disciplines. However, a willingness to expand into this area is required. Taking a major step forward is not certain. Thus, the push for development must become purposeful rather than haphazard or accidental.

B. Thinking Beyond the Concept of "Astronaut"

Due to the small number of humans who have traveled into space, we tend to place such individuals into a special category known as *astronaut*, or some equivalent depending on the culture. This elite class of space traveler will soon become less meaningful when space tourism becomes more common. As larger numbers of humans go into space, the term will become less and less prestigious. When civilians such as cooks, domestic workers, and schoolteachers move into space settlements along with traditionalists such as engineers, space physicians, natural/physical scientists, and pilots, then the elitism associated with being in space loses much of its high level of prestige. This would be a positive development.

Humanity's exodus into the cosmos is not possible if only elite astronauts constitute the groups that spread outward. So-called "civilians" of various types must take their places in such migratory efforts. Spacefarers will need to exhibit the same division of labor that we find on Earth. Long duration human spaceflights and settlements will require a diversity of knowledge and skills that the small number of astronauts cannot hope to offer, even with cross training schemes.

Astronauts share a common trait with pilots and physicians.

> The positive professional cultures of pilots and physicians exhibit a high enjoyment of the job and professional pride. However, a negative component was also identified characterized by a sense of personal invulnerability regarding the effects of stress and fatigue on performance. This misperception of personal invulnerability has operational implications such as failures in teamwork and increased probability of error.[11]

When such individuals operate in leadership positions, they may well drive their subordinates to work harder to the point that health and safety risks increase beyond reasonable levels. Errors associated with various aspects of spaceflight or other productive activities can indeed occur, as can harm to individuals' wellbeing. Professional pride can surely place undue pressures on others, and thereby raise ethical questions about health and safety.

Perhaps a term such as "spacefarer" becomes more appropriate as it designates the person's location without inferring an elite status historically reserved for a precious few. Once terrestrial societies move beyond concepts that place spacefarers into a limited elite social stratum, they can move on to the important work of designing sustainable missions and settlements (or social societies). Thinking beyond the concept of "astronaut," unless we redefine this term to describe the "everyday" spacefarer, reflects a vital social idea that allows access to space for the rest of the population. Early space tourism will not lead to this outcome directly, but it could increase the ranks of astronauts more quickly than was possible through the space agencies around the world. In turn, those in lower social strata may find that space travel is accessible as prices drop. On another front, private corporations may recruit individuals

to become spacefarers who may not pass the standards of NASA (for example). Such trends will also create the social conditions necessary for movement toward a true spacefaring society.[12] Thus, benefits will occur for humanity in space *and* on Earth as institutions in both locales become connected to one another. Such an outcome will establish connections between Earth and space.

C. The Sick Role in Terrestrial and Extraterrestrial Environments

In 1951, sociologist Talcott Parsons defined the "sick role" in terrestrial societies.[13] He asserted that there are four major characteristics of the sick role. First, the sick person is exempt from normal social roles and responsibilities. The strength of the exemption is based on the seriousness of the disease or ailment. To prevent abuse of this right, society must ensure that the condition is legitimate, most commonly accomplished by a physician or other expert. Second, the patient cannot cure himself/herself by pure will or decision. In most cases, treatment by others is required. The patient must accept help. Third, the patient must agree that being ill is undesirable. The patient should seek to get well as soon as possible. The fourth characteristic focuses on the idea that the ill person must seek competent help and cooperate with the caregiver to get well.

As a functional theorist, Parsons sought to explain the sick person in relation to the proper functioning of the social system.

> In his seminal writings on the topic, Parsons (1951) argued that the *institution* of medicine is empowered by the state to regulate illness as a potential threat to the stability of the social system. Parsons conceptualized illness as a form of deviance because it can interfere with the performance of normal role obligations and place undue stress on other social institutions, especially the economy and the family.[14]

The sick role allows a dysfunctional situation to receive corrective attention on the personal level in order to maintain the balance exemplified by the status quo on a large scale. The social system seeks equilibrium in the continual attempt to minimize deviance for the betterment of society. In a space settlement, this can theoretically prove vital because fewer members of that society exist. When a person becomes incapacitated, the absence of their multitask-oriented contributions pose an even larger threat to the proper functioning of the social system than within terrestrial societies. The lower division of labor could result in the dearth of multiple skill sets essential to space society survival. Becoming the ill or injured person back to work becomes more vital to the extent that others cannot take up the slack in terms of performing those missing specialized duties.

In contrast, conflict theory offers a different set of concerns than functional theory. For one thing, it focuses on the power differential between the patient and medical practitioner, for example, rather than the proper functioning of society. The physician makes the decisions about how to proceed with treatment while the patient normally finds himself/herself in a position in which agreement with the course of action seems almost inevitable. Conflict theorists also view sickness as a form of deviance, but with different assumptions than functional theory. In this light, the patient must become subject to social control by various representatives of the state such as physicians, mental health care professionals, and social workers. The best interests of the patient, or even society, are not necessarily the top priorities.

However, the movement to institute "patient's rights" has challenged elements of the sick role and power differential models. As to the sick role, the desire to get better may not be acceptable to an increasingly larger extent. Those seeking rights may reject the label of "deviant" and challenge prescribed courses of treatment. Recent movements and personal challenges to conventional medical practices have complicated the relationship since Parson's time without question. Examples include euthanasia, assisted suicide, abortion rights, suicide, and religion-based refusals to accept various forms of medical treatment. Parsons would view these actions or attitudes as violations of the sick role, patients as isolated misfits, and therefore harmful to society.

In isolated space habitats, stress will be high, especially in the beginning. Thus, the sick role model becomes important because a space crew or settlement population cannot afford to consist of too many people unable to contribute to the social system in productive ways. How will spacefarers and settlers structure the norms (social expectations, or formal and informal rules) related to the sick role? Medical astrosociology becomes a necessary perspective in understanding issues involving space medicine and beyond its scope. Lessons learned about sick role behavior on Earth will find applications in space, as space environments will present challenging complications.

II. Medical Complications, Both Biomedical and Sociocultural

Complications from medical procedures seem inevitable. We expect that a certain percentage of treatments for injuries and illnesses will result in various types of negative outcomes. Negative reactions to drugs provide additional chances for complications. In contrast, physicians often fail to consider complications that arise from social, cultural, or psychological sources.

Nonmedical issues can affect both crew behavioral health. Instituting a heterogeneous crew composition serves an important positive purpose as known for a long time.

> Since future space missions will usually involve heterogeneous crews working on complicated objectives over long periods of time, these features require further study. Socio-cultural factors affecting confined crews (e.g., language and dialect, cultural differences, gender biases) should be explored in order to minimize tension and sustain performance.[15]

The various differences inherent in heterogeneous populations thus provide positive and some negative influences.

In the area of the definition of illness, individuals from different cultures, sexes, classes, and ethnicities cannot be expected to share all of the same values and thus norms. Complications can arise, not from medical crises, but from different interpretations of health issues and acceptable treatments. Furthermore, one must not make the mistake of believing that biomedical complications are more important than sociocultural ones because either form, or a combination of the two, can result in disaster. In reality, biomedical and sociocultural factors exist together, interact, and thus require simultaneous attention.

Different values mean different ethical standards. Dissimilar interpretations of medical care based on religious beliefs, for example, can result in miscommunication, isolation, ostracism, and even conflict without the proper understanding of the contexts within which they occur. In fact, part of the training process should include the attempt to build a group culture that accommodates differing viewpoints in order to avoid unnecessary problems later on in the space environment.

Current efforts to collect data fall short of what is needed according to Dr. Robinson as related here.

> Spaceflight is a unique activity undertaken by a unique population under unique social, cultural, economic, political and psychological constraints; application of a set of regulations and procedures developed for an altogether different set of circumstances is mistaken. The current system does not work. Thirty years of experience in human spaceflight has yet to yield sufficient clinical information to make long duration flights medically possible. Without serious and sustained efforts to rethink the study of humans during spaceflight, we unnecessarily risk the health and safety of astronauts on future long[-]term missions.[16]

In contrast, Dr. Wolpe does not agree that collection of data should be part of an astronaut's "occupational data gathering" requirements due to privacy issues and others.[17] Due to the life sciences budget cuts at NASA, it seems inevitable that some type of compromise is necessary that fits both the budget and the ethical concerns relating to privacy. The ethics of spacefarers as research subjects is an important area of concern.

III. Preparing to Handle Serious Issues

Some individuals, including experts in various areas of space research, believe that the harshness of space environments provides humanity with conditions that it cannot overcome. Often, this assessment involves the idea that while one, two, or even a few issues can be resolved, the entirety of all conditions makes success almost impossible. Others, of course, believe that all these issues will relent to proper research over the course of time. The latter position above seeks progress although the traditional approach tends to miss many of the problems that will arise inevitably. Currently, those who plan for human spaceflight and settlement often focus on the physical or natural manifestations of problems such as radiation, weightlessness, and the host of troublesome biomedical changes to the human body that result from non-zero-g environments.

The traditional approach tends to overlook the social, cultural, and/or behavioral (i.e., astrosociological) issues involved with social interaction in small, isolated settings. Ethical issues related to strictly biomedical phenomena cannot be separated from them. The two exist together, interlinked and thus both demanding simultaneous attention. The practice of focusing only on the "obvious" medical concerns will not prove successful. Correct preparation for humans living and working in space will require a combined approach because sometimes the issues that threaten individual and group survival will be best characterized as astrosociological in nature. Sometimes biomedical counteractive measures will prove to be the easier type of solution, but they may not solve the underlying problem.

A. Inevitable Extraterrestrial Issues

Undoubtedly, the number of extraterrestrial biomedical issues is daunting. The challenges faced by spacefarers outnumber those normally faced in terrestrial societies, and they complicate the commonly experienced issues on Earth. Thus, the challenges increase in number and complexity. Space medicine becomes more complex in terms of the biomedical complications that arise in space as most in the field realize, but additional problems result from interactions between strictly medical decisions and social scientific considerations. Additional dimensions that include social, cultural, behavioral, and ethical forces do not come from the human body. Rather, they come from human society. The interaction between the two is what makes medical astrosociology important. One cannot treat a single patient without taking into account his or her connections to other people and social structures.

The very inevitability of the interplay between biomedical and sociocultural forces thus requires social scientists to begin forming a formal collaborative relationship with the space community. It should include human factors professionals, of course, but the big change will come with the addition of scientists from the largely untapped social science disciplines with expertise in a high variety of traditional subdisciplines. Within sociology, for example, these subdisciplines include the family, medicine, culture, social structure, social groups, religion, politics, education, the economy, and social inequality. Each of these areas can affect the nature of medical practice in space environments. Those interested in serious biomedical problems in space environments must first identify what they believe are the inevitable extraterrestrial issues and then attempt to cope with them *before* spacefarers leave low Earth orbit. This method would allow for better planning which would include protocols for handling specific scenarios. This is impossible without first identifying and understanding the important issues ahead of time to the extent possible.

IV. Learning from Terrestrial and Extraterrestrial Examples

Again, when considering examples of how medical practice occurs in isolated conditions, it remains important to look at the medical emergency in the context of the astrosocial phenomena at work. For one thing, we know that preventive countermeasures are vital in space environments just as on Earth following a mission.[18] The question that arises is whether we can actually implement such a system to the extent necessary. It has proven a difficult proposition on Earth as medical care tends to be reactive in too many ways. We must take to heart the lessons from both terrestrial analogs and space-based experiences.

A. Analogs that Present Us with Important Lessons

A very good reason exists for the use of analogous environments to simulate space travel and settlement. Developing countermeasures for deleterious health threats by using astronauts as subjects while in space places them in potential danger and they are reluctant to endanger the flight status for upcoming missions. Thus, the traditional clinical model is not appropriate for the space program as it is currently structured.[19] The use of analog environments often represents using the best that researchers can access for another practical reason. "Analog environments might supply larger sample sizes than are typically available either from the US or Russian space programs, and studies conducted in these settings might be less expensive than collecting similar data in space due to logistic reasons."[20] However, while these alternative social settings can provide useful data and insight, a careful analysis is necessary to determine what is applicable and what is nontransferable to the space experience. Underwater habitats and at bases in Antarctica probably represent the best analogous conditions for the space environment although submarines also have important characteristics such as their cramped and self-sustained autonomy in a harsh setting.[21] Researchers must be careful to design terrestrial simulations so that that they are relevant to space environments. Otherwise, they are wasteful and, even worse, could prove harmful to spacefarers who venture beyond low Earth orbit (LEO) due to inapplicable assumptions. Unintended health compromises can occur before both leaving Earth, during the mission, and even upon return to Earth.

The use of contemporary analogs occurs in conjunction with historical examples. The practice of terrestrial medicine has taken place in isolated conditions in the past as mentioned. Examples include submarines and warships, Arctic and Antarctic expeditions, seafaring voyages of discovery, space simulations in hyperbaric chambers, land-based and submersible simulations, oil rigs, and mountain climbing excursions. Each type of analog contributes to our overall knowledge and thus each has important lessons to teach us. While research in this area does already exist, it remains inadequate and thus requires additional study.

In space, however, the applicable lessons gleaned from simulations and historical analogs may have important limitations to spacefarers. It is important to design simulations so that applicable data for space environments can be applied with confidence to the extent possible, including behavioral data not related directly to biomedical concerns. Sometimes human behavior leads to harmful situations that require medical attention or, even better, prevention. The latter approach expends valuable – often-dwindling – resources when medical problems seem absent, and thus physicians and political leaders tend to hoard supplies until emergencies arise. If adequate medical supplies do not exist, there is little chance that preventative programs receive high enough priority to matter.

Anticipation of abnormal behavior represents an important area of research. For example, how does sick role behavior play out under harsh conditions? Most of us have heard or read about cannibalism that sometimes occurs to ensure survival of the group. In such a case, social norms that govern the taboo of cannibalism are redefined or even suppressed while the threat to the group exists. A seriously sick or injured member may not receive the highest level of medical attention and/or may sacrifice his or her life to improve the odds of group survival. Thus, we already have data that confirms the adaptability of culture under various circumstances. Sick role behavior adapts itself to specific social conditions. Here, the most important function is survival of the group and individuals potentially

become expendable, though differing value systems may result in conflict among group members. There is no expectation of the patient wanting to recover or receiving medical treatment. In space, how will a particular culture, or mixture of different cultures, address similar situations? The biomedical criteria alone cannot answer this question. In this example, unconventional group behavior results in intentional harm rather than the normal course of medical treatment.

B. Space-Based Lessons

Humans have traveled back and forth from space for over fifty years now. The Mir station and ongoing Shuttle and ISS operations provide important examples of matters that pertain to various ethical considerations. Many, such as cultural differences, influence crew performance. Often, without social-scientific considerations, it may not be at all clear why people behave the way they do. A patient may refuse treatment, and violate the sick role, due to a weighing of cultural realities that transfer the preference for survival onto another person or group.

Currently, the elitist nature of space travel produces a rather small dataset from which to draw conclusions about how human beings living in larger groups (say, over 20 people) would cope with the stresses of their space environments and interacting with the same people for prolonged periods. Too much conflict can arise in various forms, including opposing or incompatible cultural values, that jeopardize the mission or even the very survival of the space society and the individuals involved.

In an isolated habitat, the survival of the entire group or success of the mission will often take precedence over that of a single individual. This circumstance may well compromise the expected adherence to the Hippocratic Oath. While some cross training will occur, the space society increasingly takes the form of a Gesellschaft social structure as more members come into the habitat as explained earlier. This means that the division of labor increases as the social structure transforms itself from a community structure to a societal one. The latter form becomes more impersonal even while the various societal members must rely on each other's specialized knowledge and skill sets to survive as individuals and allow the society to continue largely intact. More complications within the social system lead to more exceptions to the established status quo at any point in time.

What are the medical astrosociological implications of this? It is another example of how biomedical decision-making can increase in complexity by social, cultural, and behavioral factors. They impinge on the strictly medical variables in ways that may have little to do with medicine. Impersonal systems emphasize group survival, and a higher division of labor makes the individual more expendable.

C. Terrestrial and Extraterrestrial Differences

As stated, careful analysis is required to determine which findings in terrestrial analogs truly apply to the space environment. There are differences. Thus, the incorrect application of a crucial finding on Earth may result in unintended consequences within a space habitat. Perhaps better simulations of long-term stressful conditions in isolated environments could decrease the likelihood of making incorrect inferences. The result, however, may result in situations that become ethically questionable in terms of how the volunteers are treated during these simulations. We cannot simulate the potential harmful conditions without violating ethical standards.

Additionally, we must look carefully at all lessons learned in terrestrial medicine as they can all find application to solving many of the situations that replicate themselves in space. By recognizing the dysfunctional aspects of our terrestrial medical systems, opportunities arise to do something different – that is, something better. One good example in this area that involves access to health care. In the United States, there is a strong correlation between social stratification and health care access. Simply stated, you have a lower probability of health care access and health status if you are poor or fall into a so-called "minority" category. What access you do have does not result in the best medical care that society can provide as the social production of health favors those with greater power, wealth, and prestige.

V. Differential Access to Health Care

On Earth, access to health care varies by a number of different demographic variables such as income, race, ethnicity, gender, and culture/subculture. Many of the barriers to health care are structural in nature, meaning that they are built into the very fabric of society. These types of inequalities are imposed upon the individual patient if they become pigeonholed into one or more minority categories; that is, if the labeling process designates them as some sort of a social deviant. Sometimes, however, health care may not be acceptable to the patient. For example, a person belonging to a particular religious group may follow its belief system and reject surgery, relying on prayer instead. In such a case, the patient actually rejects the sick role by refusing to overcome his or her illness or injury via conventional means. The patient is considered deviant for a very different reason, then. How do these issues play

themselves out in space environments? To the extent that the citizens of the space society allow social inequality to prevail, the differential access to health care and to the other social institutions will exist in space environments and they will have to address such problems.

When seeking to construct a long-term space society, one often considers some type of utopian social system based on democracy and equality for all. Space theoretically provides the planner with an opportunity to create a society that betters the social conditions found in terrestrial societies. On a practical level, however, one must face a daunting reality. We know that heterogeneity in the population on a number of dimensions provides the best stability and chance for long-term survival of the population. It turns out that this is a double-edged sword. Heterogeneity in terms of occupation, ethnicity, and nationality – to provide just three examples – also results in multiple value systems. Different people have their own priorities. This can lead to disagreements about health care decisions that, again, utilize criteria that have little or nothing to do with medicine from a strictly biomedical perspective. In any social environment, complexity arises due to interactions between biomedical and sociocultural factors even when medical practitioners seek to base their decisions solely on medical criteria. For example, prayer may actually improve the chance of recovery when combined with traditional treatments. Sometimes unconventional approaches produce unexpected positive results.

Members of different social classes and cultures possess different ideas about what it means to be healthy or ill, and what type of medical response to a given situation is appropriate. Differential access to health care under such circumstances comes from the patient, potentially, but it may also originate from individuals in positions of power in the medical or political institutions that arise. This will occur even if decisions come from one or a few people, a social structure that will be common in developing space societies. The complex social structures found in terrestrial societies take time to develop. They are not possible with a small crew or population. However, population growth does result in increasingly complex structures and thus more social problems.

Differential access to health care represents only one form of social inequality though it is an important one. The various institutions, however structurally sophisticated at any given time, will also create complications for medical practice and the delivery of health care.

> Medical astrosociologists will want to study issues related to social inequality of all different types. While its minimization should become a top priority even before a mission blasts off the Earth, its elimination will prove impossible. Thus, the unique characteristics of the various forms of inequality that develop in a particular space society will require careful study by medical astrosociologists and others. Only then could policy makers combat social problems that develop, including in the guise of [bio]medical ethics, medical treatment, and health care delivery.[22]

We cannot eliminate social problems on Earth or in space, but we can attempt to minimize them.

One major solution can be implemented during the training process on Earth. It is possible to create a cultural environment that encourages a single value system that unifies the population in areas regarding health care access and treatment – that is, one culture adopted by all prospective spacefarers. The avoidance of a multitier health care access system is especially important to a vulnerable small group in an isolated space environment, so values should emphasize universal access to the extent possible. Implementation of such a system will present a difficult challenge as this outcome has proven itself a complicated matter in actual practice due to issues of resistance and has thus resulted in various types of intended and unintended consequences.

VI. Bioethical Issues Transcend Space Medicine

Bioethics is defined in various ways due to its expansive purview. Essentially, however, it is the study of the ethical, social, cultural, legal, economic, political, theological, and moral implications of new biological discoveries and biomedical advances in fields such as genetic engineering, cloning, euthanasia, and drug research. Bioethicists are concerned with the potential effects of the life sciences on particular societies. It is fair to state that the scope of bioethics varies among bioethicists. For our purposes, bioethics is confined to the moral dilemmas that may arise when biomedical treatments, technological advancements, and medical practice intersect with nonmedical complications. These complications call for nonmedical decisions in conjunction with medical ones, as they possess social and psychological consequences.

A common theme of this paper centers on the idea that medical practice does not occur in a vacuum (not even in space!) As on Earth, space medicine cannot exclude social scientific input. Ethical issues tied to medical decisions often cause disagreement and conflict. In the same way, space medicine is intimately related to bioethical standards that impinge on strictly medical decisions. Often, much more than the simple notion of saving a patient's life is involved in decisions that guide health care practice. The following examples are just a sample of the possible scenarios that might arise on a long duration spaceflight or within a space society. In the long run, we would do well to view such matters seriously and begin to discuss them in earnest so we can anticipate more potential scenarios. This will allow us to better plan for them. It will minimize the number of surprises that occur in space.

A. Examples of Bioethical Dilemmas

Medical science and technology can already tout many amazing achievements. These types of results will only increase in number and complexity in the future. The rule to remember, just as with science and technology in general, is that just because humanity can build something, it does not necessarily need to do it. The atomic bomb readily comes to mind. A variant on this theme relates to the idea that a given scientific principle or technological breakthrough has many possible applications. Humanity does not need to pursue all possible applications. Restraint becomes important when the application of knowledge becomes harmful to human beings, social groups or categories, societies, the Earth, and/or other entities. Ethical dilemmas also arise when those in power make exceptions to preexisting values and the violation of norms occurs, so they bear ongoing scrutiny.

In the area of medicine, making an objective assessment of aid versus harm is crucial. Space medicine may have a different set of priorities due to the harshness of the space environment. Human beings living in space will need to decide, perhaps on a case-by-case basis, how their moral and ethical standards will differ from those of terrestrial decision makers and those in other space societies. An old question arises, do the ends justify the means? If it comes down to a question of group survival, what is ethical and what is not?

The examples below are intended to raise questions, to alert the reader to potential issues, rather than provide answers. They should contribute to stimulating the contemporary dialog concerning bioethics in the future. It will arrive before we realize it, so we must prepare ourselves.

1. *Example: Human Cloning to Build a Settlement's Population*

The use of cloning technology to augment the growth of a settlement's population, once this technology becomes feasible on a large scale for humans and other forms of life, provides a good example of a bioethical dilemma. Undeniably, this method could increase the rate of population growth far more quickly. The question is, is it a good idea? Nations on Earth have banned human cloning. Do the needs of a distant, isolated space society outweigh the importance of protecting the sanctity of human life? Is this a way to cope with the potential problems of pregnancies in dangerous space environments? These types of ethical questions will arise. Perhaps the cloning of plants and animals for food and domestication is more palatable. Is the cloning of insects and/or microbes more acceptable?

2. *Example: Termination of Pregnancy to Sustain the Needed Workforce*

During the early stages of a space society's social and physical construction, there may be a need to make sure that all individuals remain available to perform their duties. Survival of the group may depend on it. What happens if an unplanned pregnancy occurs? The leadership may to decide to require a termination of such a pregnancy to keep the woman available to work in harmful conditions. Such actions may also involve expectations of medical complications due to exposure to the space environment. Of course, this would result in a situation in which a future worker and addition to the existing population would be sacrificed for more immediate concerns. Alternatively, as a preemptive solution, is it ethical to implement forced birth control strategies?

3. Example: Transformation of Parsons' Conceptualization of the Sick Role

With a limited crew or population size, how will the leadership of a space mission or settlement cope with illness and injury? By forcing a person to return to work earlier than medically advisable, they sacrifice the patient's exemption from work and other social responsibilities. The controversial aspect of this alteration of the sick role relates in part to the possibility of harming an individual to the point that he or she becomes disabled or unable to work for an even longer time than if they had provided the proper treatment in the beginning.

4. Example: Withholding of Drugs or Medical Supplies such as Bandages Due to Shortages

This practice also runs contrary to one of the tenets of the sick role – specifically, assisting a patent to get better. Unless it is possible to replace medical provisions such as drugs, medical supplies, and surgical instruments utilizing *in situ* resources, then rationing will become necessary. When is the use of these provisions authorized and when is it not? Do only the elites and individuals in critical statuses receive the best medical care? As always, these types of decisions have social consequences. For example, work stoppages may occur in protest of unfair medical practices. On the flip side, the sick role assumes that the patient seeks to get better. What does the leadership do when a patient refuses medical care and thereby threatens the group's survival?

5. Example: Conduct Genetic Experiments and Controversial Surgeries

Ethical questions often deal with questions related to implementing procedures that seek to advance the current status of medicine through technological improvements in areas of equipment, drugs, and various forms of therapy. In order to "improve" human physiology for a particular space environment (e.g., to cope better with radiation or

lowered/increased gravity), the residents of a habitat may opt for taking greater risks. Here, the ethics related to performing potentially dangerous procedures or therapies on what amounts to research subjects would present themselves. How much is acceptable when experiments on humans have unknown risks? These actions may actually result in more harm to spacefarers than the space environment poses to their safety or health.

6. *Example: Forcing Risky Exposures to Radiation and Other Hazards*

It is well known that spacefarers will be subjected to much higher levels of radiation than those living on Earth. What level is considered appropriate for a particular space environment? What social conditions would arise if workers were encouraged to work in conditions that subjected them to even higher doses of radiation and/or contaminants? A decision to take higher risks may result from the population's mutual consent and thus possess fewer ethical issues. Conversely, the decision may come down from those who exercise greater power in the space society. In this latter circumstance, resentment may arise within the population – especially if a number of these workers begin to suffer from radiation poisoning or other ailments.

7. Example: Minorities are Subjected to Greater Safety Risks

We have learned from the history of societies on Earth that inequality seems inevitable. While the planners of a space community may aim for the utopian goal of equality for all, some sort of social stratification on a number of dimensions (e.g., race, ethnicity, gender, social class) will emerge. The goal then becomes to minimize the inequality and reduce its harmful effects to the extent possible. Citizens will need to be careful that the leadership is not encouraging certain categories of people to take greater risks in the guise of contributing to group survival. As in terrestrial societies, the "more expendable" citizens may receive the more dangerous duties to perform. At the same time, will they receive better health care for their injuries and exposure to dangerous environments and elements? It depends on criteria such as how their illnesses affect group survival and how treatment affects the level of medical supplies available for the entire population.

8. Example: How Does a Space Society Treat the Aging

Gerontological issues will have an important impact. How will a space society treat the aging portion of its population as time passes? The first generation will likely consist of several middle-aged individuals. If these societies are stable, they can more readily absorb an increasing number of retiring individuals. Conversely, they may choose to keep the aged productive to the extent and in the ways possible based on a case-by-case basis tailored to the individual's capabilities and interests. Another solution could involve including a mixture of age grades in the initial population. For those who reach retirement age, the ethical questions arise if they receive unequal treatment.

These examples may seem like science fiction to many. However, science fiction often provides ideas that scientists pursue in the course of their occupations. They can also serve as cautionary tales that becoming applicable in the future. Many bioethical dilemmas could be avoided, which requires planning. Additionally, we should begin to think about these scenarios and others in order to avoid harmful situations and to work out ways to cope with them if it is deemed they are inevitable. This will allow planners to implement policies to which potential spacefarers must agree. These types of exercises will likely have terrestrial policy applications as well.

Conflict theory from sociology becomes pertinent when functional theory's major tenet of consensus does not exist among the entire population. What medical values become acceptable? Can those in power unilaterally institute medical practices that violate the values of the average citizen? Norms, or social expectations/rules, are created to protect corresponding values. But this raises a question. Whose value system is protected? Is it that of the elites or of the people? The political system thus impacts on the health care system in space just as it does on Earth. If the system is democratic, can the leaders of a given space society improve the democratic systems over those that exist in terrestrial societies. Should they aim for a fairer system or simply just replicate the characteristics that already exist on Earth?

VII. Establishing Medical Astrosociology in a Timely Manner

Medical sociology and medical anthropology became necessary subfields on Earth because they provided important perspectives for understanding the social, cultural, and behavioral implications of illness and health care in human societies. If we send humans into space, they will replicate the social systems they know or attempt to construct utopian models to which they aspire. In either case, the same necessity for medical astrosociology will exist in space simply because humans are involved. Without doubt, research into issues relevant to medical astrosociology will prove indispensible for the same reasons as it does on Earth.

Thus, the prudent plan involves the establishment of medical astrosociology in a timely manner. This subfield should be of interest to social/behavioral scientists and humanities scholars interested in space medicine and related fields. Additionally, those in space medicine, bioethics, and related fields should consider working with medical astrosociologists as they begin to specialize in this new area. Of course, not all of those in this general area will become medical astrosociologists, but they can still work with them to further our understanding about issues involving biomedical and sociocultural interactions in space social environments.

Satava[23] points to part of the solution when calling for physicians and surgeons to take responsibility for the technologies that they create and unleash into society.

> Surgeons and physicians, as pillars of moral conscience, have recently been forgetting their Hippocratic Oaths and stewardship to society, and have been languishing in the short-term gain of financial security and self-centered comfort and leisure. As scientists and humanists, surgeons must be aware of their responsibility in this awesome challenge and accept a leadership role through the coming decades of nearly impossible decisions.

This laudable call for placing society's well being before individual gain is indeed important. However, it only addresses one side of the coin. When it comes to the implications for living in space, the social and behavioral scientists also share part of the responsibility to provide clarity to issues that clearly have social, cultural, and psychological consequences for individual and societal survival. Thus, developing medical astrosociology in a timely manner translates to expanding its development immediately with the cooperation of the space community. This will involve a formal collaboration between the social science and space communities.

VIII. Conclusion

An important consideration when living in harsh, distant, and isolated space environments focuses on how to survive as a self-sustaining social unit, a space society, since it will lack the convenience of immediate Earth-based assistance and resources. Settlers will need to cope with social problems and medical emergencies within their own habitats. A tunnel-vision-like perspective on medical diagnosis and treatment alone will prove untenable and thus undesirable as well. The need to consider astrosocial phenomena served as a repetitive theme throughout this paper in order to drive home this point. Thus, the social sciences are necessary to provide complementary perspectives on biomedical issues so that the criteria used in decision making come from factors that involve the patient and other relevant parties in addition to those focusing solely on physicians and administrators. While many of the pertinent issues are addressed by bioethicists and other traditional specialists, the near absence of social scientists beyond psychologists and psychiatrists reveals a major hole in our general approach to understanding nonmedical factors that affect medical decisions. The contributions of medical astrosociologists will fill this missing gap.

With the advent of space tourism upon us, and plans for space settlements underway, the perceived status of astronauts as elites in terrestrial societies will not continue. This could pave the way for civilian spacefarers. On the other hand, these relatively untrained individuals could place additional pressures on the medical institution of a space society due to increases in biomedical complications and lowered safety standards.

Biomedical and sociocultural complications inevitably arise. Spacefarers will face serious challenges to their physiological well-being as the biomedical issues alone could result in failed missions and settlements. Additionally crews and space societies will face equally difficult challenges to their survival that arise from astrosocial sources. Social interactions in close quarters, far from Earth, and while on long-term or open-ended missions create problems in the social environment, of course, but they can also result in medical problems that require solutions from both social and medical professionals. For example, an individual may worry about unsafe working conditions though receive no direct harm in the form of illness due to exposure or disability due to accident. Nevertheless, this same individual may begin to experience psychological impairment, such as an acute form of depression due to the unsafe conditions, and this may in turn result in an ulcer. The point is that while it is possible to separate the physical environment from the social environment, the two are interconnected, and each one affects the other.[24] We need to take a more holistic approach to space medicine by taking into account issues related to medical astrosociology. These issues expand most current approaches touching on bioethics in space.

Learning from extraterrestrial experiences and terrestrial analogs can be helpful. However, in a sense, even the lessons learned from astronauts aboard spacecraft and space stations operating in low Earth orbit cannot fully approximate life in environments far from the Earth. These latter locales do not have the luxury of mission control assistance in real time. Further, those in LEO lack the same physical and psychological stress levels than those who will travel farther away from Earth. It remains important to be cognizant of possible differences, not only as they may apply to terrestrial analogs, but also as they may apply to extraterrestrial ones.

Bioethical issues become important because decision making in space environments beyond low Earth orbit fall to the spacefarers under extremely dangerous conditions outside the spacecraft or habitat. The physical environment requires a high level of technology to keep the occupants alive and comfortable. High tech biomedical procedures

will prove necessary to acclimate them to their environment due to dangers that include radiation and altered gravity fields. Some of the decisions to implement these procedures – whether they come in the form of drug therapy, genetic manipulation, mechanical enhancement, or other "unnatural" treatment to the human body – will require the weighing of benefits versus risks. Other types of decisions will require behavioral issues that relate, for example, to how to practice medicine, who has access to medical care and who does not, when withholding treatment is an acceptable alternative, and when the sick role is inappropriate (that is, when the removal from occupational duties is deemed unacceptable). Coping with these sorts of issues requires the input of social and behavioral scientists that specialize in medical issues but from a societal context.

Someday in space, we will inevitably need to cope with a diverse population consisting of several subcultures on a number of social dimensions (e.g., religion, occupation, gender, race, social class, and politics). In many ways, then, the nonmedical issues that we will cope with in space environments will seem rather familiar. Nevertheless, space environments will present medical practitioners with additional complications due to less familiar conditions such as radiation, varying gravitational fields, and the absence of a breathable atmosphere beyond the habitat. Medical astrosociological research will yield insights about bioethical issues utilizing the full range of knowledge accumulated by the social and behavioral sciences.

What we have learned points to the need to ensure proper integration of individuals into their settlement/space society.[25] The unequal treatment and access to medical care of all members of a space society can have important implications for social interactions in other areas of social life. Thus, the leaderships of space societies will need to remain cognizant of such issues as they can threaten the very survival of the population if they instigate a cascading effect into various subcultures and other dimensions of social life.

We know that life in space will be difficult for space dwelling groups.[26] We can presumptively remove needless complications before leaving Earth if we can identify them beforehand. Research is vital in this regard.

The multidisciplinary nature of astrosociology, and thus of medical astrosociology, must lead us toward the integration of the other fields and disciplines with space psychology that focuses on space medicine and related areas. **Instituting medical astrosociology is vital** for the future of space exploration and settlement due to the near absence of sociology, anthropology, political science, economics, history, and the other disciplines. Organizing them into one subfield tied together with a shared focus on human spaceflight and settlement will allow us to recognize and combine the important issues into a single body of work recognizable by interested social scientists. It will also provide the space community with a recognizable subfield with which to collaborate and make its unique contributions to our understanding of space medicine in the context of social structures and social interactions.

References

[1]Harris, Philip R., "Behavioral Science Space Contributions," *Behavioral Science*, Vol. 34, No. 3, 2009.

[2]Harrison, A.A., *Spacefaring: The Human Dimension*, University of California Press, Berkeley, CA, 2001.

[3]Satava, R.M., "Disruptive Visions: Moral and Ethical Challenges from Advanced Technology and Issues for the New Generation of Surgeons," *Surgical Endoscopy*, Vol.. 16, 2002, p. 1403.

[4]Williams, R.S., and J.R. Davis, "A Critical Strategy: Ensuring Behavioral Health During Extended-Duration Space Missions," *Aviation, Space, and Environmental Medicine*, Vol. 76, Supplement 1, 2005, p. B1.

[5]See reference note #4, pp. B1-B2.

[6] x[0]Pass, J., "The Astrosociology of Space Colonies: Or the Social Construction of Societies in Space," *Space, Technology, and Application Forum (STAIF) / AIP Conference Proceedings*, Volume 813, 2006.

[7]Stewart, L.H., Donald Trunkey, D., and Rebagliati, G.S., "Emergency Medicine in Space," *The Journal of Emergency Medicine*, 32(1), 2007.

[8]Eksuzian, DJ. (1999). "Psychological and Behavioral Health Issues of Long-Duration Space Missions." *Life Support & Biosphere Science : International Journal of Earth Space*, Vol. 6, No. 1, 1999.

[9]Pass, J., "Space Medicine: Astrosociology in the Sickbay," ASM Proceedings, *Astrosociology.org Virtual Library* [online archive], URL: http://astrosociology.org/Library/PDF/ASM2008_MedicalAstrosociology.pdf, 2008, p.3 [cited 1 August 2009].

[10]Nicogossian A, and Pober D., "The Future of Space Medicine," *Acta Astronautica*, Vol. 49, No. 3-10, 2001.

[11]Helmreich, R.L., "Culture and Error in Space: Implications from Analog Environments," *Aviation, Space, and Environmental Medicine*, Vol. 71, No. 9 Suppl.), 2000, abstract, p. A133.

[12]Pass, J., "Shifting from Airports to Spaceports," Space Conference Proceedings, *Astrosociology.org Virtual Library* [online archive], URL:http://astrosociology.org/Library/PDF/Contributions/Space%202007%20Articles/Airports%20to%20Spaceports.pdf, 2007 [cited 1 August 2009].

[13] Parsons, T., *The Social System*. New York: The Free Press, 1951.

[14] Kotarba, J. A., "Social Control Function of Holistic Health Care in Bureaucratic Settings: The Case of Space Medicine," *Journal of Health and Social Behavior*, Vol. 24 (September), 1983, p. 275.

[15]Kanas, N., "Psychosocial Value of Space Simulation for Extended Spaceflight," *Advances in Space Biology and Medicine*, Vol. 6, 1997, p. 81.

[16]Wolpe, P.R., and Robinson W.M., "Dialogue: Bioethics in Space," *Medical Ethics*, Vol. 12, No. 1, 2005, p. 11.

[17]See reference note # 16, p. 10.

[18]Kanas, N., "Group Interactions During Space Missions," *Aviation, Space, and Environmental Medicine*, Vol. 75, No. 7, 2004.

[19]Shepanek, M., "Human Behavioral Research in Space: Quandaries for Research Subjects and Researchers," *Aviation, Space, and Environmental Medicine*, Vol. 76, No. 6 Suppl., 2005.

[20] Sandal, G.M., "Psychosocial Issues in Space: Future Challenges," *Gravitational and Space Biology Bulletin*, 14(2), 2001, p. 47.

[21]Gilles, C., "Psycho-Sociological Issues of Spaceflight," Chapter Six in *Fundamentals of Space Medicine*, 2004.

[22]See reference note #9, p. 21.

[23]See reference note #3, p. 1408.

[24]See reference note #6.

[25]See reference note #9.

[26]Emurian, H.H., and J.V. Brady, "Behavioral Health Management of Space Dwelling Groups: Safe Passage Beyond Earth Orbit," *The Behavior Analyst Today*, Vol. 8, Issue 2, 2007.