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# Astronauts and Personnel of Space craft: Are they the lost Envoys of Mankind

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Outer Space, which are often called the realm of mankind is subjected to exploration with the scientific advancement. Presently, the exploration is not limited to sending objects to Outer Space but even human exploration has also been initiated when Yuri Gagarin orbited around the earth. In the present world astronauts frequenting the Outer Space is very often, thus raising the main concern with respect to his health issues. Since the scientific advancement in Outer Space is developing day by day, how much impetus is given to the health of astronauts. The reason being, human body reacts to change of weather but here, there is a question of travelling to Outer Space. NASA's human research Program has studied the changes encountered by human body in space. Thus over a period of time scientist have design procedures, devices, and strategies to keep astronauts safe and healthy throughout their missions. The research also aids in the development and assessment of medical standards, physical fitness programs and standards, physiological and psychological adaptation training, sensorimotor training, and nutritional health protocols.

This paper will discuss about the issue of several health hazards faced by astronauts during their space flight and stay in International Space Station. The paper will also look into the International Legal Regime to address such issues coupled with the question that, whether there is a sufficient International Legal Regime to support the astronauts faced with health hazards. In this context, if required domestic legislation and the guidelines made by International Space Organization will also take into consideration. To keep up with this, since India has also embarked on the space journey, the domestic legislation concerning the issue will also be examined.

The main concern in this paper, is that Outer Space is still at developing stage, which demands vigilance, concern and consensus to address the issues of astronauts.

Keywords: astronauts, Outer Space, Health, Research, Legal Regime, Domestic Legislation

## Introduction

On December 19, 1967, the General Assembly of the United Nations by a vote of 115-0 approved an "Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched in Outer Space"; requested the Depositary Governments "to open the Agreement for signature and ratification at the earliest possible date"; and expressed its hope "for the widest possible adherence to this Agreement."[1]

Within international space law, the notion of astronauts has been present since the adoption in 1963 of the resolution on Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space. The ninth and final principle declares that astronauts shall be regarded, by States, as “envoys of mankind in outer space”. States shall also provide to astronauts “all possible assistance in the event of accident, distress, or emergency landing on the territory of a foreign State or on the high seas”. In addition, when astronauts make such landing, they shall be “safely and promptly returned to the State of registry of their space vehicle”. While the Declaration is a resolution and holds no legally binding effect on its parties, it is evident that its contents set the tone for later developments in space law.[2] At the same time it also initiated a debate on the health hazards face by astronauts.

## Condition of Health Hazard faced by astronauts

The high energy cosmic particles from Sun will spread in the entire cosmos. Earth is saved from such cosmic energy due the presence of magnetosphere which deflects the most of the solar particles. The dangerous cosmic energy is called as radiation and it causes harm to human body. Since the International Space Station travels through low earth orbit within Earth’s protection and is shielded by metal hull, thus crew member of International Space Station (ISS) is protected from cosmic rays[3].

[1]Paul G. Dembling & Daniel M.Arons, *The Treaty on Rescue and Return of Astronauts and Space Objects*, DOC. OUTER SP. LAW (1968), http://digitalcommons.unl.edu/spacelawdocs4.
[2]Louise Holm, *Legal Protections for the Health of Astronauts : an Analysis by* (2020).
[3] Dirk C. Gibson, “Terrestrial and Extra-terrestrial Space Dangers – Outer Space Perils, Rocket Risks and the Health Consequences of the Space Environment” 1st edition (United Arab Emirates, Bentham Science Publishers, 2015) at 61

**Weightless "Weight" Lifting Builds Muscle on Earth**

The feeling of weightless is ecstatic but for astronauts it creates complication. Since they are exposed to earth's gravity, their bone and muscles weakens, thus creates critical health condition. Thus special exercises are needed to address the situation. Paul Francis, OYO Fitness Founder developed a special exercise device suitable for use on the International Space Station[4].

**Solar Energetic Particles (SEPs)**

SEFs are the solar flares and coronal mass ejections, spread across the solar system by the solar wind. These particles are electromagnetic waves containing protons or ions. This causes extreme harm when collided with spacecraft or astronauts. It may cause fragmentation of cells or DNA if passes through skin. The person became highly susceptible to cancer and in extreme cases radiation sickness. In such circumstances Scientist alert mission may inform the astronauts about delay spacewalks or shelter in heavily shielded area inside the space station until the event passes[5].

**Galactic Cosmic Rays (GCRs)**

GCRs are more dangerous than SEPs. They are the remains of long gone stars from elsewhere in milky way, which are showered in the form of steady drizzle. It is very difficult to get shielded from GCRs, as it consists of helium, oxygen or iron. On collision with space craft or astronauts they knock the atoms apart, causing secondary radiation[6].

**Isolation and Confinement**

The detailed study on isolation and confinement by NASA for years, have helped them to develop strategies to counter the same. It is observed that sleep deprivation and prolonged working hour have evil effect on the health of astronauts causing fatigue on performance. Astronauts can take out their pent up frustration and feeling of isolation in a journal, which are used for behavioural study[7].

**Gravitational Issues**

With the change of gravity hand eye coordination, locomotion, spatial orientation, balance, bones, muscle and heart function will be effected. Our constant work to fight the effects of earth's gravity makes out bones and muscle strong. Fluctuation of gravity in orbit or Outer Space contributes in the weakening of bones. Thus emphasis is made on calcium rich foods

[4] Mars, K., 2022. "*What Happens to the Human Body in Space?"*. [online] NASA. Available at: <https://www.nasa.gov/hrp/bodyinspace> [Accessed 15 October 2022].
[5] Id.
[6] Mars, K., 2022. "*What Happens to the Human Body in Space?"* [online] NASA. Available at: <https://www.nasa.gov/hrp/bodyinspace> [Accessed 15 October 2022].
[7] Id.

and vitamin D along with physical exercise. They are also given bisphosphates to increase bone mass and decrease the occurrence of bone fractures.

Astronauts also faces the problem of fluid shift. Our circulatory system is accustomed to work against the gravity but during space flight, circulatory system works differently. The heart does not work hard to maintain the fluid pressure, due to which blood started shifting towards upper body. This increase in volume of the blood shifting to upper body causes vision loss. Thus the astronauts have to wear compression cuffs on their thighs, which controls the fluid shift[8].

**Environment**

Space craft environment plays a major role in astronaut's life. There is a possibility of transfer of microorganisms from one body to another specially in a close place like International Space station. Thus astronauts are given flu shot before their flight to boost their immunity and quarantined before their flight to avoid any kind of illness. Even there are technology to monitor the air quality of space station like thermal control system maintains the temperature of the space station and provide comforting environment to astronauts. There is a regular analysis of blood and saliva samples of astronauts to keep check on their immune system. Space Station is regularly swabbed for the analysis of the microbial population in its environment. Crew also takes care to change the air filters, clean surfaces, and treat the water to prevent illnesses due to the accumulation of contaminants[9].

## Legal Regime to monitor the health of astronauts

Following articles VIII of the 1967 Outer Space Treaty and II of the 1975 Registration Convention, States Parties retain jurisdiction and control over any object launched that is carried on their registry and over any personnel thereof. That means the principle of nationality will apply on astronauts and personnel. Thus they are subjected to national Legislation on occupation health and labour.

"States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make

[8] Id
[9] Id

such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle".

In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties.

"States Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the moon and other celestial bodies, which could constitute a danger to the life or health of astronauts"[10].

"If, owing to accident, distress, emergency or unintended landing, the personnel of a spacecraft land in territory under the jurisdiction of a Contracting Party, it shall immediately take all possible steps to rescue them and render them all necessary assistance. It shall inform the launching authority and also the Secretary-General of the United Nations of the steps it is taking and of their progress. If assistance by the launching authority would help to effect a prompt rescue or would contribute substantially to the effectiveness of search and rescue operations, the launching authority shall cooperate with the Contracting Party with a view to the effective conduct of search and rescue operations. Such operations shall be subject to the direction and control of the Contracting Party, which shall act in close and continuing consultation with the launching authority"[11].2

"If information is received or it is discovered that the personnel of a spacecraft have alighted on the high seas or in any other place not under the jurisdiction of any State, those Contracting Parties which are in a position to do so shall, if necessary, extend assistance in search and rescue operations for such personnel to assure their speedy rescue. They shall inform the launching authority and the Secretary-General of the United Nations of the steps they are taking and of their progress"[12].3

"If, owing to accident, distress, emergency or unintended landing, the personnel of a spacecraft land in territory under the jurisdiction of a Contracting Party or have been found on the high seas or in any other place not under the jurisdiction of any State, they shall be safely and promptly returned to representatives of the launching authority"[13].4

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[10]Fabio Tronchetti, *Annex 2 - "Treaty On Principles Governing The Activities Of States In The Exploration And Use Of Outer Space, Including The Moon And Other Celestial Bodies"*, EXPLOIT. NAT. RESOUR. MOON OTHER CELEST. BODIES 311 (2010).

[11]Irmgard Marboe, "*Agreement on the Rescue and Return of Astronauts and Objects Launched into Outer Space"*, OXFORD RES. ENCYCL. PLANET. SCI. 2 (2019).

[12]*Id.*

[13]*Id.*

The word astronauts appear in Outer Space Treaty 1963 in Article V for six times but did not used the term 'personnel of space craft'[14].

In the rescue agreement the word 'astronauts' appears in the title of the agreement and in first paragraph of the preamble. Then instead of the word 'astronauts' the 'personnel of space craft' is used in Article 1, 2, 3, 4[15].

The word astronauts are not present in Liability Convention[16], but with reference to the Registration Convention it appears twice in the preamble in the form of '*Recalling* also that the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space'. The term 'personnel' is used under Article II.2 only for once[17].

With reference to the Moon Agreement, the same appears six times twice in preamble, twice in Article 10 and twice in Article 12. Whereas the 'personnel of spacecraft' is used once in the Moon Agreement. Thus it raises the question with respect to the meaning of 'astronauts' and 'personnel of Spacecraft' and the differentiation between two[18].

Article V of the Outer Space Treaty uses the term astronauts," which might be construed narrowly as applying only to those persons who pilot or operate a spacecraft. The term "personnel" may more clearly be regarded as encompassing the whole crew of a spacecraft, or even future passengers[19].

The word 'astronauts' is neither defined in the Outer Space treaty or the Rescue agreement. They are selected based upon training, altitude and selection. Astronauts cannot be equated with the personnel of Space craft, as he is the one on whom lies the entire responsibility of manoeuvre the vehicle. Astronauts is one of the personnel of Space craft but same cannot be considered vice versa.

That leads us to the question that Whether health measures can be incorporated with reference to the word 'accident' and 'distress'? Secondly, in which stage assistance is to be provided, on earth or at post landing?

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[14] "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies", 27 January 1967, 610 UNTS 205 (entered into force 10 October 1967) [The 1967 Outer Space Treaty]

[15] "Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched Into Outer Space", 22 April 1968, 672 UNTS 119, (entered into force 3 December 1968) [The 1968 Rescue and Return Agreement]

[16] "Convention on International Liability for Damage Caused by Space Objects", 29 March 1972, 961 UNTS 187 (entered into force 1 September 1972) [The 1972 Liability Convention]:

[17] "Convention on Registration of Objects Launched into Outer Space", 6 June 1975, 1023 UNTS 15 (entered into force 15 September 1976) [The 1975 Registration Convention]

[18] "Agreement governing the Activities of States on the Moon and Other Celestial Bodies", 5 December 1979, 1363 UNTS 3 (entered into force 11 July 1984) [The 1979 Moon Agreement]

[19]Dembling and Daniel M.Arons, *supra* note 1.

For this I have looked into definition of accident as provided in Cambridge dictionary, 'Something bad that happens this not expected or intended and that often damages something or injures someone'[20].

The word 'distress' means 'feeling of extreme worry sadness or pain'. It can be either due to physical or mental causes[21].

By plain reading of para 1 of Outer Space Treaty, the word 'accident', 'distress' is succeeded by the word or 'emergency landing' on high seas. Thus 'all possible assistance' includes accident or distress anywhere other than earth.

Assistance to each other in the event of carrying on the activities of the State Party regardless of nationality makes the working environment less stressful and friendly.

The word 'life or health' appears for the first time in Article V of Outer Space Treaty. The concern for 'health' appears for the first time. The term health includes the condition of the body or mind and the degree to which it is free from illness or the state of being well[22]. The word health includes both physical and mental health.

Further, the concept of health is also discussed on human rights Covenant.

"The States Parties to the present Covenant recognize the right of everyone to the enjoyment of the highest attainable standard of physical and mental health. 2. The steps to be taken by the States Parties to the present Covenant to achieve the full realization of this right shall include those necessary for: (a) The provision for the reduction of the stillbirth-rate and of infant mortality and for the healthy development of the child; (b) The improvement of all aspects of environmental and industrial hygiene; (c) The prevention, treatment and control of epidemic, endemic, occupational and other diseases; (d) The creation of conditions which would assure to all medical service and medical attention in the event of sickness".[23]

Thus with respect to health, the International Covenant on Economic and Social Rights, where State Party to the Covenant are under an obligation to provide facilities and services to the personnel of space craft. The same is extended under healthy working environment, preventing occupational accidents and diseases and also to reduce the harmful effect of radiation on human health. Health related issues are also discussed under ISS Project.

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[20] In: *Cambridge dictionary*. 2022. [online] United Kingdom. Available at: <https://dictionary.cambridge.org/> [Accessed 14 October 2022].
[21] In: *Cambridge dictionary*. 2022. [online] United Kingdom. Available at: <https://dictionary.cambridge.org/> [Accessed 14 October 2022].
[22] In: *Cambridge dictionary*. 2022. [online] United Kingdom. Available at: <https://dictionary.cambridge.org/> [Accessed 14 October 2022].
[23] Alston, *supra* note 3.

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The ISS project was started by the U.S. in the 1980's and evolved into a more international project which culminated in the 1998 "Agreement Among the Government of Canada, Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station". The 1998 Inter Governmental agreement (IGA) remains the heart of several bilateral agreements entered into following the creation of the IGA, including four Memoranda of Understanding (MoUs) between the involved space agencies and various implementing agreements[24].

The ISS framework consists of the 1998 IGA, the four MoUs between NASA and ESA[25], the Canadian Space Agency (CSA), the Russian Space Agency (RSA)[26], and the Government of Japan[27], respectively, implementing agreements of the MoUs, and the Code of Conduct. This is also the order of the hierarchy of the instruments that make up the framework.

Multilateral Medical Policy Board, is constituted which is supported by a Multilateral Space Medicine Board and a Multilateral Medical Operation Panel which functions on a principle of consensus and attends to matters including clinical care, medical standards, preventative medicine, and environmental monitoring, by creating medical standards, certification, care requirements covering pre-flight, in-flight and post-flight phases, as well as operational procedures and recommendations, to be presented to and finally approved by the crew operations panel and the medical policy board[28].

It is interesting to note that the MOU's entered between NASA and Canadian Space Agency, Russian Space Agency and Government of Japan covers creation of Health Policies during design and developmental activities and utilization and Operational activities, but for reasons unknown the same is not present in the MOU's between NASA and European Space Agency, only health policies during utilization and operational activities are covered.

Under the MOU's the responsibility of the partnering State is to continuously develop safe requirement to deal with the danger to radiation exposure. Each individual Space agencies are can develop its own safety requirement but at the same time they have to harmonize with the plans and safety requirement of partner Space agencies.

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[24]Holm, *supra* note 2.

[25]Memorandum O F Understanding & T H E National Aeronautics, *2012 – 0091* (2012).

[26]یمرهـــــاپـــل در یفنـــــاور کـــــــاربرد بـــر یـــیا مقدمـــــه *No Title*, اصـــل یخان یـــــمک----ر ی؛وحیـــــدحداد یـــــدوح (1386).

[27]NASA & CSA, "*Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Canadian Space Agency Concerning Cooperation on the Civil International Space Station* (1998)".

[28]6.Doc.001 Crime dans lespace_accord_intergouvernemental, 53 (1998).

Apart from this, there is a Code of Conduct for International Space Station crew. The crew is required to be abide by the standards and requirements given by crew operational panel, Space medicine board and medical operation panel throughout the stages of pre-flight and post flight conditions. This Code of Conduct board is more of an enforcement system of policies passed by Space Medicine Board[29].

Exclusively, In United states, federal employees are exempted from Occupational Safety and Health Act of 1970. The NASA employees are federal employees, thus they are exempted from Occupational Safety and Health Act of 1970[30]. Since the need of astronauts and personnel are different so NASA has special federal plans covered under NASA Space Flight Human-System Standard Volumes 1 and 2 for astronauts and personnel. The main objective of the same is as follows:

"Astronaut health care starts at selection, is implemented throughout training, space flight missions, and post-mission reconditioning, and continues past retirement from the astronaut corps via the TREAT (To Research, Evaluate, Assess, and Treat) Astronauts Act, which authorizes NASA to monitor, diagnose, and treat medical and psychological conditions associated with space flight for NASA (U.S. government) astronauts. Deeply rooted in preventive medicine, aerospace medicine puts an emphasis on preventive care, while being prepared to respond to the known physiological and psychosocial challenges of space flight, as well as unexpected illness and injury that could afflict crewmembers due to their active lifestyles, their training for flight, their missions in space, and their post-mission recovery. The following requirements reflect this comprehensive approach to astronaut health and wellbeing, addressing screening, preventive health strategies, medical care, contingencies during launch and landing, and post-mission Healthcare, reconditioning and long-term monitoring"[31].

The space activities in Russia is governed by, the Law of the Russian Federation on Space Activities which states that payment for cosmonauts' labour and other terms of their professional activity shall be determined by contracts in accordance with laws and other normative legal acts of the Russian Federation. Interestingly, there is a general application of Labour Code without any exception. Even Cosmonauts of Roscosmos are also governed by

[29]A. Farand, *The code of conduct for International Space Station crews.*, 105 ESA BULL. 64 (2001).
[30]G. A. Hellmuth, *Occupational Safety and Health Act of 1970.*, 71 WIS. MED. J. 14 (1972).
[31]NASA standards, *Crew Health - NASA-STD-3001*, 1 1 (2022), https://standards.nasa.gov.

it. The positive aspect of the Labour code is its emphasis on safety. Russia also has a mandatory general health insurance system.[32]

Labour Code of Russia applies to all except military personnel, employees under civil law contracts, board directors of organisations, and employees explicitly exempted by federal law. Space craft personnel are also covered under this.

Section X of Labour Code elaborates on safety principles prioritizing the preservation of employees' life and health, and propagating best practices of improving working conditions. Mandatory labour protection requirements and obligation on employers to provide safe working condition and environment. Special care and protection for those labourers working in radiation, vibration or noise.

Thirdly, the detailed procedure of investigation of workplace accidents to determine liability and compensation[33].

Cosmonauts can avail the fundamental rights as Russian citizen and personnel of space craft. Mandatory General insurance is there for all the citizens which includes Russian Space Craft personnel. As a citizen, all the possible help and treatment will be extended to Russian space craft personnel but what remains to see is, whether the same is extended beyond the earth. The answer to this is available in The GOSTR 50804-95. The protection policies for those workers who are exposed to radiation are mentioned in The GOSTR 50804-95. The prediction of radiation situations during in-flight phases and the planning of emergency measures in the event of return of crew to Earth, if the radiation poses dangerous to the life and health of the crew member. It also provides for preventive measures to the adverse effects of weightlessness.

Discussing about China, the same has identified 100 health requirements for the astronauts which includes, "No scars, no history of serious illness in the last three generations of their family, no tooth cavities, runny noses, ringworm, drug allergies or bad breath". Aside from the physical requirements of the job, the candidate must also possess a pleasant and adaptable disposition, the paper said.[34]

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[32] "LAW OF THE RUSSIAN FEDERATION NO. 5663-1 OF AUGUST 20, 1993 ON SPACE ACTIVITIES (with the Amendments and Addenda of November 29, 1996, January 10, 2003, March 5, August 22, 2004, February 2, December 18, 2006)"

[33] 1 & راهيم عامر ----------ديلجي إب----------قنـ----------دين عـلاء ، الـ------ادر عبـ----د القـ------ابي الجنـ----------, *No Title*ـم نظـــات المعلومـــــــــــة الإداريـــــــــــة, 2001 3 (2007).

[34] reuters.com. 2022. "*China doctor reveals 100 rules for would-be spacemen"*. [online] Available at: <https://www.reuters.com/article/us-astronaut-odd-idINTRE57247U20090803> [Accessed 17 October 2022].

Chinese Space Station which will be established in low earth orbit, incorporates within its agenda, to conduct study related to medical issues faced by astronauts and their long term solution for it.[35]

Their mission is also to establish an Astronaut system to ensure the long term health and efficiency of on board astronauts. Its main purpose is also to build up qualified astronaut team for Space Station operations, selecting flight crews, establishing living protocols on board the Space Station, establishing health protection systems to ensure safe and habitable conditions on the spacecraft, and studying and developing advanced medical and human support systems and technologies to ensure the efficient work of astronauts in space[36].

India presently is discussing more in the line of utilizing Space technology to enhance its public health care system, but very soon it also requires a comprehensive policy to address the issue of health and safety of its own astronauts in cases of manned mission.

Thus the discussion encompasses several health related issues of astronauts and effort to minimize it. Radiation risks can be minimizing by appropriate shielding of space vehicle and continuously monitoring the radiation level.

Exercise is the only protection against muscle loss, bone loss and cardiovascular diseases.

With respect to Psychological risk due to isolation, stressful environment, lack of privacy, continuous exposure to noise and vibration, lack of sleep, together creates a very negative environment. The same can be minimize by planning work schedule and communication with family members on regular basis, making environment lively by giving them leisure activities. Grooming of crew members on behavioural health aspect is necessary so that they are well prepared in advance with respect to the kind of environment, which can be expected from the mission and situation which they have to face.

The word ‘health’ and ‘distress’ indeed is present in Outer Space Treaty and Rescue Agreement but the same was left to be decided by nation accordingly. Thus it creates a disparity in terms of the issue of health and distress and the manner it is to be dealt with.

MOU’s are basically identical in nature. Although it provides for monitoring, researching, providing health care services, but yet the same cannot be considered as exclusive. Although the Code of Conduct is in place, which is legally binding on crew members, but it falls short

[35] UN Office for Outer Space Affairs & China Manned Space Agency, "*Handbook: China Space Station and its Resources for International Cooperation"* (2018), http://www.unoosa.org/documents/doc/psa/hsti/CSS_1stAO/CSS_1stAO_Handbook_2018.pdf.

[36] *Id.*

to monitor in the event of psychological outburst. Another major limitation is not every nation has ratified Economic and Social Rights Covenant, which further complicates the issue. For instance, Germany is a member of European Space Agency. When Germans are sending their Space Personnel, they come under European Space Agency and not under Germany. German health care system which applies on German Nationals will not apply to their own national working under European Space Agency. The same is an inter- governmental Organization having legal personality of its own.

Another issue is those space faring nations who have recently started their space faring activities requires a guideline to formulate their health policies concerning astronauts and personnel of space craft. With this respect India has to walk a long way to develop the policy on health care system pre-flight, in-flight and post flight system.

## Conclusion

This is the need of the hour to develop comprehensive guidelines with respect to health and safety of astronauts. We have to remember that we cannot go on implementing the domestic legislation on Outer Space. Very soon we have to transgress the limit of national legislation and start working towards Convention exclusively addressing the issue of health and concern of astronauts and personnel of space craft. Temporarily NASA Space Flight Human-System Standard Volumes 1 and 2 for astronauts and personnel can be adopted until the new Convention comes into force.