Do Space Programmes Benefit the Health Sector

India has successfully launched Chandrayan 3 to the southern pole of the moon, a feat yet to be achieved by developed countries like the USA, Russia or China. In addition to the obvious expansion in our understanding of the moon and other planetary systems, it is a gigantic step forward in the technological advancement of the country. It also opensup huge opportunities of earning revenue through launch of satellite from other countries and private organisations. However, despite agreeing to these obvious successes, it is not surprising to see people criticise the utility of space programmes, and argue that the funds could have been better utilised in the health sector.

The NASA program and advances initiated by other space research organisations of the world have resulted in the development of novel technologies that have been adapted in fields other than space research. The use of satellite imagery to plot disease transmission and the prediction of pandemics, that areextensively uses by epidemiologists and public health specialists nowadays, are a direct by-product of space exploration. The NASA project Spinoff (https://spinoff.nasa.gov/) lists more than 2000 such applications that have been developed based on NASA's space projects. Of them 28 are listed in the health and medicine category.

Let us look at some of the technologies that were originally derived for the space programs that are now being used in healthcare and medicine.

Robotic surgery

Canadian technology on the International Space Station (ISS) has allowed for innovations in the operating rooms. The Canadian robotic arm was used to perform station maintenance jobs, movement of supplies, equipment and astronauts and docking vehicles to the International Space Station. This technology that powered Canada's space robots, Canadarm, Canadarm 2 and Dextre, were subsequently used for the development of NeuroArm, a surgical robot specificallydesigned for neurosurgery. It is the first image-guided, MR-compatible surgical robot that has the capability to perform both microsurgery and stereotaxy.

Ventricular assist device

A ventricular assist device (VAD) is a device **t**hat helps pump blood from the lower chambers of the heart to the rest of the body, usedin people with low ejection fractions or heart failure.It is used during or after the heart surgery (when patients wait for the heart transplant surgery or when one not eligible for the surgery). David Saucier and other engineers from the Johnson Space Centre under NASA, developed this implantable heart pump, based on the computational fluid dynamics modelling employed when designing rocket engines.

ArterioVision

Advanced video imaging software developed at NASA's Jet Propulsion Laboratory, used for accurate and reliable imagery of our solar system, led to the development of the ArterioVision software. This advanced image analysis software, used with ultrasound, noninvasively measures the carotid intima-media thickness (CIMT) that provides the earliest evidence of atherosclerosis and thus a person's risk for heart attack and stroke.

ResQCD

A new medical device developed as a result of collaboration between NASA and other partners, called ResQCD, which was originally used to treat orthostatic intolerance in astronauts upon re-entry into Earth's atmosphere, has found use in patients with experience sudden cardiac arrest. ResQPOD improves circulation in patients suffering cardiac arrest and other high-risk conditions attributed to low blood pressure, and has been significant improvement in cardiac output and blood flow compared to conventional resuscitation techniques.

Bio-monitor

Developed by the Canadian Space Agency (CSA) in 2019, The BIOMONITOR is wearable smart shirt, that was originally used tostore and forward physiologic data through body worn sensors in astronauts on space missions. The sensors monitor heart rate, breathing, blood pressure, temperature, electrocardiogram, physical activity and blood oxygen levels, round the clock, and are now being used in patients that need continued monitoring, like in Covid-19. Such devices could also be used to monitor the health of healthcare personnel, for monitoring during such times like the pandemic.

Closer home, ISRO's technology spinoff, with inputs from ISRO, has already helped in developing cheaper artificial limbs, left ventricular assist, artificial jaw and ventilators, among other things. In the area of safety, spinoffs include flame-proof coatings (fire safety), Aerogel - Thermal wear for soldiers (for protection from extreme cold weather), distress alert systems and search & rescue beacons have come in handy in the area of disaster management. In addition, ISRO has conducted a pilot

study, Health-Quest (Quality Upgradation Enabled through Space Technology), in select hospitals across Chennai and Bengaluru, leveraging space technology in emergency care and critical care departments that have yielded positive results.

With subsequent space explorations, newer space technologies will be developed to overcome technologies issues faced in previous explorations. Some of them will translate to the development of by-products in other fields, including healthcare. We await such bold strides made by space organisations over the world, and look forward to the exciting new spinoffs in the field of healthcare and medicine.

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Bibliography

- The Economic Times. Healthworld.com. Available at https://health.economictimes.indiatimes.com/news/hospitals-/indian-hospitals-set-for-quality-upgradation-thanksto-isro/91800400. Last accessed August 2023.
- Times Now. Mirror Now Digital. How ISRO intends to revolutionise India's healthcare. Webpage (updated May 26, 2022). Last accessed August 2023.
- Government of Canada. Broadening our understanding of the human body. Available at https://www.asc-csa.gc.ca/eng/about/everyday-benefits-of-space-exploration/imp-roving- health-care.asp. Last accessed August 2023.
- National Aeronautics and Space Administration. NASA technologies enhance our lives. Health and Medicine. Available at https://spinoff.nasa.gov/category/Health%20- and%20Medicine. Last accessed August 2023.
- Brian. Arteriovision [Webpage]. Available at https://www.spacefoundation.org/space_ technology_hal/arteriovision/. Last accessed August 2023.
- Brian. RESQCD [Webpage]. Available at https://www.spacefoundation.org/space_ technology_hal/resqpod/. Last accessed August 2023.
- Asrar FM, Saint-Jacques D, Chapman HJ, Williams D, Ravan S, Upshur R, Clark JB. Can space-based technologies help manage and prevent pandemics?. Nature Medicine. 2021 Sep;27(9):1489-90.
- Brian. RESQCD [Webpage]. Available at https://www.spacefoundation.org/space_ technology_hal/resqpod/. Last accessed August 2023.
- Asrar FM, Saint-Jacques D, Chapman HJ, Williams D, Ravan S, Upshur R, Clark JB. Can space-based technologies help manage and prevent pandemics? Nature Medicine. 2021 Sep;27(9):1489-90.