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Case Review

Packaging Solutions in Microgravity (For Pharmaceutical Products)

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Introduction

Packaging plays a significant role in Microgravity environment since microgravity is having extreme heat, radiation and relative humidity. Most of the cases these have been observed and experimentally prove that comparatively solid doses are more stable compare to injectable and ophthalmic dosage form. While travelling in the speed of 12800 km/h Astronauts are facing sever weightlessness and extreme radiation which leads to degradation of bones, rapid drying of eye fluid and cancer. So as a packaging technologist we prefer to design innovative packaging for ophthalmic, injectable and orthopedic products and those are having high demand. Microgravity medicine advanced borrowing lessons learned not only from space missions, but also from similar environments. The most direct results of this progress are the medical kits that have flown through the years on every manned mission. Approved medicine, lessons from research and clinical experience are the principal drivers that led each program or mission to the development of improved kits in a never-ending effort to secure astronauts' lives while in orbit. The design and content of any medical suite is always an unfinished work in progress, with continuous updating based on science, research, mission objectives, vehicle constraints, training of the caregivers and levels of desired care. By late 70's Packaging plays an important role to protect pharmaceutical products from extreme climate of microgravity [1-4].

Purpose and special role

- To provide most suitable packaging solutions in order to protect wide range of formulation dosage form.
- To save life of Astronauts and visitors in space (micrograv ity environment).
- Selection of primary packaging material is most important to avoid product stability loss before shelf life.
- Packaging design shall be best suited as per dose instruct ed by physician.
- User friendly Packaging also guarantees the good use of medicine products and promotes Patient Compliance.
- The purpose is to advance the field, study and innovate special kind of packaging material and design to keep the Medicine safe from microgravity environment. On Earth through research investigations conducted in the microgravity conditions of space which may provide advances in understanding that cannot be achieved on Earth.
- Excellent packaging design helps to maintain the quality of the product and reachability of the product in the As tronauts hand without any defects.
- Protect against all adverse external influences that can alter the properties of the product, like moisture, heavy radiation light, oxygen and temperature variations, pro tect against biological contamination, protect against physical damage, carry the correct information and identification of the product

Effect of high radiation on human body

Figure 1

Packaging materials and medical device suitable for microgravity

Type of pack	Solid Dose	Injectable	Ophthalmic product
Blister pack	OPA/Aluminium/ PVC		
Bottle pack		Glass. COC, COP , PP	LDPE ,PP and glass bottle.

Table 1

Injectable device in Earth VS Microgravity

Figure 2: Earth Microgravity.

Figure 3

Figure 4

Figure 5: The gas bubbles group 0.7 cubic cm. is falling under n decrease from 1 to 0.03.

Range of Packaging design using in Microgravity

Figure 6

Alternate Copolymer for MOON

Figure 7

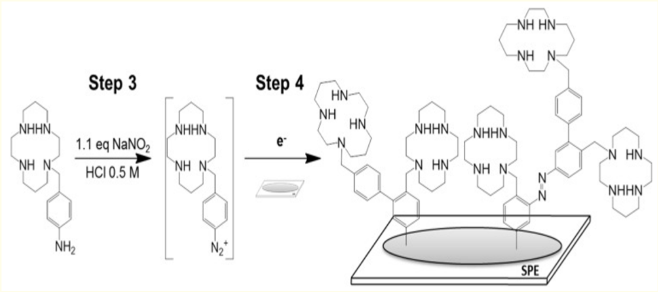

Figure 8

Oxygen barrier layer of COP vial

Figure 9

High quality COP syringe

Figure 10

Multilayer COP vial oxygen Transmission

Packaging challenges in microgravity

- Ophthalmic, Bone lose, Gastroentrocology Cardiovascular, oncology(cancer)and non oncology drug delivery system.
- Bubble formation inside the prefilled syringe
- Reduce Protein adsorption to the glass/polymeric surface
- Sticking of tablet/capsule with container and blister

This application is not possible in microgravity

Figure 11

Single bubble in the syringe can spoil the Eye

Figure 12

Bone lose in space (Due to long time no muscle tress)

Figure 13

Cardiac problem in space station

Figure 14

Figure 15

Figure 16

Few medical packaging device (New concept)

Figure 17

Temperature, Pressure, Rh and Gravity adjustable Device Remark

This is a new concept of injectable device which can be used in Earth, moon and Mars. Possible to adjust temperature, relative humidity and pressure. Especially for Biologics and Biosimilar products.

Below two Designs concept are like

- **1st one:** ophthalmic product (semi solid/suspension) de vice possible to use since liquid based ophthalmic product is not possible to use in Microgravity.
- **2nd one:** Easy to use for solid dose product. Manual inside spring based press type.in every press only one tablet/cap sule is come out and user can directly take inside the mouth.

Risk assessment in microgravity (case study)

DRM Categories	Mission Duration	Operations		Long-Term Health	
		LxC	Risk Disposition *	LxC	Risk Disposition *
Low Earth Orbit	6 months	3x2	Accepted	3x2	Accepted
	1 year	3x3	Accepted	3x2	Accepted
Deep Space Sortie	1 month	3x2	Accepted	3x1	Accepted
Lunar Visit/Habitation	1 year	3x3	Requires Mitigation	3x2	Requires Mitigation
Deep Space Journey/Habitation	1 year	3x4	Requires Mitigation	3x4	Requires Mitigation
Planetary	3 years	3x4	Requires Mitigation	3x4	Requires Mitigation
Note: LxC is the likelihood and consequence rating.					

Table 2

Eye Ointment (Biosimilar product) packaging design for microgravity

Figure 18

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