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Departments Visited	**Date**
Nuclear Medicine	29/01/2025
Developmental Pediatrics	31/01/2025

I have attached photos of our visit, which were clicked after permission from the guiding doctor, assistant & patient. The images will only be used for educational Purposes.

Nuclear Medicine Department

Nuclear Medicine Concept and Preparation room.

During our visit, we were first taken to the area where thyroid health was checked. There the guide explained about the principle behind the nuclear medicine. Whenever higher atomic number elements are unstable, they degrade into daughter elements and some extra energies are released as radiations. These radiations can be alpha, beta, gamma, positron, neutron rays. Out of all the medical grade radiation only 20% are used in treatment and other 80% is used in Diagnostic. These are artificially manufactured using cyclotron, generator, and reactor. There are only a few elements which are used for the medical purpose depending upon the price, availability, radiation, half-life, and energy. Some of the radio isotopes are mentioned in the table.

Radio Isotope	**$T_{1/2}$**	**Energy**	**Radiation Type**	**Purpose**	
Technetium-99m	6.0 Hrs.	140 keV	Gamma	D	D-Diagnostic Imaging T-Treatment
Iodine-131	8 Days	606 keV	Beta, Gamma	T, D	
Fluorine-18	110 Min	635 keV	Positron	D	
Galium-68	68 Min	1920 keV	Positron	D	
Lutetium-177	6.7 Days	208 keV	Beta, gamma	T	
Yttrium-90	2.67 Days	936.7 keV	Beta	T	

Every company producing and medical institutes using it should be certified by AERB (Atomic Energy Regulatory Board). These isotopes can either be consumed directly or consumed in the form of organ specific radiopharmaceutical tagged with radio isotopes. The purpose of isotope depends on the radiation type. As alpha rays get absorbed by thin paper whereas gamma rays can be stopped by thick lead sheet. For imaging the radiation must come out so we use gamma source, and for treatment the radiation must stay inside the body, so we use beta or alpha source. If done opposite, then image won't be of good, and the patient would be exposed to radiation.

Figure 1 For binding the isotopes radiopharmaceuticals are used such as EC (ethylene Di cysteine), DMSA (di-mercapto-succinic acid), DTPA (diethylenetriamine pentaacetate). They are mixed with radio isotopes and incubated before injecting into patients. This mixing and incubation are done in a separate closed room with radiation protections. But the protection was not full which can be remodeled from an engineer's perspective.

After the preparation it was measured for the dose of radiation in a cylindrical equipment which works on the principle of ion chamber. Basically, the photon from radiation causes ionization and then due to electric field they produce current, and the amount of current depends upon the amount of radiation. All the equipment were placed in lead shielding, but it partially covered them which had design improvements. After the drug was prepared it was stored in a led cylinder which also had leaking of radiation.

If incase of any spill there were absorbent paper to clean the working space and there was a closed chamber to dispose the used generator, storage container and other outdated radioactive materials. There were Lead cylinders of storage container which were kept unused. ***Figure 2***

The person working there were using TLD badges which records the radiation exposure. There was Giger counter to record radiations. This was used to monitor the environment regularly.

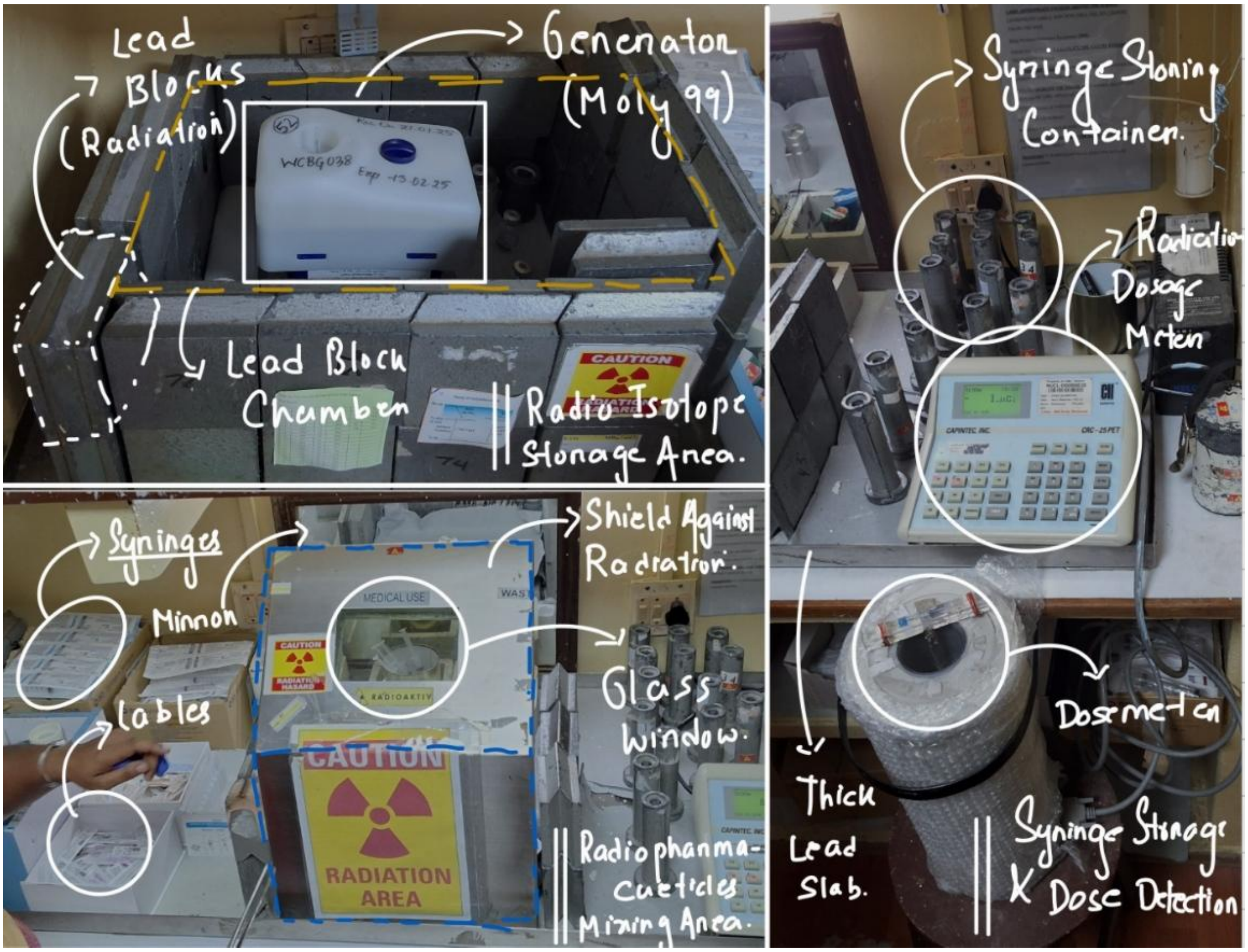

Figure 1 Radiopharmaceuticals preparation area.

To extract the radioisotopes from the generator vaccume containers are used. Each and every stock is maintained and documented properly to keep it in order.

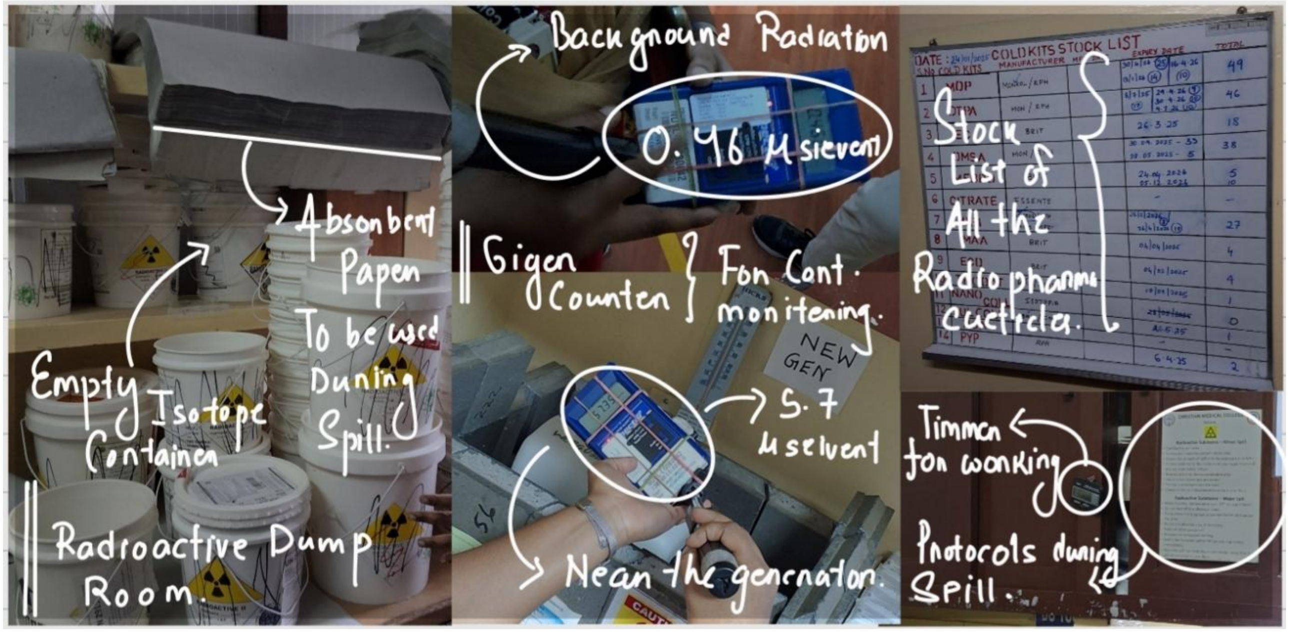

Figure 2 Spill management and waste management

Scanning Room (Gamma Camera).

After the radiopharmaceuticals are prepared either they need to be injected and monitored quickly for easy access organs like kidney, stomach, liver or else they need to inject and wait for perfusion for parts like bones and then scanned. This process of observing the patient is done in the Gamma Camera room ***Figure 3.***

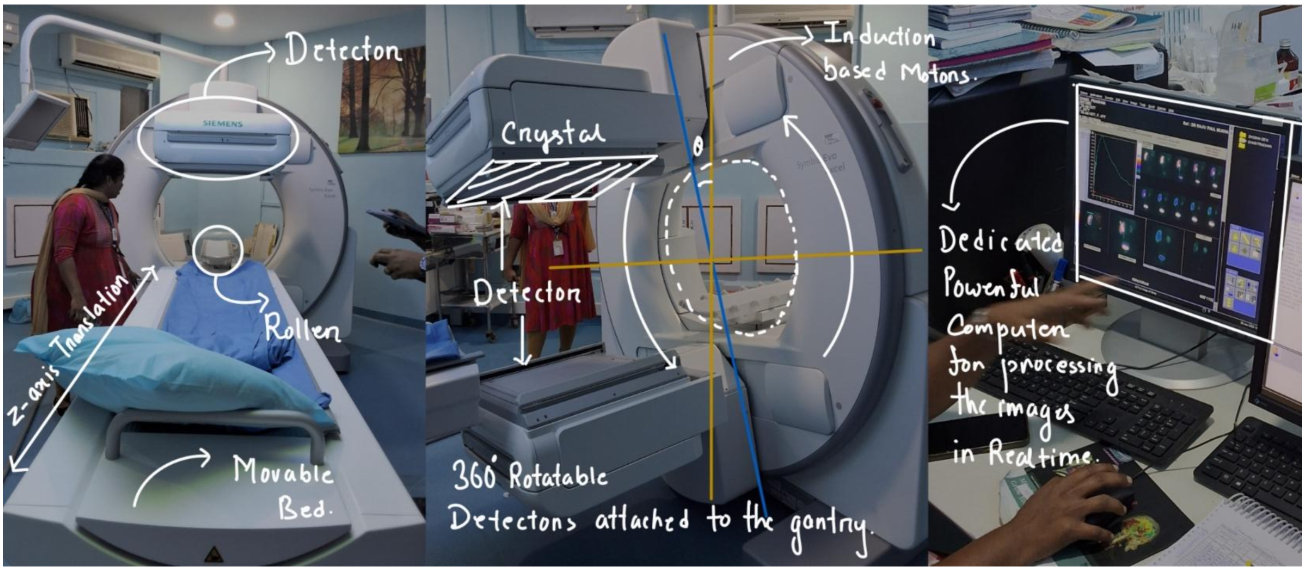

Figure 3 Gamma Camera Room and it's parts.

The gamma camera room has a big bulky machine by Siemens. It has various part as labeled in the figure. It has a movable bed which is adjusted according to the part being imaged. When the radiopharmaceuticals were injected into the body, they radiate gamma rays which passed through the body comes out and gets to the detector. Then the part is imaged. The machine is capable of scanning in 3D by the rotation of the detector. The images are computed in Realtime and processed using high efficiency. The radiopharmaceuticals will get into the body and only attach to the desired organ.

Being attached with the organ then compounds will radiate gamma radiation which will be captured by the crystals then it goes to the collimator then to photon multiplier tube and then goes to amplifier and then image is formed.

Pathophysiology of Arrythmia

Nuclear medicine detects functional and molecular changes in diseases using radiopharmaceuticals. It helps visualize pathophysiological alterations in various conditions:

- Cardiovascular – Myocardial Perfusion Imaging (MPI) detects ischemia, and MUGA scans assess heart function.
- Neurology – PET/SPECT identify Alzheimer’s, Parkinson’s, and epilepsy by detecting abnormal metabolism.
- Oncology – FDG-PET scans detect cancerous tissues, while I-131 therapy treats thyroid cancer.
- Endocrine – Thyroid scans (I-131, Tc-99m) diagnose hyperthyroidism and thyroid nodules.
- Renal & Bone – Renal scintigraphy evaluates kidney function; bone scans detect metastases and fractures.

Therapeutic Applications include radionuclide therapy (I-131, Lutetium-177) and SIRT for liver cancer. Nuclear medicine enables early detection, precise diagnosis, and targeted treatment of diseases.

Technology Used

Here the listed technologies were used for diagnostic and treatment purpose in the clinics.

1. ***Nuclear Radiation***
    a. ***Alpha Rays***
    b. ***Beta Rays***
    c. ***Gamma Rays***
2. ***Ion Chamber (Giger Counter)***
3. ***PET Scanner (Gamma Camera)***
4. ***Radio Pharmaceuticals***
5. ***Radioactive shielding***
6. ***Photo path Guider***
    a. ***Collimator***
    b. ***PMT (photo multiplier tube)***
    c. ***Scintillator***
7. ***Photo amplifier***
8. ***Nuclear Imaging***

These were the main technologies used in the Nuclear Medicine department.

Limitations/Problems and their Solution.

Problem: After the Radiopharmaceuticals were prepared, they were stored and transferred in a lead cylinder which was prone to spill, leakage and radiation spread. This must be redesigned to keep the syringe in proper position without spilling or disturbing the syringe.

Solution: To solve this problem we have modelled a simple container and make it cuboidal to make it steadier. If in case, it falls it won't roll due to edges. We can add heavy base to prevent it from toppling. We can add notch to get hold of the syringe barrel flange. We can add an extra top layer to prevent the syringe from getting pressed. And to prevent this system from accidental opening we can add push lock which uses springs to keep the device locked. Once push lock is released the top part can be removed and the syringe can be used. The detailed structure and part are designed below ***Figure 4***. This is an entirely mechanical system so the price of making it won't be very high.

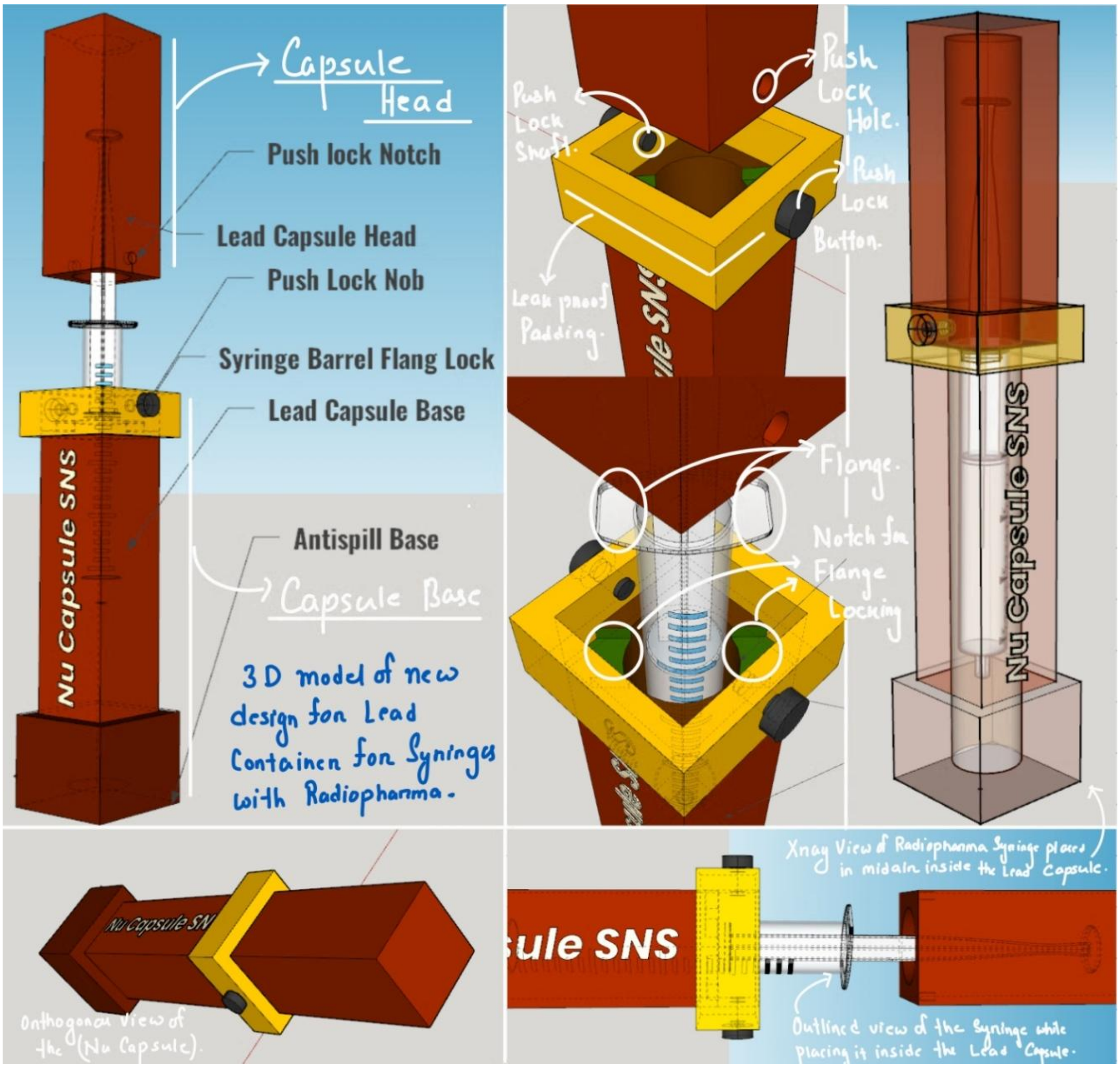

Figure 4 New Design of the Syringe carrier with push lock

Problem: The generator and the radiopharmaceuticals preparation area not covered properly with lead blocks which causes radiation to escape to free space which might cause the high dosage to the doctors. The main reason was the weight of the lead block which must be moved every time. If covered then it won’t be easy to operate. Task is to design an easy and safe working bench for the.

Solution: Whenever new generator or isotopes comes; they are packed in lead cylindrical container. Once the content is used, they are never recycled and dumped and pile up for long time. We can use those cylindrical containers and break them into half and arrange it to make a shield and we can redesign a mechanical hood to cover the generator area. The design of the entire workspace is given below ***Figure 5***.

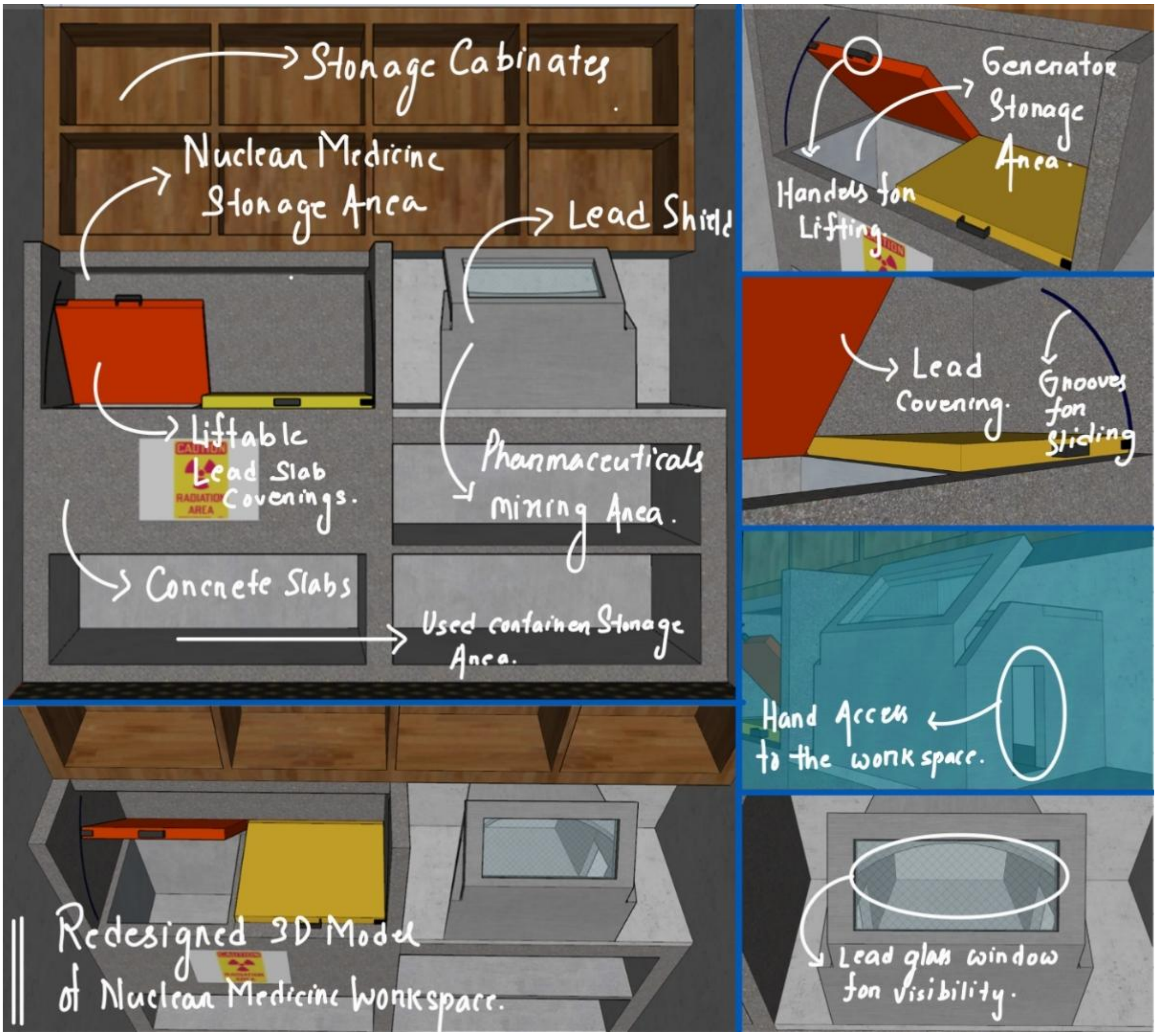

Figure 5 3D Design of the workspace with proper management for the nuclear medicine

Developmental Pediatrics Department

Doctor's room.

During our visit to the Developmental Pediatrics Department, we explored the process of diagnosing and managing children with special needs, particularly those with motor disabilities. A key challenge identified was the lack of standardized assessment tools, with many diagnoses relying on history-taking and subjective questionnaires. There was a discussion on asphyxia, the importance of a newborn's cry for proper brain oxygenation, and the potential genetic and prenatal factors influencing developmental delays.

We also examined the role of therapists in rehabilitation, focusing on speech, occupational, and psychological therapy. Therapists work closely with children, setting specific developmental goals. The visit highlighted the need for better communication channels between therapists and parents, which could be enhanced through an app- or web-based platform. An automated questionnaire system was proposed to help detect symptoms early.

The discussion emphasized the importance of a private discussion portal for parents and therapists to share concerns and progress updates. Regular patient follow-ups, typically every two weeks, help monitor improvements. Additionally, brief but structured reporting is crucial for tracking developmental milestones. The visit underscored the collaborative role of doctors and therapists in forming effective intervention plans based on assessments and goal setting for children with developmental challenges.

Pathophysiology of developmental disorder

Neurological Causes

- **Cerebral Palsy (CP)**: Brain injury or abnormal development affects motor control, often due to hypoxia, infections, or genetic mutations.
- **Asphyxia at Birth**: Lack of oxygen (hypoxia) can damage brain areas responsible for motor function, causing long-term impairments.
- **Neurotransmitter Imbalances**: Issues with dopamine, serotonin, or acetylcholine can affect motor planning and execution.

Musculoskeletal Abnormalities

- Muscle tone disorders (spasticity, hypotonia) alter movement and posture.
- Joint contractures and skeletal deformities may develop due to prolonged abnormal movement patterns.

Metabolic and Genetic Factors

- Disorders like mitochondrial dysfunction or metabolic syndromes can impair energy supply to muscles and neurons, leading to fatigue and poor motor control.
- Genetic mutations affecting neural or muscular development can contribute to conditions like **Duchenne Muscular Dystrophy** or **Spinal Muscular Atrophy**.

Technology Used

There is no specific technology used in the department.

Problem: There is no standard way of accessing the history from the parents and it takes time to ask questions and record them and it takes a lot of time for the doctors to analyze the data and then send it for treatment.

Solution: This issue can be resolved by automating data recording and communication. A web and mobile application can be developed with multilingual support and text-to-speech features. This platform will allow patients to input relevant data, which will be automatically summarized and made available to doctors. A standardized protocol for patient assessment will ensure consistency and efficiency. By centralizing patient data, the system will enhance collaboration among medical professionals, reduce delays, and improve patient outcomes.

Plan for Implementation

Requirement Analysis

- Identify key data points doctors and therapists need.
- Define a standardized protocol for patient assessment.
- Gather accessibility requirements (multilingual, text-to-speech, etc.).

Design & Development

- Database: Secure patient record storage.
- Web & Mobile App: User-friendly interface for patients and doctors.
- Automation: AI-driven summarization of patient data.

Testing & Deployment

- Conduct trials with doctors and therapists.
- Improve based on feedback.
- Deploy and provide training for users.

Maintenance & Updates

- Regular updates for improvements.
- Implement new features based on feedback.
- This system will streamline medical communication, ensuring better and faster patient care.

Problem: Communication between doctors and therapists is slow due to manual record-keeping and face-to-face discussions. Tracking patient progress across multiple cycles is inefficient, leading to delays and miscommunication. Coordinating inputs from different specialists is challenging, making it difficult to ensure timely and consistent treatment decisions.

Solution: In hospitals and therapy centres, doctors and therapists need to continuously communicate about a patient's condition, progress, and treatment plans. Currently, this process relies on physical records and manual data collection, which is time-consuming, prone to miscommunication, and makes tracking patient progress difficult over multiple treatment cycles. To address this, a digital platform can be developed to streamline communication and record-keeping among healthcare professionals. This platform would store patient details, including hospital numbers, assigned doctors, and therapy plans, allowing multiple therapists—such as psychology, occupational, and speech therapists—to log assessments, goals, and comments in a structured format with timestamps. A dedicated doctor's dashboard would summarize patient conditions based on therapist inputs, enabling real-time updates and informed decision-making. The system would also facilitate multi-cycle communication, ensuring a continuous feedback loop for treatment modifications. By implementing this solution, hospitals can achieve faster decision-making, improved communication, better patient tracking, and reduced paperwork, ultimately enhancing the overall quality of patient care.