

Review Article

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Historical Evolution of Anesthesia for Radiotherapy in Children with Cancer in National Institute of Cancer (INCA)

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ABSTRACT

This article aims to describe the historical evolution of anesthesia applied to RT at INCA, highlighting changes in protocols and the various drugs used for RT procedures in children with cancer that have contributed to safety and comfort over the years. The article examines several types of procedures that necessitate sedation, pre-sedation assessment protocols, and pharmacological considerations. At INCA, the emphasis of the story was placed on the qualifications required for anesthesiologists and anesthesia residents involved in the administration of anesthesia or sedation, along with essential equipment and safety protocols.

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Introduction

In 2000, the history of Radiotherapy (RT) at the National Cancer Institute (INCA) was comprehensively described [1]. However, until that date, there were no systematized records on the development and consolidation of anesthetic practices used in this context. Considering the importance of anesthesia for the safe feasibility of RT procedures, especially in pediatric and oncology patients, it is relevant to document this trajectory. This article aims to describe the historical evolution of anesthesia applied to RT at INCA, highlighting milestones, protocol changes, and technological advances that have contributed to improving patient safety and comfort over the years.

The estimated number of new cases of childhood cancer in Brazil for each year of the three-year period 2023 to 2025 is 7,930 cases, which corresponds to an estimated risk of 134.81 per million children and adolescents [2]. There are an estimated 4,230 new cases in males and 3,700 in females [2]. Radiotherapy is a fundamental part of cancer treatment in pediatric patients and provides an effective and often rapid means to alleviate

symptomatic progression in pediatric patients with advanced or metastatic cancer. Sedation and/or general anesthesia are commonly utilized to facilitate RT treatment in children.

At the beginning of RT at the INCA, halothane was used, and metabolism in children is explained [3]. Universal bubble vaporizer, vaporization of the liquid through the base by micro-bubbles in the bubble chamber, usable with any volatile agent, through oxygen in torpedo and monitoring through stethoscope in the precordium of children and in the ear of the anesthetist (Figure 1). Although the anesthesiology department did not publish its technique, it consisted of inhalation anesthesia, with monitoring using a stethoscope on the precordium and monitoring outside the RT room, on the precordium and a sponge on the children's abdomen for the observation of ventilatory thoracic movements from outside the room. Halothane has largely been removed from the market because of the increased associated cardiovascular risks as well as the introduction of sevoflurane and desflurane [4]. Sevoflurane is a safe and versatile inhalational anesthetic compared with currently available agents and is useful in adults and children for both induction and maintenance of anesthesia in inpatient and outpatient surgery [5].



Figure 1: Stethoscope Placed on the Chest in Children During RT Until the Monitoring Room

Years after implementing RT at INCA, a dedicated department was created. Thus, the department is entirely dedicated to performing RT on children. The department consists of a reception room with toys and a space for conversation (Figure 2). After admission, the child is placed in a preparation room with a chair for the mother or any family member (Figure 3). After examination and pre-anesthetic medication, the child is sent to the RT machine, which contains the anesthesia device for monitoring, anesthesia and a certificate of courage to perform the procedure (Figure 4, Figure 5). After RT, the child returns to the PACU where they will be monitored until fully awakened, there is a chair for the companion, humanizing the procedure (Figure 6). After the child is fed and without PONV or any other complications, the child will be released to his or her home.



Figure 2: Reception of the INCA Radiotherapy Sector



Figure 3: Reception room to prepare the child with armchair for mother or father

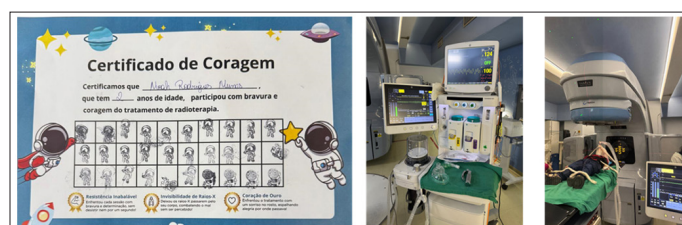


Figure 4: Certificate of Courage for RT, Anesthesia Machine and Radiotherapy Machine



Figure 5: Monitoring Room During RT used Today



Figure 6: PACU for the Child with Armchair for Mother or Father

RT is used in approximately one-third of children with cancer and is active during the week and lasts 3 to 6 weeks [6]. RT is painless but requires calm and cooperative patients, exhibit heterogeneity in terms of duration, level of immobility, discomfort, and potential for patient distress. In some services, sedation no longer limited to the scope of the anesthesiologist; dedicated non-anesthesiology sedation services have been shown to be capable of administering sedation safely and successfully [7,8]. However, in the INCA anesthesia department, all radiotherapy procedures are performed by anesthesiologists, with extensive experience in sedation and general anesthesia.

There is a need for a systematic and multidisciplinary approach that includes pre-sedation evaluation, physiological monitoring, and post-procedure recovery strategies to mitigate associated risks [9]. RT at INCA consists of a procedure room with anesthesia equipment, monitoring when possible, and a pre-anesthesia administration room that also functions for post-anesthesia

recovery. All RT procedures are performed on an outpatient basis.

In a retrospective observational study in a tertiary hospital, between January 2006 and December 2017, 434 pediatric patients underwent RT, with a total of 10,357 sessions, showed that in 1,276 RT sessions (11.8%) either general anesthesia or sedation was required, and requirement for anesthesia decreases in an age-dependent fashion. Regardless of the type of anesthesia, the complication rate was low [10].

The benefits and risks of anesthesiologist presence during sedation and/or anesthesia in pediatric patients undergoing RT represent a crucial dimension of the medical discourse. One of the main benefits is the reduction of patient and family anxiety. Anxiety can be a significant impediment to the successful completion of RT procedures in pediatric cancer patients, where cooperation can be challenging. The use of sedatives and anesthetics is not without risks, the most significant of which is respiratory depression. Central nervous system depressants have the potential to depress respiratory drive, which can lead to hypoxia and, in extreme cases, respiratory arrest. No respiratory depression has been observed over the years in children with cancer using the inhalation technique, intravenously or intranasally.

The administration of anesthesia or sedation by non-anesthesiologists in pediatric radiology and radiotherapy has become a subject of important debate and active research, with several articles on the subject. The feasibility and safety of this practice depend on multiple variables, including the specific procedure in question, the sedative or anesthetic agents selected, and the competence and experience of the non-anesthesiologist. However, since INCA trains anesthesiologists through residency, radiotherapy is always performed by an anesthesiologist and accompanied by a resident to learn the sedation or inhalation anesthesia technique.

RT provides an effective and often rapid means to alleviate symptomatic progression in pediatric patients with advanced or metastatic cancer. Rapid technological advances have dramatically changed radiation delivery to children with cancer, enabling improved normal-tissue sparing. Immobilization in RT is of paramount importance, since many pediatric tumors are located close to critical organs. Although the application of external beam RT itself is painless, the immobilization devices used can cause anxiety and discomfort in children too young to understand and cooperate. Therefore, anesthesia or sedation are unavoidable in these cases.

Standardized anesthetic protocol using laryngeal mask airway, propofol, and sevoflurane for pediatric radiotherapy has been successfully indicated [10]. During RT there is a need for immobilization, and the treatment environment is always unfamiliar with potential for discomfort or pain during the procedure contributing to significant anxiety and distress, especially in children under 3 years of age. Therefore, the main objective during RT is to ensure a more relaxed treatment experience, minimize anxiety and increase patient cooperation, thus improving the effectiveness of the treatment, especially in school-aged children.

Pharmacology and drug administration are critical aspects of pediatric sedation, determining the safety, efficacy, and predictability of sedative outcomes. Intravenous agents are used for pediatric sedation and are tailored for rapid onset and specific effects, ensuring that complications during RT are avoided. In children in whom intravenous access is not feasible, alternative agents are administered by other routes such as intramuscular

and intranasal, which have unique pharmacokinetic and pharmacodynamic profiles suitable for pediatric patients. Several drugs can be used through the following routes: oral, intranasal, intramuscular, subcutaneous and rectal, facilitating use as a pre-anesthetic or even for sedation.

Several Drugs have been used for Sedation or General Anesthesia during RT Sessions

Ketamine is renowned for offering both sedation and analgesia, especially for painful procedures without causing significant respiratory depression, but sialorrhea is an issue; propofol provides deep sedation but lacks analgesic properties; dexmedetomidine offers sedation and modest analgesia without respiratory depression, midazolam, despite its poor oral bioavailability and ventilatory impairment, provides amnesia, anxiolysis, and sedation; hydroxyzine, an antihistamine, is occasionally employed for its anxiolytic properties; clonidine is a centrally acting α_2 agonist that reduces blood pressure and slows heart rate by reducing sympathetic stimulation and is used for sedation [11].

Sedation and anesthesia play a crucial role in pediatric radiology by reducing anxiety, managing pain, and minimizing motion artifacts. The necessity for sedation or anesthesia is often multifactorial and must be assessed individually. In aggressive children who do not allow venipuncture, the use of clonidine as a pre-anesthetic in a specific room and after the intranasal use of ketamine and dexmedetomidine has been a new application modality during radiotherapy sessions [12]. In children with cancer and aggressive behavior, the anesthesia department prefers to use oral clonidine as premedication and, after reducing aggressiveness, the use of ketamine and dexmedetomidine intranasally, without the need for oxygen and repeating the drugs [12].

The frequency of procedural sedation for children outside the operating room has dramatically increased. In the reports from the pediatric sedation research consortium as early as 2009, there were 49,805 sedations reported of which only 5,117 (10.3%) were performed by anesthesiologists [13]. The latest report from 2017 shows an even lower percentage of anesthesia-provided sedation (2.2%) outside the operation room [14]. Data available in various reports and databases, such as the pediatric sedation research consortium, demonstrate that sedation by properly trained non-anesthesiologists can be performed safely and successfully.

Unlike most of these cited studies on sedation in pediatrics, in pediatric cancer patients, treatment for childhood cancer is determined based on the type and stage of the disease, and options may include surgery, radiotherapy, and chemotherapy. Children with cancer and their families have special needs that can be better met at specialized centers, such as INCA. Childhood cancer treatment involves a multidisciplinary team that should include pediatricians, pediatric oncologists, pediatric surgeons, radiation oncologists, pediatric nurses, psychologists, social workers, nutritionists, and physical therapists. However, at INCA the anesthesia department is responsible for sedation in endoscopies, colonoscopies and radiological procedures.

Traditionally, anesthesia has been used in pediatric patients to control pain, anxiety, and facilitate children's compliance during various medical procedures. Non-pharmacological interventions offer a promising avenue for the future of sedation and anesthesia in the radiation oncology suited to pediatric patients [15]. Techniques such as virtual reality, music therapy, and mindfulness-based approaches have shown success in reducing anxiety and promoting relaxation in other medical settings [15].

Conclusion

The future of pediatric RT procedures should include new anesthetic approaches for this population with cancer, mainly because it is a painless procedure. Children with cancer can become aggressive and new approaches incorporating playful approaches, distraction techniques and parental involvement reduce anxiety and promote a positive environment during their treatment. It is critical that healthcare professionals understand all the equipment required for RT, service protocols, and specific challenges such as positioning, immobilization devices, and monitoring requirements. Unlike other countries where RT is anesthetized by non-anesthesiologists, at INCA, all RT procedures in children are performed by the anesthesiology department where a staff and anesthesia resident are always present.

Study Carried at Hospital HC 1 INCA.

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Conflict of Interest

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Contribution

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