

Gamma Knife

Gamma Knife® is a radiation therapy that uses computerized treatment planning software to help physicians locate and irradiate small targets within the head and brain with very high precision. The treatment delivers intense radiation doses to the target area while sparing surrounding tissue.

If you're scheduled for radiation therapy using Gamma Knife®, a treatment team consisting of a radiation oncologist, a medical physicist and a neurosurgeon will work together to provide your treatment. Safety is ensured by the medical physicist who tests the machine's mechanical functions and verifies that the imaging and treatment planning computers and software are correct and acceptable.

What is this equipment used for?

The Gamma Knife® and its associated computerized treatment planning software enable physicians to locate and irradiate relatively small targets in the head (mostly inside the brain) with extremely high precision. Intense doses of radiation can be given to the targeted area(s) while largely sparing the surrounding tissues. The Gamma Knife® can be used for a wide variety of problems. For example, it can be used to treat selected malignant tumors that arise in or spread to the brain (primary brain tumors or metastatic tumors), benign brain tumors (meningiomas, pituitary adenomas, acoustic neuromas), blood vessel defects (arteriovenous malformations) and functional problems (trigeminal neuralgia). Possible future uses are being evaluated for epilepsy and Parkinson's disease.

Single-session Gamma Knife® treatment is usually unsuitable for targets larger than three or four centimeters in size.

How does the equipment work?

The Gamma Knife® utilizes a technique called stereotactic radiosurgery, which uses multiple beams of radiation converging in three dimensions to focus precisely on a small volume, such as a tumor, permitting intense doses of radiation to be delivered to that volume safely. Currently, the available models use advanced robotic technology to move the patient in submillimeter increments during treatment to focus radiation successfully on all parts of the target.

Treatments using Perfexion

Most treatments are given in a single session. Under local anesthesia, a special rigid head frame incorporating a three-dimensional coordinate system is attached to the patient's skull with four screws. Imaging studies, such as magnetic resonance imaging (MRI), computed tomography (CT), or angiography, are then obtained and the results are sent to the Gamma Knife®'s planning computer system. Together, physicians (radiation oncologists and neurosurgeons) and medical physicists delineate targets and normal anatomical structures. They use a planning computer program to determine the exact spatial relationship between the target, normal structures and the head frame to calculate Gamma Knife® treatment parameters. Targets often are best treated during the treatment session with combinations of several successive highly focused treatments, commonly known as "shots." The physicians and physicists routinely consider numerous fine-tuning adjustments of treatment parameters until an optimal plan and dose are determined.

Using the three-dimensional coordinates determined in the planning process, the frame is then precisely attached to the Gamma Knife® unit to guarantee that when the unit is activated, the target is placed exactly in the center of approximately 200 precision-aimed, converging beams of (Cobalt-60 generated) gamma radiation. Treatment takes anywhere from several minutes to a few hours to complete depending on the shape and size of the target, the number of "shots" and the dose required. Patients do not feel

the radiation treatment as it is delivered, although they may experience seeing flashes of light while the treatment is being delivered. Following treatment the head frame is removed and the patient may return to normal activity.

Treatments using Icon

Icon treatments differ from Perfexion treatments in that:

- Treatments are given in single or multiple sessions.
- An external frame is not required.
- Icon uses a combination of onboard stereotactic Cone Beam CT (<https://www.radiologyinfo.org/en/info/dentalconnect>) imaging and real-time infrared motion detection and management to achieve 0.15 mm treatment accuracy even without a rigid frame.

See the *Stereotactic Radiosurgery* (<https://www.radiologyinfo.org/en/info/stereotactic>) page for additional information.

Who operates this equipment?

A multidisciplinary team approach provides patients with the greatest safety. The team is most commonly comprised of a radiation oncologist, a medical physicist and a neurosurgeon—all specially trained in the use of the Gamma Knife®—with support from nursing staff, anesthesiologists (for patients who are unable to cooperate, such as children) and radiation therapists, who work together to provide patients with the high-quality care they deserve. It is a requirement of the Nuclear Regulatory Commission that an "authorized user," usually a radiation oncologist, be at the treatment console during the entire procedure.

How is safety ensured?

Because placement accuracy of the shots is critical to localization of the radiation (to a fraction of a millimeter), anything that would degrade this precision is unacceptable. Rigid attachment of the head frame, geographic targeting accuracy of the imaging studies, shaping of the volume of tissue to be treated (selection of the number, size and relative intensity of the shots) and accuracy of attachment of the frame to the Gamma Knife® unit are all critical. As is true of all radiation therapy procedures, correct selection and calculation of the amount of radiation to deliver are essential. A qualified medical physicist assures that the imaging and treatment planning computers and software are correct and acceptable. The mechanical functions of the machine are tested on a regular basis to ensure the safety of patients and medical staff.

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