UNIVERSITÀ GIUSTINO FORTUNATO
D.M. 13 aprile 2006 - G.U. n° 104 del 6/05/2006 - TELEMATICA

UniforJob ACADEMY

Accademia Eraclitea
ENTE DI RICERCA E DI ALTA FORMAZIONE ACCREDITATO

Master Universitario di primo livello in "Deglutologia geriatrica"
A.A. 2023/24

Radiazioni e Radioprotezione

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Società Italiana di Radiologia Medica e Interventistica

Società Italiana di Deglutologia SID già G.I.S.D.

European Society of Gastrointestinal and Abdominal Radiology ESGAR

EUROPEAN SOCIETY FOR SWALLOWING DISORDERS ESSD

Radiazioni ionizzanti

- ✓ Non si vedono
- ✓ Non si sentono
- ✓ Non profumano…

…ma sono tossiche!

Devono essere adottate adeguate precauzioni

Radioprotezione

La radioprotezione (o protezione sanitaria contro le radiazioni ionizzanti) è una disciplina che si occupa della protezione delle persone rispetto ai rischi potenzialmente derivanti dall'esposizione a sorgenti di radiazioni ionizzanti

SCOPO DELLA RADIOPROTEZIONE

↙ ridurre I RISCHI

↘ aumentare I BENEFICI

→ Le sue conoscenze vengono applicate mediante leggi e procedure

Legislazione Radiazioni Ionizzanti

SWE/ CAN	International Commission on Radiological Protection (ICRP)
EU	**Direttive EURATOM** Comunità europea dell'energia atomica
ITA	**DLgs. 230/1995** Radioprotezione della popolazione e dei lavoratori
ITA	**DLgs. 187/2000** Radioprotezione dei pazienti
ITA	**DLgs 101/2020** Protezione contro i pericoli derivanti dalla esposizione alle radiazioni ionizzanti

- Principio di giustificazione
- Principio di ottimizzazione
- Principio di limitazione della dose

Formulati per la prima volta nella pubblicazione n. 26 del 1977 e successivamente ridefiniti nella pubblicazione n. 60 del 1990

Tali principi devono **SEMPRE** ispirare l'impiego di radiazioni ionizzanti

Art. 3 DLgs. 187/2000: Principio di giustificazione

(DLgs 101/2020 - 2013/59/Euratom)

E' vietata l'esposizione non giustificata

Art. 4 DLgs. 187/2000: Principio di ottimizzazione

(DLgs 101/2020 - 2013/59/Euratom)

L'esposizione alle radiazioni ionizzanti deve essere mantenuta ai livelli più bassi possibili, compatibilmente con le condizioni economiche e sociali : Principio ALARA (*as low as reasonably achievable)*

Art. 2 DLgs. 230/1995: Principio di limitazione di dose

(DLgs 101/2020 - 2013/59/Euratom)

La somma delle dosi derivanti da tutte le pratiche non deve superare i limiti di dose stabiliti per i lavoratori esposti, gli apprendisti, gli studenti e gli individui della popolazione

Radiazioni

Distribuzione media stimata dei contributi alla dose media individuale annuale per la popolazione italiana

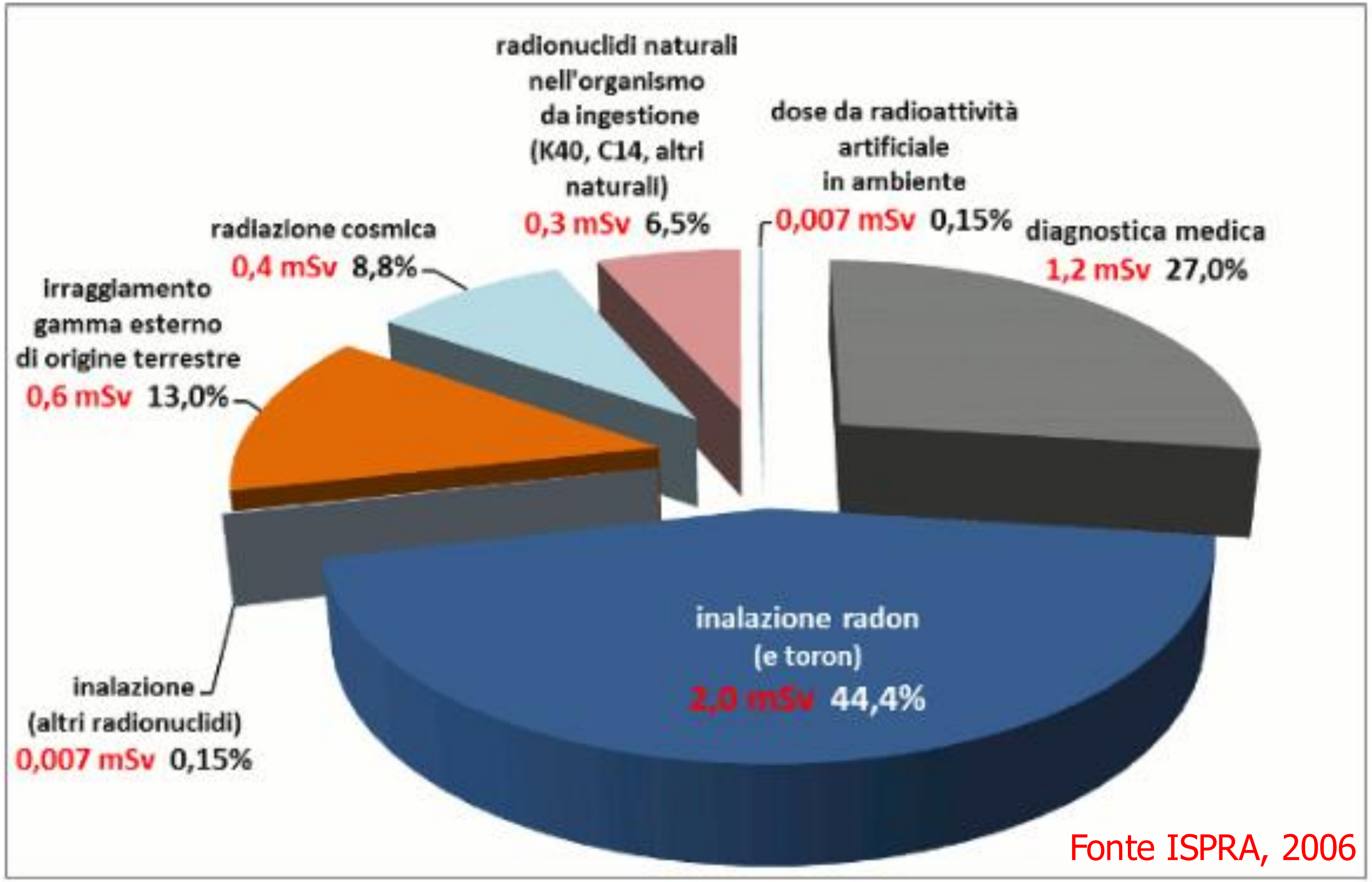
4,5 mSv/anno

Dose efficace radiazioni naturali anno:

- 3,3 mSV

Dose efficace esposizione medica anno:

- 1,2 mSV



Fonte ISPRA, 2006

Radiazioni Ionizzanti

- Sono chiamate così per la loro capacità di ionizzare gli atomi, che compongono le strutture molecolari alla base delle cellule negli organismi viventi, con cui interagiscono determinando un danno biologico

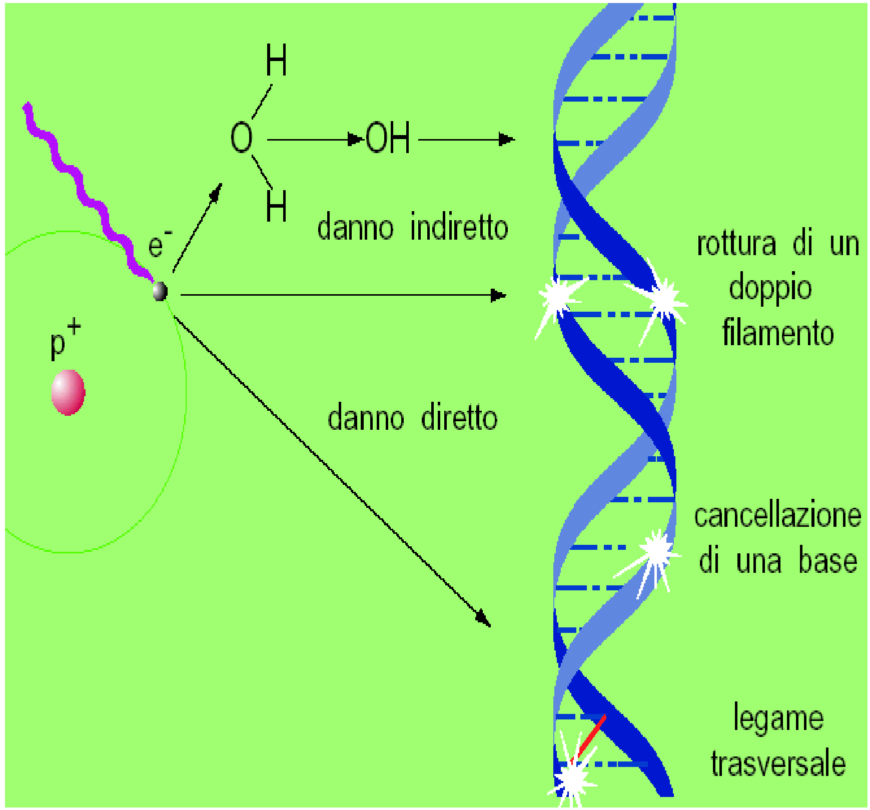
- Gli effetti dannosi (chimici e biologici) delle radiazioni ionizzanti nei tessuti del corpo umano, dipendono dalla dose assorbita

- Maggiore è l'energia assorbita maggiore è il numero di ionizzazioni e maggiore sarà il danno

Radiazioni Ionizzanti

- Danno diretto: la radiazione crea ionizzazione negli atomi che costituiscono le macromolecole vitali (DNA)

- Danno indiretto: prodotto dai radicali liberi dovuti dalla ionizzazione delle molecole d'acqua che costituiscono circa il 80% del corpo umano



Effetti delle radiazioni ionizzanti

Gli effetti delle radiazioni sul corpo umano possono essere riassunti in due grandi tipologie di effetti:

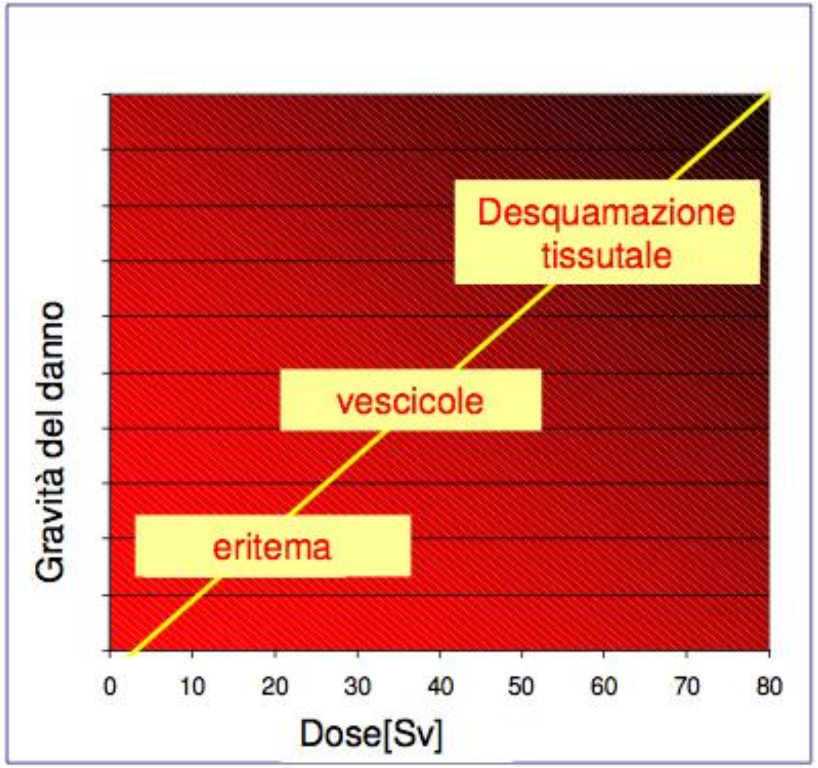
Effetti deterministici

Effetti stocastici

Effetti deterministici (reazioni del tessuto)

La gravità del danno è correlata alla dose

- Il danno si manifesta con dosi superiori a una certa dose soglia e entro tempi brevi (ore, giorni, 3 settimane)
- Esempi: variazione del quadro ematico, danni cutanei, cataratta…



Dose soglia per la cute: 250mSv

Effetto deterministico riconosciuto (~500 mSv)

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Limiti di dose per le persone

Persone del pubblico	1 mSv/anno
Lavoratori non esposti	1 mSv/anno
Lavoratori esposti	6 mSv/anno - cat. B 20 mSv/anno – cat. A

D.Lgs. 230/95 e s.m.i.

Effetti stocastici (incerti e a lungo termine)

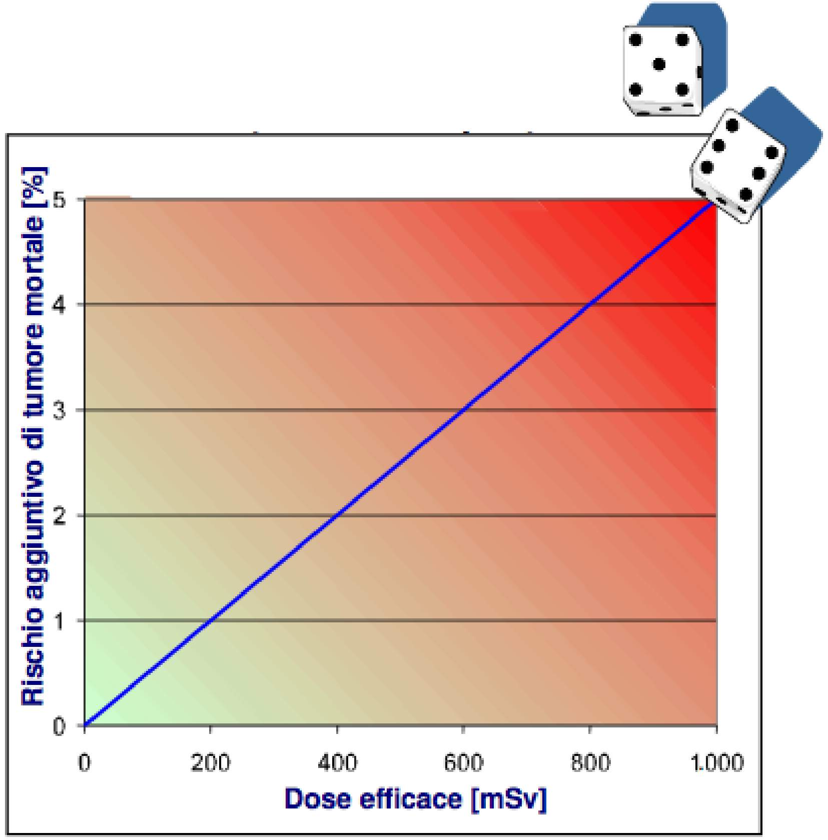
La gravità del danno è indipendente dalla dose

- Sono effetti probabilistici la cui frequenza nella popolazione è legata alla dose totale ricevuta dall'intera popolazione

- Il danno indotto di solito compare a distanza di molti anni

- Non c'è un valore soglia

- Esempi: tumore, leucemie, danni genetici…



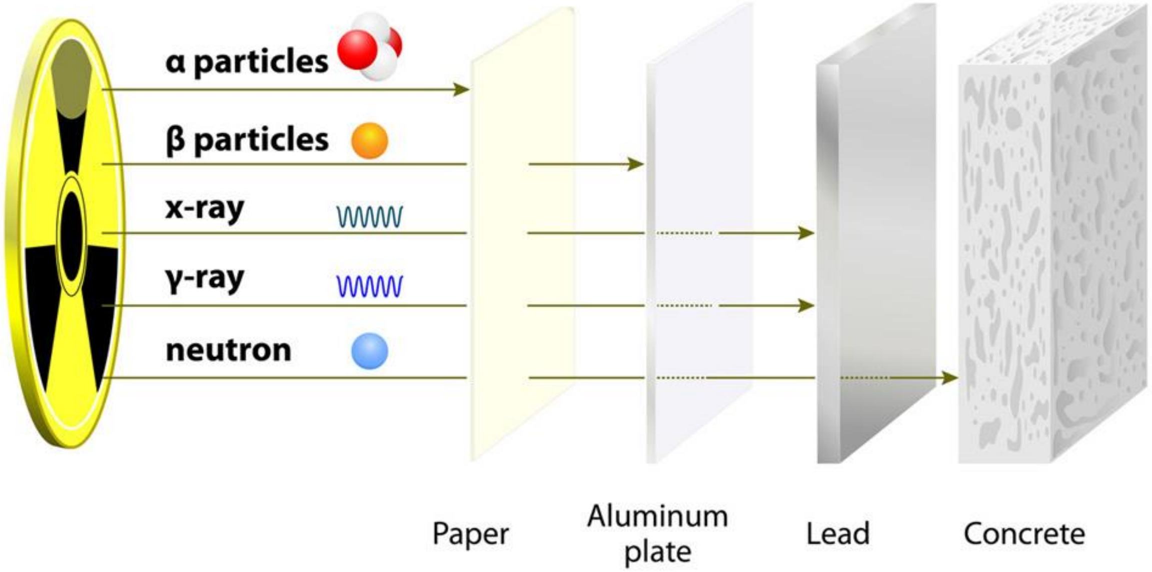
Tipi di radiazioni ionizzanti

- **Radiazioni alfa:** radiazione corpuscolare composta da due protoni e due neutroni, è dotata di due cariche positive
  Molto ionizzante-debolmente penetrante

- **Radiazioni beta:** radiazione corpuscolare dotata di una carica negativa, è simile all'elettrone, da cui differisce solo per la sua origine nucleare
  Molto ionizzante-debolmente penetrante

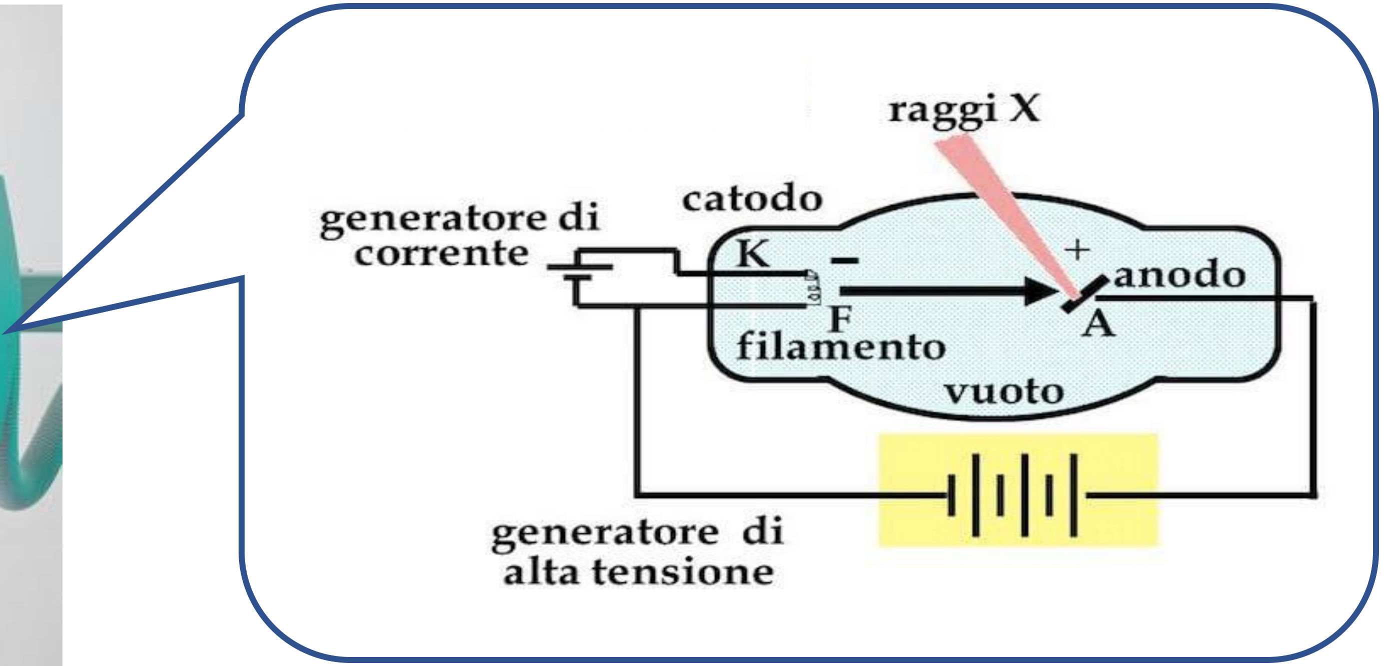
- **Radiazioni Gamma:** radiazione elettromagnetica simile alla luce, ovviamente, priva di carica elettrica e di massa
  Poco ionizzante-molto penetrante

- **Radiazioni X:** radiazione elettromagnetica simile alla gamma da cui differisce per la sua origine, in generale per l'energia associata
  Poco ionizzante-fortemente penetrante

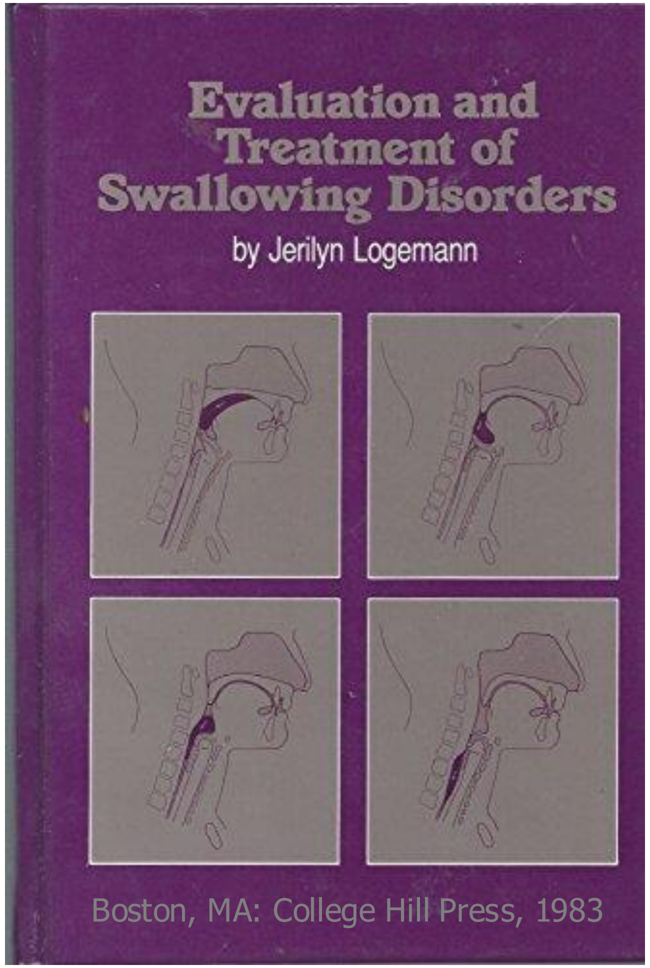


RADIAZIONI X

- Sono radiazioni elettromagnetiche che si producono quando alcuni atomi sono colpiti da fasci di elettroni di elevata energia
- L'apparato per la produzione dei raggi X si chiama tubo radiogeno



Utilizzo delle Radiazioni Ionizzanti nei disturbi della deglutizione
…la Storia…



Boston, MA: College Hill Press, 1983

Role of the modified barium swallow in management of patients with dysphagia

JERI A. LOGEMANN, PhD, Evanston, Illinois

The modified barium swallow is a radiographic (videofluoroscopic) procedure designed to define the anatomy and physiology of the patient's oropharyngeal swallow and examine the effectiveness of selected rehabilitation strategies designed to eliminate aspiration or excess oral or pharyngeal residue (the symptoms of the patient's dysphagia). Rehabilitation strategies introduced during the modified barium swallow after the patient's oropharyngeal anatomy and physiology have been defined include (1) postural changes to redirect food flow and change pharyngeal dimensions, (2) sensory enhancement techniques, and (3) swallow maneuvers. Combining the modified barium swallow with a follow-up swallowing rehabilitation plan can decrease the cost and time for rehabilitation of patients with dysphagia. In some cases the patient can begin safe oral intake immediately after the modified barium swallow, and therapy may not be needed if consistent spontaneous recovery is anticipated. (Otolaryngol Head Neck Surg 1997;116:335-8.)

The radiographic study known as a modified barium swallow has two major purposes: (1) to define the anatomy and physiology of the patient's oropharyngeal swallow during boluses of various types, representing various foods and liquids; and (2) to examine the effects of rehabilitation strategies designed to eliminate the symptoms of the patients' swallowing problem (aspiration and inefficient swallow causing residue in the mouth or pharynx).[1,2] The modified barium swallow can be used with patients of all ages, from birth to old age, and with patients who have sustained a variety of types of damage to the central nervous system or to the structures of the oropharyngeal region, including gunshot wound or surgical treatment for head and neck cancer.[3-6]

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Supported by National Institutes of Health grant no. PO1-CA-40007 (National Cancer Institute).
Presented at the Annual Meeting of the American Academy of Otolaryngology–Head and Neck Surgery, Oct. 2-6, 1993, Minneapolis, Minn.

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0194-5998/97/$5.00 + 0 23/1/74959

PROCEDURE FOR THE MODIFIED BARIUM SWALLOW

The procedure for the modified barium swallow involves examining the patient initially in a lateral view, seated in an upright position in a chair or wheelchair or lying on a cart with a back support to elevate him or her to vertical.[7,8] Usually, the patient is first presented with measured volumes of thin liquids containing barium, beginning with 1 ml (representing saliva) and progressing to 3 ml, 5 ml, 10 ml, and cup drinking. Two swallows of each are examined. If the patient exhibits any significant swallowing difficulty (i.e., aspiration or significant oral or pharyngeal residue), the patient is given intervention/therapy strategies to improve the swallow. The strategies begin with postural techniques and then sensory enhancement and therapy strategies as needed.[2] If these strategies are successful in improving the swallow and eliminating aspiration and significant residue, the patient is given larger volumes of liquid to test the extent of effectiveness of the strategies. If the strategies are effective on at least some volumes of liquids, the recommendation is made to allow the patient to take those volumes of liquid orally using these strategies. Then, thicker foods are presented. These may include measured amounts of thick liquid, purees, and food requiring chewing, such as a cookie coated with barium pudding. Again, if the patient exhibits aspiration or excessive residue, intervention strategies are introduced to eliminate the aspiration or reduce the residue.

Dysphagia 15:136–141 (2000)
DOI: 10.1007/s004550010015
Dysphagia

Clinical Utility of the Modified Barium Swallow

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Abstract. The purpose of this investigation was to evaluate the immediate and clinically relevant information gained from the modified barium swallow study and to determine the impact of the procedure on patient management. A database containing a nonrandom sample of 608 swallowing studies was reviewed. Results showed that only 10.4% of the studies were classified as normal examinations and aspiration occurred in 32.4%. However, swallowing abnormality without aspiration was recorded in 57.2% of the studies. Five additional outcome variables were assessed: referrals made to other specialties, effectiveness of applied compensatory strategies, treatment recommendations, mode of intake change, and diet grade change. Nearly 83% of the 608 studies showed change in at least one of the variables: needed referral to a specialist was identified on 26.3%; compensatory strategies that improved swallow physiology were identified on 48.4%; swallowing therapy was recommended on 37.2%; changes in mode of intake occurred on 31.4%; and diet texture changes were recommended on 43.8%. The low percentage of normal studies coupled with the high percentage of change in measurable variables indicate high clinical utility for the modified barium swallow study. The misguided tendency to refer to the modified barium study only as a tool for identifying aspiration and the appropriate utilization of the examination for identification of underlying abnormality in swallowing physiology are explained.

Key words: Modified barium swallow — Dysphagia — Swallow database — Modified barium swallow outcomes — Deglutition — Deglutition disorders.

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The pathology of rapid physiologic processes is best studied using dynamic examinations capable of capturing the salient components of the process over time. Deglutition is an example of rapid complex movement comprised of a series of muscle contractions leading to channel formation, valvular closure, and valvular opening, allowing for safe and efficient passage of swallowed material through the upper aerodigestive tract [1–6]. The approach to evaluating this complex mechanism should allow examination of two basic parameters: efficiency of bolus preparation and transport throughout the upper aerodigestive tract, and safety or airway protection. The highest clinical yield will result when the diagnostician is able to examine structural movement as it relates to bolus movement [7–10] and observe the impact of compensatory swallowing strategies on function [11–18]. In our experience this has been achieved with the modified barium swallowing (MBS) study procedure. The MBS study is a radiographic examination that permits observation of the dynamic swallowing process as the patient is administered graduated bolus volumes of different radiopaque consistencies [19]. Despite our positive experience using the MBS in routine management, the current financial constraints imposed on health care providers attempting to deliver quality care with competition for financial resources [20] forces us to continually evaluate the usefulness of the tests we recommend.

The purpose of the present investigation was to evaluate the immediate clinical yield from the MBS and the impact of the procedure on patient management in a program at a tertiary care medical center. At our center, the modified barium swallowing study is a videofluorographic examination that involves analysis of the physiologic components of the swallowing mechanism and evaluation of bolus flow in relation to structural movements throughout the upper aerodigestive tract. The examination is performed by a speech-language pathologist and attending radiologist. In addition to the role of the

Gastrointest Radiol 10:213–224 (1985)

Gastrointestinal Radiology

Dynamic Imaging of the Pharynx

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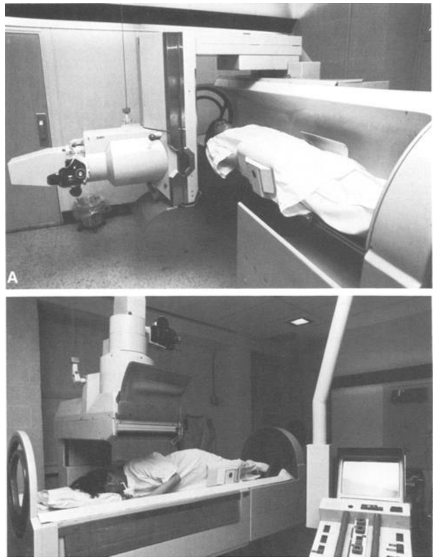
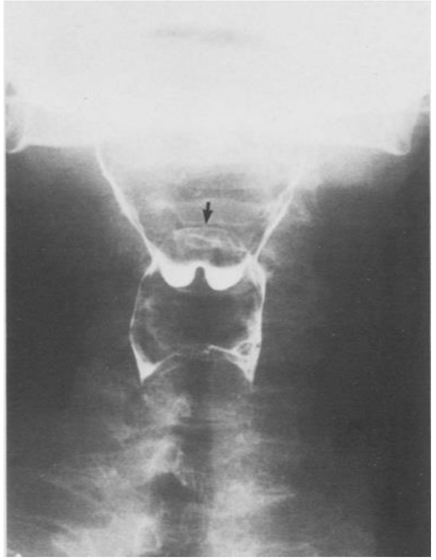
Abstract

… **In examining this area, it is vital to have dynamic imaging capability** (either cinefluorography or videotape recording). Such technique sallow the frame-by-frame analysis of individual swallows necessary to an understanding of a complex motility disturbance…

…This film may be supplemented by a lateral xeroradiogram (average exposure factors, **110 kVp, 160 mAs**, and negative xeromode…





The British Journal of Radiology, 77 (2004), 654–656
DOI: 10.1259/bjr/22832251

Patient and operator dose during fluoroscopic examination of swallow mechanism

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Abstract. Dose–area product (DAP) measurements were made for 21 patients undergoing a modified barium swallow. The procedures were performed by a radiologist and speech and language therapist, to characterize swallowing disorders in patients with head or spinal injury, stroke, other neurological conditions or simple globus symptoms, in order to inform feeding strategies. The DAP values were used to estimate effective dose to the patient, in order to provide a measure of the radiation risk associated with the procedure. Whole body doses to operators, together with equivalent doses to extremities and eyes were also measured to inform the employer's risk assessment. Median DAP for the series was 3.5 (3.1–5.2) Gycm2 with a corresponding effective dose to the **patient of 0.85 (0.76–1.3) mSv, and a low associated risk, mainly of cancer induction, of about 1 in 16 000. The organ receiving the greatest dose was the thyroid, with a calculated median equivalent dose of 13.9 (12.3–20.7) mSv.** Median screening time was 3.7 (2.5–4.3) min. Mean operator doses were 0.5 mSv equivalent dose (eyes), 0.9 mSv (extremities), and less than 0.3 mSv whole body dose. Extrapolating for an annual workload of 50 patients per year, this work will lead to annual operator doses of less than 0.6 mSv whole body dose, and approximately 1 mSv equivalent dose (eyes) and 1.8 mSv (extremities), against corresponding legal dose limits of 20 mSv, 150 mSv and 500 mSv, respectively.

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

Received 4 January 2019; Accepted 22 February 2019 Available online 25 February 2019 0165-5876/

Radiation exposure during videofluoroscopic swallowing studies in young children

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ABSTRACT

Objectives: Swallowing difficulties are best assessed by videofluoroscopic swallowing studies (VFSS). However, limiting radiation exposure is important, especially in young children. The purpose was to evaluate radiation dose in young children during VFSS, and to investigate factors associated with it.

Methods: Children with swallowing difficulty who underwent VFSS from February 2012 to July 2014 were recruited. Dose area product (DAP) and screening time were offered by the fluoroscopy machine, and effective dose was calculated from the DAP using a conversion coefficient published by the National Radiological Protection Board (NRPB-R262). The age, gender, height, weight, body mass index (BMI), body surface area (BSA), underlying disease of the subject children, and results of VFSS were investigated.

Results: In 89 children (mean age 1.57 ± 2.17, 55 boys and 34 girls), mean effective dose was 0.29 ± 0.20 mSv, mean DAP was 2.41 ± 1.65 Gy cm2, and mean screening time was 2.24 ± 0.99 min. The effective dose correlated with the screening time ($r = 0.598$, $p < 0.001$), age ($r = 0.210$, $p = 0.049$), height ($r = 0.521$, $p < 0.001$), weight ($r = 0.461$, $p < 0.001$), and BSA ($r = 0.493$, $p < 0.001$). There was no such correlation with gender, BMI, underlying disease, or the results of VFSS.

Conclusions: **The effective dose during VFSS (0.29 mSv) in young children, which is affected by screening time, age, and body size, is considerably lower than the pediatric radiation exposure limit of 1 mSv per year. However more than 4 VFSS annually would exceed this limit. Our findings will help physicians to reduce the radiation exposure and provide a useful references for future pediatric VFSS guidelines.**

Key Point

- Sebbene la dose di radiazioni del paziente da un esame videofluoroscopico sia relativamente bassa, tra 0,2 e 0,85 mSv , qualsiasi esposizione deve essere ridotta al minimo per conformarsi al principio ALARA (As Low As Reasonably Achievailable)
- Il tempo totale di esposizione alle radiazioni è uno dei fattori più importanti che influenzano le dosi dei pazienti negli esami fluoroscopici

Moro L, Cazzani C. Radiol Med, 2006

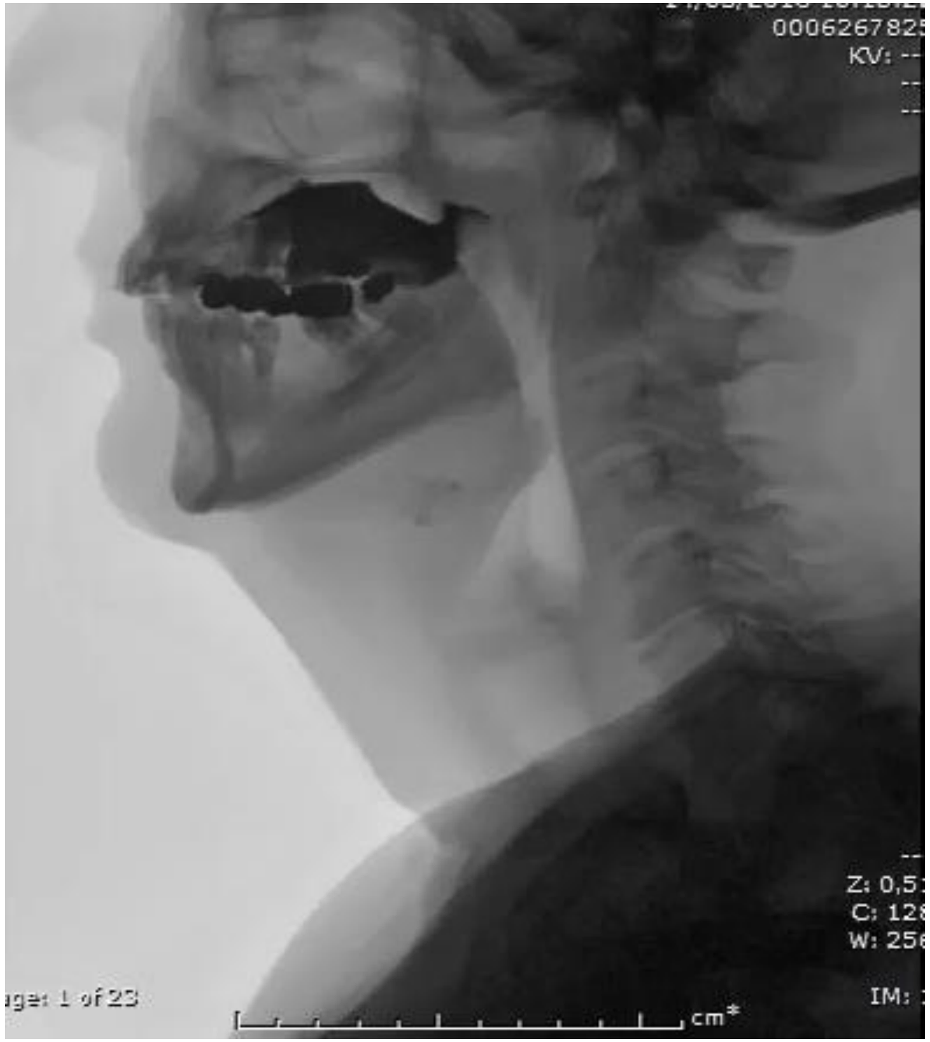
Chau KH, Kung CM. Dysphagia, 2009

- Patologia del paziente: funzione cognitiva
- La gravità del deficit di deglutizione
- L'esperienza dell'operatore

Possono aumentare il tempo di esposizione

Bonilha et al. Dysphagia, 2013

Tra passato e presente



Conclusioni

- La filosofia della Radioprotezione si è evoluta negli anni con un approccio ben definito che deve essere applicato ai pazienti da sottoporre a procedure che li espongono a radiazioni ionizzanti
- Qualsiasi esame radiologico deve essere "GIUSTIFICATO»
- Sebbene le dosi di radiazioni associate alla videofluoroscopia siano relativamente modeste, resta importante quantificare questi rischi per i professionisti che richiedono questo esame considerando il rapporto rischio / beneficio e la reale utilità delle informazioni che può fornire