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Radiation Safety for Speech-Language Pathologists
Radiation Awareness and Practices Among Speech-Language Pathologists

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Introduction
As members of the Division 13 newsletter committee, we hold an annual conference call to select topics of interest to feature in upcoming newsletters. In our summer 2003 call, the topic of radiation awareness and radiation safety practices among speech-language pathologists performing videofluoroscopic swallowing examinations (VFSS) was proposed. We agreed to invite a radiation physicist to contribute an article to this issue, addressing the many questions that are commonly asked by speech-language pathologists regarding their own safety and the safety of their patients during the VFSS procedure. We also decided that it would be of interest to the membership and helpful to the radiation physicist if we first conducted a survey of Division 13 affiliates, to capture existing variations in the level of knowledge regarding radiation and the associated risks, and to identify the range and variety of radiation safety practices that are currently used by members. The response to the survey confirms this is a topic of great interest to the members; 121 completed surveys were received. Many of you thanked us for tackling this topic and requested copies of the results. We hope that this report, together with the related articles in this issue of Perspectives will be informative and also serve as a resource to promote improved radiation safety practices in your workplaces.

Survey Respondents
We received 121 completed surveys from respondents working in a variety of settings: acute-care neurology (63%), rehabilitation hospitals (36%), acute-care tracheotomy and ventilator dependent populations (31%), acute-care oncology (20%), acute-care pediatrics (11%), nursing homes (8%), home-health (6%), and schools (3%). Survey respon-
dent tended to be an experienced group of clinicians, with 32% reporting greater than 20 years in clinical practice, an additional 29% reporting between 10 and 20 years of experience, and a further 22% reporting at least 5 years in the field. Similarly, respondents reported many years of experience performing VFSS examinations, with 35% reporting at least 10 years of experience and an additional 30% reporting at least 5 years of experience with the procedure. The majority of respondents (67%) reported performing between 2 and 10 VFSS examinations per week, while 10% reported that they conduct more than 10 VFSS procedures each week. In terms of skill performing the procedure, 56% of respondents rated themselves as “independent, equal to my peers” and 30% rated themselves either as the “best in my facility” or the “best in my area.”

**Length of VFSS Procedure**

Radiation exposure accumulates with time; it was, therefore, important for us to ask affiliates to report the average length of the radiation exposure involved in their VFSS examinations in minutes. This revealed that members endeavor to be efficient in their VFSS assessments, with 22% of respondents reporting an average of 1-2 minutes of radiation exposure, a further 30% respondents reporting 2-3 minutes, and an additional 29% reporting 3-4 minutes of radiation exposure during their VFSS examinations. Interestingly, this question also revealed that a substantial number of respondents (16%) did not know how much radiation exposure (in minutes) was involved in their VFSS procedures. We also asked affiliates to tell us what sorts of procedures were used to monitor or curtail the duration of radiation exposure involved in the VFSS exam. Almost half of the survey respondents (45%) reported that a bell ring is used to alert them to the fact that a time threshold has been exceeded; 5 minutes was the most commonly reported threshold setting for this bell. Two individuals reported that their bell was set to ring at a radiation amount threshold rather than a time threshold. Only 9% reported that a log of exposure duration or amount was maintained in addition to the warning bell, while 12% reported a log but no bell. One quarter of respondents reported that they currently have no procedures in place to limit or monitor the duration or magnitude of radiation exposure to their patients during videofluoroscopy.

**Time Constraints**

A related area of interest to us, was the extent to which VFSS procedures are curtailed due to time, radiation exposure, or other considerations. Therefore, we asked a series of questions to determine how frequently clinicians find it necessary to end the VFSS procedure before exploring all the textures, maneuvers, and other swallowing tasks that they would consider necessary to guide management of the patient’s dysphagia. These questions indicated that clinicians are often unable to gather sufficient information to guide management with the time constraints applied to their facilities. Some 43% of the respondents reported that they sometimes found it necessary to curtail the VFSS prior to exploration of the full range of desired consistencies. While most clinicians (45%) reported that they were able to explore the impact of compensatory maneuvers to their satisfaction within any existing time limitation. An addition 33% reported curtailing this component of their examination less than 25% of the time. Interesting side comments from some respondents indicated that the time limitations experienced in their facility were sometimes more a factor of apparent hurry on the part of the radiologist than of any instrumental indication that the duration of radiation exposure was approaching an excessive amount. Less than 7% of respondents reported that radiation exposure led to early termination of the examination more than 25% of the time. Respondents reported that it was rare for the clinician to need to ask to continue the examination and override a radiation exposure alarm (52% never; 40% less than 25% of the time); however, side comments suggested that these results may reflect a frequent practice of ignoring the bell and, hence, no need to request continuation of the VFSS procedure.

**Feeder Protection**

Since radiation exposure increases with proximity to the radiation field, we were interested to explore protective measures employed for individuals administering food and liquids to the patient during the VFSS. In 85% of cases, this individual was reported to be the speech-language pathologist who completed the survey. Radiation technicians participated in feeding
only 5% of the time, while families, familiar caregivers, or nurses were involved 7% of the time. Lead aprons were reportedly used by all feeders, with one-piece designs worn 88% of the time and two-piece designs available 25% of the time; the overlap in these statistics suggests that both models were available in some institutions. Thyroid collars were also commonly (83%), but not unanimously, used. Radiation dosimetry badges were also commonly used, with 69% of respondents reporting the use of a badge worn outside the lead apron, and 21% reporting a dosimeter worn underneath the apron. This contrasts with the low reported use of lead gloves while feeding during VFSS (16%), with some additional side comments indicating that gloves are not commonly offered to significant others who assist with feeding patients during the procedure. Similarly, the use of wrist or ring dosimeters was rare (17%), as was eye protection (14%) and/or a plexi-glass/plexi-glass plus lead shield (4%) by the feeder. Following bolus administration, feeders were reported to stand directly in front of the patient (close enough to feed) 16% of the time. Standing directly in front of the patient, but at a slight distance (not close enough to feed) was more common (25% of the time), while moving off to one-side was the most commonly reported practice (44%). Moving behind a barrier after bolus administration was extremely uncommon (3%). In light of these reported feeder locations, we will be curious to learn whether the radiation physicist feels the use of protective equipment by the feeder (three pieces of equipment on average) was sufficient.

We also asked survey respondents to indicate whether any protective equipment or radiation safety information was provided to their patients prior to the VFSS procedure. This question was only answered by 62% of responding members, with the majority (79%) providing some sort of protective advice or equipment to their patients. However, side comments to this question provided a fascinating glimpse into common practices. Many clinicians indicated that lap covers are provided only to certain subsegments of their patient population. Consideration of patient age and childbearing potential was frequently cited as a reason for offering lap covers, while others reported only providing coverage to patients of either male or female gender. These comments suggest that our inquiry may have prompted closer examination of the rationale for and fairness of these practices.

**Safety Policies**

The survey concluded with questions intended to probe the level to which strict policies and procedures are used to ensure radiation safety within speech-language pathologists’ workplaces. These questions revealed that feeders are rarely required to attend radiation safety inservicing, with 63% of respondents reporting that this requirement either did not exist or was not enforced. Only 25% of respondents reported attending a radiation safety in service themselves within the previous year, and a full 43% reported that they had never received this type of education. The frequency of inspecting lead aprons for cracks was also reported to be low, with 57% of members reporting that this never occurred, and only 11% reporting inspection every 6 months.

Finally, the survey inquired whether pregnant workers were required to perform VFSS. It was our speculation that concerns regarding restrictions from VFSS or additional safety precautions to be taken in the event of real or desired pregnancy would be common, given the predominant demographic of speech-language pathologists as females of childbearing age. The majority (80%) of survey respondents indicated that pregnant workers would not be required to perform a VFSS procedure in their workplaces, while 12% indicated that this work expectation would continue to apply. Several side comments indicated that pregnant workers commonly choose to continue to perform VFSS examinations, while using additional protective measures (fetal dosimetry badges or double aprons).

**Conclusion**

In conclusion, the results of this survey suggest that speech-language pathologists frequently engage in VFSS examinations without being knowledgeable about the radiation risks that may be inherent in the procedure and about measures that can be taken to reduce these risks. Common measures for limiting the duration of radiation exposure, such as warning bells, appear to be frequently overridden, and a substantial number of clinicians do not appear to move to a position of distance from the radiation field after bolus...
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administration. It appears that many clinicians may be assuming risks without an appreciation that this is occurring and without taking simple and appropriate measures to promote their own safety and well-being. We look forward to the comments of the radiation physicist and to a continuing dialog regarding radiation safety practices and awareness among speech-language pathologists.

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Radiation Safety for Speech-Language Pathologists

A Discussion of Radiation in Videofluoroscopic Swallow Studies

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Introduction

The use of X-rays in medicine is well established. However, the past few decades have seen increasing public and professional concern regarding the biological effects of low levels of radiation, particularly of possible risks from the rapidly increasing numbers of medical irradiations received as part of the medical diagnostic process. Much of the public concern is for its use in screening asymptomatic populations—such as mammography—but there has been considerable scrutiny of other procedures as well in efforts to improve the overall standard of the imaging exams (examples: American College of Radiology accreditation programs, Joint Commission on Accreditation of Health Organization standards, National Evaluation of X-ray Trends surveys). As part of the expansion of x-ray technology into new diagnostic and therapeutic medical applications, the study of how x-rays interact within biological tissue has led to improvements in both equipment and in procedures aimed at reducing unnecessary and unintentional exposures, while maximizing the diagnostic information obtained. However, it is still “essential that all personnel professionally involved with the use of medical radiation develop an understanding of the risks involved, and of methods for minimizing them without compromising medical benefits” (Webster, 1980, preface). This statement was originally aimed at medical physicists, but is equally applicable to individuals from non-radiology clinical disciplines who are becoming much more involved in using radiological imaging methods as an integral part of their specific diagnostic protocols.

Thus the goals of this paper are to provide for those individuals:

1. A general review of radiation interaction with human tissue and the biological effects of the absorbed dose.
2. An understanding of the risks, particularly for fluoroscopy, with respect to both acute radiation damage (i.e., risk of erythema, etc.) and with respect to cancer induction, genetic, and fetal risks from radiation exposure.
3. Information on radiation dose estimates to both patients and staff for fluoroscopy and comparative common radiological procedures.
4. Review methods for reducing risk, both to the patient and to the professional staff.

Interaction in Tissue

In a standard diagnostic x-ray exam, most of the radiation incident on the portion of the body being imaged is readily absorbed by the tissues. Different tissues within the body absorb, or attenuate, the radiation to varying degrees, thus producing the contrast differences seen in the projected image. This absorption is a transfer of energy from the x-ray photons to the tissue cells and may or may not directly damage the cell. The x-rays cause ionization within the cells, either by the photoelectric effect, when the x-ray photon interacts with an inner electron of an atom, or by Compton scatter, which is an interaction with a loosely bound or free electron. The interaction may be with a biologically important molecule (such as the DNA) or a biologically inert part of the cell. In either case, the ionization produces free radicals within the cell, most commonly from the water molecules of the cytoplasm, and these may also produce cellular damage—called the “indirect action” effect of the radiation. Cell repair mechanisms are able to correct most of the damage. However, if there is irreparable damage, or if damage is repaired incorrectly, the typical result is delay of the cellular division and commonly death of the cells by an inability to complete the division process properly (Bond, 1980).

The radiation output of an x-ray machine is described in terms of its intensity at a given technique setting (i.e., 5 R/mAs at 70kVp measured at 100cm from the source). The unit of “R,” for “roentgen,” describes the ionization per unit mass of air, which is produced by the x-rays. It is the traditional unit of “exposure” and is the quantity of x or gamma radiation needed to liberate 2.58*10^-4 coulombs of charge per kilogram of air. Measurements in air, therefore, are given either in terms of “R” or in terms of “C/kg.” The
“rad” is the traditional unit used for the “radiation absorbed dose” (i.e., the amount of energy from either particles—electrons, positrons, alphas, betas—or photons—any wavelength—which is absorbed by a unit mass of any material). In the International System of Units (SI), the unit used is the Gray (Gy), where 100 rads = 1 Gy. For water and muscle, the roentgen and the rad are approximately equivalent across the range of diagnostic x-ray energies, and the units are often used interchangeably in describing “entrance skin exposures (ESE)” and “skin dose” from x-ray units. However, in bone, the photoelectric absorption is much higher for photon energies below 100keV, producing a conversion factor of approximately 4 rads per R for the absorbed dose in bone from diagnostic x-rays. The “rem” or “Sievert (Sv)” in SI units (100 rem = 1 Sievert) is a measure of the amount of biological damage per unit dose possible from the radiation. As an example, heavily charged particles such as alphas have about 20 times more potential for producing biological damage than does x-ray radiation. For the types of radiation used in medical imaging (x-rays in diagnostic radiology, gamma rays and light charged particles in nuclear medicine), the “weighting factor” is 1, and rad and rem are equivalent.

Early radiation workers and patients encountered erythema (reddening of skin), epilation (loss of hair), nausea, diarrhea, and other acute effects as extensive as necrosis and loss of fingers and hands, from using the first radiation sources. Their exposures were usually hundreds of times greater than typical exposures today (National Council on Radiation Protection and Measurements [NCRP], 1989). Major equipment advances (such as development of the image intensifier tube used in fluoroscopy) have enabled radiologists to obtain high quality images using far less radiation. As an example, the radiographic entrance dose for an AP lumbar spine x-ray has dropped from 1,430 mrad (14.3 mGy) in 1920 to 220 mrad (2.2 mGy) in 1990 (Gray, 1996). Study of the biological interactions has determined that the principle risk in humans is from radiation damage to dividing cells in the proliferative organ systems. Radiation protection measures are, therefore, aimed at avoiding or reducing potential damage to those cell types in particular.

Damage to stem cells means that the re-supply of mature functional cells is temporarily absent, and organ function will be impaired. Cellular depletion in bone marrow and in the circulating lymphocyte count can be detected at doses of 50 rads (50 cGy; Bond, 1980). Such effects are closely monitored following radiation accidents (such as at Chernobyl) and during radiation therapy treatments of tumors in cancer patients, if the sensitive organs are near the target tumor. The dose-effect curves for acute effects (seen within days or weeks of the radiation dose being received) demonstrate a clear threshold dose below which the body can cope with the level of cell death and no explicit damage is seen (bone marrow suppression, skin burns). Above the threshold dose the severity of the damage increases with dose” (Walker, 1995, p. 3).

It is important to note that the tissues receiving most of the radiation dose (either direct or from scatter) during a videofluoroscopic swallow study (VFSS) are fairly resilient. “Skin has an enormous capacity to repair radiation damage so that very large doses are needed in order to produce threshold changes. On the basis of repair of sublethal damage alone, the threshold single dose may be increased by a factor of 5 if given over a long period” (Mettler, 1980, p. 88). The Strandquist plot used as a guide in radiation therapy was an early application of this knowledge (developed in 1944), showing that a single dose of 1,000 rads (10 Gy) would produce skin erythema, but if the therapy was spread out in three fractions per week over a period of 60 days, then skin erythema would not result until a cumulative dose of over 3,000 rads (30 Gy) had been administered (Hall, 1988). As a more practical guide for the radiation levels used in fluoroscopy, this type of an acute skin effect has only been reported following complicated interventional procedures with very long times on (100 minutes or more—and at high exposure rates (>20R/min), or with extended cine and VCR-fluoroscopy times when use of the recording mode bypassed the system’s rate limits. However, transient erythema has
been observed at 200 rads (2 Gy; American College of Radiology [ACR], 1995). As a caveat, late effects of irradiation—such as skin cancer—are not considered to have a specific dose threshold. Rather, the probability of the biological effect occurring increases with dose. On a historical note, “Skin cancer was common in early x-ray workers, principally physicists and engineers who worked around accelerators before radiation safety standards were introduced” (Hall, p. 387).

Considering other nearby tissues in VFSS, “the esophagus demonstrates considerable ability to recover from sublethal damage with extensive cellular re-proliferation. Lung tissue is more radiosensitive than skin. However, the lung also has a large capacity for repair of sublethal damage, which enables it to tolerate a high level of fractionated irradiation without necrosis, although function is impaired...” However, “irradiation of the spinal cord may result in myelopathy, the probability and time of onset being dose dependent. ...The eye is generally considered to be one of the more sensitive tissues with damage to any part of the eye being possible. The most sensitive structure is felt to be the lens. Growing cartilage is also one of the more radiosensitive tissues. The normal thyroid is a non-proliferating tissue,” so radiation effects may occur after many years (Mettler, 1980, pp. 87-88).

In some cells, chromosome breaks may have occurred which lead to changes in the inheritable characteristics of the cell, basically a mutation of the cell line. Note that these changes are not different from the types of aberrations seen in normal, un-irradiated cells (i.e., they are not new types). Instead, there is an increase in the rate of production of normal cell mutations. Thus, although “radiation carcinogenesis has been recognized since about the year 1900; and genetic effects since 1927” (Bond, 1980, p. 26), there is not a method to distinguish between radiation-induced cancers and mutations, and those from any other cause. At low doses (<100 rads), it is difficult or impossible to demonstrate an increase even in large exposed populations. Hence, indirect methods from acute high-dose data (interpolation or extrapolation with human data; use of animal data and models) must be employed to provide estimates of possible effects at low doses and low dose rates.

Most of the populations studied for stochastic effects—cancer induction and hereditary defects—received high doses at high dose rates (i.e., Japanese atomic bomb survivors). It is believed that a low radiation dose and low rate of exposure is proportionally less damaging. A dose rate effectiveness factor of 2 is used as a conservative estimate in extending the risk assessments from high dose rates to low levels of radiation (<0.2 Gy or 200 rem; Faulkner, Jones, & Walker, 1995). The effect of radiation is less if the dose is delivered over a long period of time (days, months, years). This concept is part of the basis for restricting the occupational dose received in any one year by an individual working with radiation. The report by the U.S. National Academy of Sciences Committee on Biological Effect of Ionizing Radiation (BEIR) III estimated the increased risk of cancer occurrence for 1 rad/year of low linear energy transfer (LET) whole body exposure for ages 20-65, to be 2% of normal expectation (Bond, 1980). Probabilities of fatal cancers were estimated at 0.01% per rem (1% per Sv) in the 1970s, and at 0.05% per rem (5% per Sv) for models in the 1990s (Gibbs, 1996). In epidemiological studies, incidences in excess of those for a comparative group are interpreted with care as being evidence of somatic radiation effects—and are often re-interpreted and debated extensively as to what they actually represent. For example, the U.S. Bureau of Radiological Health conducted a follow-up study in 1961 of 36,000 patients who were treated for hyperthyroidism either by surgery or with radioactive iodine (I-131). The study was precipitated by reports of patients developing leukemia after receiving the I-131 radiation. However, the analysis actually found a slightly higher incidence of leukemia in the surgery patients (though not significantly different statistically). It was noted that the incidence in both groups was one and a half times higher than the incidence expected for the general population. A comparison of just the I-131 group with the general population would have indicated that the leukemia was a definite late radiation effect. Instead, by looking at both groups, it was concluded that patients with hyperthyroidism have an enhanced risk of leukemia, regardless of the method of treatment. However, data from the Japanese A-bomb survivors, and from patients receiving higher doses of external beam radiation, indicate that the possibility of some effect cannot be completely ruled out, and in
nuclear medicine, it is assumed that there is a small additional risk of leukemia from the radiation, but that it is more than counterbalanced by the therapeutic benefits (Hall, 1988).

Also problematic for the models is that “nearly all available dose-response relationships are generally based on whole-body irradiation. Diagnostic x-ray procedures constitute partial body irradiation and only a small portion of the body at that” (Bushong, 1980, pp. 110-111). Studies of cancer induction and cancer mortality among radiologists and radiation technologists provide a good reference for other medical personnel who may also work occasionally with radiation, but whose groups are not yet large enough for a separate epidemiological study. There was a significant shift in cancer death rates among British radiologists between those who entered the profession before 1921 (75% higher than their colleagues) and those after 1921, whose death rate was comparable to that of other physicians (Yalow, 1996). Radiology technologists at the Cleveland Clinic in 1953 received between 5-15 rem/year (note this is above the current annual limit of 5 rem for radiation workers), and Army radiology technologists trained during WWI are estimated to have received 50 rem or more during their service. A 29-year follow-up study of these technologists “revealed no increase in malignancies when compared with a control group of similar size consisting of army medical, laboratory or pharmacy technologists” (Yalow, p. 1). This is an encouraging comparison for individuals following the newer radiation protection measures and working with more tightly regulated equipment.

The organ doses of particular significance in diagnostic radiology are: the lens of the eye; the bone marrow, gonads, and the fetal dose received as part of medically necessary imaging of pregnant patients. Short summaries of the concerns are given below:

- **Lens Dose**: possible radiation induced cataracts following a latency of 20 yrs, but this effect also has a threshold of 200rads.
- **Marrow Dose**: leukemia as a result of exposure to hematologic stem cells, particularly in bone marrow.
- **Gonad Dose**: males are more sensitive than females as there is less overlying tissue to shield the organ. Minimal spermatocyte depression may occur at 5rads; transient infertility at 100rads, sterility at 500rads. Diagnostic x-ray exposures are therefore more of a concern for possible genetic effects than direct fertility problems.
- **Fetal Dose**: the *in utero* fetus is more sensitive to radiation exposure than postnatal infants; and exposure is essentially a whole body dose for the fetus—more likely to amplify suspected late somatic and genetic effects.

The take home message is: “Radiation is similar to all other potentially hazardous and lethal agents, in that at high doses it can produce organ injury, illness and death” (Bond, 1980, p. 21).

**Fluoroscopy Risks**

Fluoroscopy is well established as an extremely useful diagnostic tool for examining kinetic events, which are best evaluated by viewing an entire sequence of events/actions. To study an action such as swallowing, a recording is made that can be reviewed later in addition to the real-time interaction. The ability to do so from the images captured directly from the fluoroscopic image intensifier tube, rather than a film-screen spot recording, has greatly reduced the x-ray exposures required to obtain these images. Film-screen spots typically require 3-4 times the exposure of digital photospot systems (Schueler, Dixon, & Wilson, 2001). It should be noted that adherence to equipment exposure rate limits is not required by most state regulatory agencies during recording of fluoroscopic images. Although there has been significant discussion of not allowing video recording (as opposed to film recording) to be included in this exception (ACR, 1992), current state wording rarely distinguishes between the methods. However, FDA regulation does limit the exception to recording using the fluoroscopic pulsed mode (and either photographic film or a video camera) for equipment manufactured after May 19, 1995. Additionally, although the older 35mm cine camera typically required 10-15uR/frame at the image intensifier (corresponding to 10-15mR/frame patient entrance exposure; Lin, 1992), most newer fluoroscopic equipment is able to meet the current recommendation of 1-3uR/video frame for the default dose setting (ACR 1995), which does greatly alleviate much of the earlier concern.

Clinicians most commonly use the standard GI suite equipment of a diagnostic radiology department
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to clinically evaluate swallowing disorders. However, interventional radiology suites and C-arm units are also used. Several different personnel may assist in the exam (speech pathologist, nurse, physician, radiation technologist), and the person actually operating the equipment may vary according to training and facility and state licensure requirements for medical utilization of ionizing radiation. All need to be aware of the radiation used in the procedure, the amount absorbed by the patient, the amount absorbed by those involved in the procedure, and the relative risks of radiation exposure.

The x-ray beam produced by a standard medical X-ray tube is composed of a broad spectrum of high energy photons, with the specific energy of these x-rays determined by the technique chosen and the tube target material. The very lowest energy photons produced are not penetrating enough to provide useful diagnostic information and are, therefore, removed from the beam using filters placed within the x-ray tube and collimator housing. These filters reduce the patient’s skin dose.

During a diagnostic x-ray examination, the radiation beam is collimated so as to be incident on a relatively small portion of the body—just that area that needs to be imaged. Those tissues and organs, which are in the path of the useful beam, will absorb energy through interactions with the primary x-rays. Many of these interactions produce scattered photons, most of which will be absorbed by other nearby tissues; but, others scatter into regions outside the primary field. Thus, tissues and organs not in the primary beam will also absorb radiation, but receive a much smaller dose. “In general, less than 5% of the radiation incident on the patient will exit the patient to interact with the image receptor. The radiation that exits the patient includes both primary and scatter” (Bushong, 1980, p. 111). By collimating the beam closely, the exposure of non-involved tissues and organs is reduced. Some of the more energetic scattered photons will exit the patient. In general, these are the ones, which result in exposure to the other individuals in the room. The ratio of scattered x-rays to incident x-rays increases proportionally to the surface area exposed. At 70kVp, this ratio increases from 2.5 to 16 when opening a field from 10x10cm to 35x43cm (Robinson, 1995). Other sources of scatter are from x-rays that completely penetrate the patient, but which then scatter off the cover of the image intensifier. All fluoroscopy systems are designed such that when the collimators are fully open, the primary beam is completely intercepted by the image intensifier. This is also verified on a periodic basis. This feature protects the users of the equipment from unintentionally being within the path of the beam. If the operator’s hand is visible on the image, then it is in the primary beam. Under-table tube systems also have significant scatter from the primary beam hitting the underside of the table. These systems are provided with a lead shield cover over the opening for the film bucky, which must be pulled into position during fluoroscopy. C-arm type systems do not have this method of reducing scatter from the table.

The most common fluoroscopic procedure is the upper GI abdominal study using barium contrast. This is a much thicker portion of the body than the neck and, therefore, will require more penetrating radiation to form images. The exam uses a technique with higher kVp and higher tube current than used for pharyngeal videofluoroscopy. The radiation output of the system measured at the skin entrance point is typically 3-6 R/min during an abdominal study. Since the neck is relatively thin in most cases and, therefore, does not have much attenuation, radiation output rates are closer to 1R/min in most situations. If a higher resolution image is needed, a higher mA may be used to reduce the noise in the image; but, this will increase the patient dose. Improvements in image enhancement capabilities have enabled lower doses to be used for most fluoroscopic procedures.

In the late 1980s and early 1990s, a fluoroscopic mode known as “boost mode” became available on many C-arm and angiography systems. The purpose is to enable the physician operator to greatly increase the number of x-rays being emitted in fluoroscopy in order to improve the resolution/reduce the noise for a particular image. It was meant to be used only for brief periods (i.e., a “boost”). And in fact, the extra heat load on the tube does limit it since this mode uses a much higher tube current (mA). It produces a significantly higher radiation output, in fact, which many physicians used to the very low currents of fluoroscopy failed initially to fully appreciate. The current limit for high dose rate mode is set at 20R/min, but some of the C-arm units in use before the limit was put into effect.
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had measured outputs between 30-40R/min, and some of the cath lab equipment was capable of outputs of more than 100R/min. Systems with a boost mode are required to have both a separate trigger method (such as a two-step switch) and an audible alert (usually a very fast beep) when the high rate mode is activated. This mode is unlikely to be necessary for swallowing studies, but clinical situations can vary, so it is important for all to recognize when the radiation output of the machine may change dramatically and to take appropriate measures to reduce the doses received.

The development of last image hold was a major improvement in fluoroscopic imaging capabilities. Being able to “freeze” the last part of the live signal transmission to the monitor once the exposure pedal is released, enables the physician to see the view more clearly without having to use continuous exposure. This allows significant reduction in exposure to the patient—and in scatter to the operator. Systems now implement this feature automatically. Digital image capabilities have also improved significantly. Angiography systems have “real-time” subtraction techniques, in addition to interpolation, and low-pass/high-pass filter software (such as edge enhancement).

The standard GI room in the USA has a tube under the table and the image intensifier (II) tube above. The table is moved to a 90° vertical rotation for standard VFSS. Radiation penetrates the radiolucent tabletop prior to entry to patient—note the table will assist with removing lower energy photons, but may require technique settings to be higher to obtain sufficient penetration. For these situations, skin entrance exposure values measured by physicist/consultant will be at table top. For over-table radiographic exposures, the measurement is made at the tabletop (American Association of Physicists in Medicine, 1990). The exposure varies from being nearly linearly at 50 kVp to kVp² at 120kVp (Bushong, 1980).

“Actual skin dose in fluoroscopy is much more difficult to estimate because the radiation field moves and sometimes varies in size during the procedure. If the field were of one size and stationary, the skin dose would be directly related to exposure time…. estimate maximum fluoroscopic skin dose at 2.0 rads/MA-min” (Bushong, 1980, p. 113). Estimate of absorbed dose to a selected organ is based on these measured entrance skin exposures (ESE).

The Conference of Radiation Control Program Directors conducts a program known as the Nationwide Evaluation of X-Ray Trends (NEXT). This program periodically gathers data for a very common radiographic procedure, such as screening mammography, CT of the head, or the standard chest x-ray, and

Doses and Comparative Procedures

“As early as 1908 concerns were raised over the safety of patients exposed to prolonged or excessive fluoroscopy. Questions raised by both sides centered on the importance of the dynamic physiological changes observed in fluoroscopy as opposed to static anatomical data from films alone” (Gagliardi, 1999, p. 1).

Reports of erythema from cardiac catheterization procedures became commonplace again in the late 1990s and prompted concern with radiation doses in medical procedures. The FDA has identified 5 fluoroscopic procedures, which carry a risk of skin injury: cardiac radiofrequency ablation, vascular embolization, transjugular intrahepatic portosystemic shunt (TIPS), and percutaneous endovascular reconstruction (Marx, 1996). All of these procedures typically use much longer fluoroscopic times (sometimes as much as 30 minutes or an hour of fluoroscopic exposure) than the mean for VFSS (~4min, according to the recent survey of Radiation Awareness and Practices; Steele & Murray, 2004).

The most common specification of dose in x-ray procedures is entrance exposure or skin exposure. The output intensity of an x-ray tube is measured using ion chambers for at least one standard technique and expressed in mR/mAs. For an over-table radiographic exposure, it is calculated for a distance approximating the source-to-skin distance for the particular exam (i.e., abdominal or chest or extremity). For under-table exposures, the measurement is made at the tabletop (American Association of Physicists in Medicine, 1990). The exposure varies from being nearly linearly at 50 kVp to kVp² at 120kVp (Bushong, 1980).

“Actual skin dose in fluoroscopy is much more difficult to estimate because the radiation field moves and sometimes varies in size during the procedure. If the field were of one size and stationary, the skin dose would be directly related to exposure time…. estimate maximum fluoroscopic skin dose at 2.0 rads/MA-min” (Bushong, 1980, p. 113). Estimate of absorbed dose to a selected organ is based on these measured entrance skin exposures (ESE).
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in 1991 surveyed practices for an upper GI exam fluoroscopy. Data were collected on the equipment available, the techniques used, the dose rates for the abdominal exam (both typical and maximum), image quality, and viewing systems. At the time, VCR recording was only available in about 10% of the facilities surveyed. For a hospital-based practice, the median exposure rate for the upper GI exam was 5.0 R/min without contrast and 7.9R/min with the high-attenuation barium sulfate contrast agent (Conway, 1994). These values are for an abdominal rather than a neck study, but the concept that administration of the contrast agent will cause an increase in the technique needed, and thus the resultant exposure, should be noted.

In a standard GI suite, exposure to the physician standing next to the II tube is typically less than 5mR/hr when the protective lead curtain is in place, and ~30mR/hr when it is removed. Scatter from C-arm type configurations can be significantly different, as indicated here by scatter measurement for a bi-plane neuroradiology suite and a special procedures room (Chakra-borty & Boone, 1991).

1. Scatter in bi-plane neuro suite— data for lateral tube position
   100kVp, 0.5mA fluoro technique; 23cm thick phantom
   Operator standing at side of table next to tube—
   Operator’s waist: 400mR/hr
   Operator’s eyes: 220 mR/hr
   Operator’s foot: 100mR/hr
   1 meter: 300mR/hr

2. Scatter in Special Procedures suite with C-arm (not specified as under or over-table tube)
   89kVp, 2mA fluoro technique; 14cm thick phantom
   Operator standing at side of table near C-arm (0.43m distance)—
   Operator’s waist: 500mR/hr
   Operator’s eyes: 180 mR/hr
   Operator’s foot: 400mR/hr
   1 meter: 110mR/hr

Note that these rates are quoted per hour— for the typical 4min exposure during a VFSS, the scatter received by these operators would be on the order of 6.6 – 33 mR for the procedure, and most likely less, since the body part being exposed is smaller—both in area and thickness, which also means that a lower technique will be used, and have less potential scatter.

To put these values in perspective, consider the natural “background” radiation, which all individuals are exposed to every day. These include cosmic radiation from the sun, radioactive minerals in the earth’s surface, trace amounts of natural radioactive elements absorbed by the body, and sometimes inhalation of radon released from rocks and soil. Background radiation levels vary with altitude and location, but excluding the highly variable radon exposure, are generally between 60 and 130 mrem per year (Tolbert, 1991). Thus, if the scatter was 15mR/ procedure, it would be ~1/6 of the annual background exposure received. If the individual performed 4/week or as many as 200/year, could receive as much as 3 rem—still well below the regulatory limit of 5 R/year. However, these measurements are for the operator, and other individuals, particularly ones who are able and conscientious about stepping back from the tube and patient, would receive far less. Most fluoroscopic radiology technologists receive an average of 1 rem per year or less from their occupation (J. Nelson, personal communication, August 6, 2004).

Reducing Risk

As Tolbert (1991, p. 4) points out, the regulatory limits on exposure levels for the public, also known as maximum permissible dose, “are set well below levels at which bioeffects are seen to occur. Recommended limits for occupationally exposed individuals are set at ~10times that for a member of the general public. This is because occupationally exposed individuals are monitored and subject to requirements of a radiation safety program. Patients undergoing radiation exposures for medical and dental purposes are not subject to general public and radiation worker protection limits. Instead, they are subject to two rules of reason. One is the matter of medical necessity. Does the patient’s physician need information best obtained by the imaging procedure? The second is the principle of keeping exposure ‘As Low As Reasonably Achievable,’ i.e. ALARA….In all instances, ALARA means limiting exposures to that needed to achieve the purposes of the procedure.”

Although the occupational exposures limit for a radiation worker is 5 rads per year, it is typically 1 rad/
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The highest occupational exposures of diagnostic radiology personnel occur during fluoroscopy procedures and portable radiography. Since during fluoroscopy, personnel exposure is directly related to beam-on time, care should be maintained to ensure efficient imaging procedures. This is of particular note when several repetitions of exposure sequence may be required, as in VFSS due to the need to study the ability of the patient to swallow various different consistencies and volumes of material. Special interventional procedures tend to use longer fluoroscopy times than in general radiography, frequently must be done in the absence of a protective curtain on the II tower, and extensive use of cine or another recording method.

Individuals present in the procedure room may receive scatter radiation. As discussed above, most scatter is generated within the patient, but may be limited by the use of small fields-of-view (i.e., tight collimation to region of interest). Standard radiation protective measures—lead aprons, use of remote foot pedals for fluoroscopy activation, and others—provide significant reduction in personnel exposure from the scattered radiation. Gloves should always be used if it is necessary to hold the patient or have hands near the beam. However, most gloves only partially block the primary beam (they would be far too cumbersome to use if designed to fully block it), so care should still be exercised to keep the hand out of the beam as much as possible. Monitoring badges record external radiation exposure and are useful for alerting personnel to any unexpected exposures. The designated dosimeter practice in the USA is to wear it at the shirt-collar level, outside the apron.

A common question is whether a pregnant technologist can work in fluoroscopy. The basic answer is yes, assuming that the worker and other staff involved in the procedure are using good work habits to reduce unnecessary exposures. Pregnant radiation technologists and nurses usually continue to work in their positions throughout the entire pregnancy. Specific task assignments may or may not be changed, depending on local hospital policy. It is, however, useful to review how the basic tenements of radiation protection—time, distance, and shielding—may be improved upon in relation to the specific role the individual has during the procedure. In particular, the pregnant individual should not hold patients and should remain at the maximum possible distance during all exposure (NCRP, 1989). The inverse square law for radiation exposure means that even a single step further away from the x-ray tube and patient provides a significant reduction in exposure to the individual. Similarly, use by the operator of any dose-reducing features available on the equipment, such as low dose or pulsed mode, will lower both the patient dose and the scattered radiation.

A separate fetal badge will be issued for declared pregnant radiation workers. Current regulations require a written statement, including the best estimate of date of conception, be submitted to the facility’s Radiation Safety Officer (RSO)—not a phone call or casual comment. The total dose to the fetus is required to be kept less than 0.5rem over the gestational period. Note that this is a tenth of the annual 5.0R value allowed for the radiation worker mother, and a 20th of the standard 10R value for discussing potential radiation effects. Since it is for monitoring radiation exposure to the fetus, it is important that it be worn at the abdomen, under the apron. With good radiation protection practices and proper positioning of the badge, it is unlikely that the badge reading will ever approach the recommended maximum permissible dose (Marx, 1996; Robinson, 1995). The worker’s normal whole body badge is still to be worn at the collar, outside the apron. Since the badges are designated and tracked differently, it is important to never switch the badges, nor to use the whole body badge for monitoring fetal dose rather than obtaining a separate one. The trigger limits for concern on a fetal badge are calculated for exposure over a 9-month period instead of 12 months. When the badge is issued, the RSO or his/her designee will typically meet with the individual to discuss recommended precautions and to answer any questions the worker has regarding the radiation risks to the fetus.

Summary

For the patient, always balance relative risk to the medical need for the diagnostic information. The patient will be the individual receiving the highest radiation dose and is trusting that the clinicians involved will be working to keep it at a minimal amount. So what is minimal? It needs to be enough to answer the
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medical question, but not more. Using pulsed fluoroscopy, collimation, and fewer recorded images; maintaining x-ray tube distances; and having efficient procedures assist in reducing the patient’s dose.

For radiation workers in the room, the predominant radiation exposure will be from scatter. If hands are placed directly in the beam during exposure, the individual will also have direct radiation to the extremity. Extremity doses are of less concern, although still monitored, as hands do not contain highly sensitive organs. However, individuals still need to be concerned with long-term radiation damage to skin. Acute damage typically shows up 2-3 weeks after radiation exposure. It may look like a sunburn (erythema) and develop later to an ulcer and necrosis, depending on total dose absorbed. But this is a fairly high value, requiring greater than 200Gy of radiation, which are not values typically encountered within the swallowing videofluoroscopy exam.

The principle of ALARA—as low as reasonably achievable—is in practice by all institutions using medical radiation devices, to further lower doses by refining protocols and practices to reduce potential exposures. This is in addition to federal mandates on safety protections required of the equipment manufacturers. The practice of ALARA includes such simple measures as limiting the number of people in the room during the procedure and providing protective lead aprons for those personnel who are present. Two-piece apron sets are useful for sharing the apron weight between shoulders and hips. Wrap-around style aprons are recommended for individuals involved in interventional procedures. For overhead tube configurations (as some C-arm positions), the scattered radiation levels close to the table may be 20 times higher than for an under-table configuration (Robinson, 1995). Backscatter from the primary beam will be much higher to the operator’s upper-torso and neck in this situation. Scatter is also higher if the patient’s skull is in the beam. Thyroid shields are recommended for these procedures (Marx, 1996). The thyroid shield, in addition to covering the gland, shields some of the bone marrow and fills in the area above the collar of the apron—a situation of particular help if the apron is large for the individual. Lead-lined gloves are recommended for anyone needing to have their hand at the edge of the beam during exposure or for procedures that require palpation. In general, the person’s hand should not be in the beam, because at 90kVp, 85% of the primary beam will penetrate the first layer, thus exposing the hand (Wagner, 1992). Additionally, the lead glove and a person’s hand will attenuate part of the radiation being received by the II tube, and the system may boost the tube current to compensate for the fewer photons if a significant amount is blocked.

Regular checks and preventive maintenance of equipment should be followed to verify proper performance and exposures as expected for technique factors chosen. In all cases, the collar badge worn by the person operating the fluoroscopic system is a good indicator of both equipment performance and work habits. Specific “feedback about this dose may reinforce work habits that have a beneficial effect on the patient as well as the worker” (Marx, p. 26).

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References


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Must a Radiologist Be Present During a Videofluoroscopic Swallowing Study?

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Introduction

The videofluoroscopic swallow study (VFSS) is currently the most widely used procedure for the management of patients with oropharyngeal dysphagia. The primary purposes of the procedure are to assess oral, pharyngeal, laryngeal, and cervical esophageal swallow dynamics and examine the impact of compensatory swallowing strategies on function. Martin-Harris, Logemann, McMahon, Schleicher, and Sandidge (2000) demonstrated that the procedure can play a powerful role in patient management by providing immediate and clinically relevant information critical to the development of the dysphagic patient’s plan of care, including referrals to other specialties, mode of intake change, and diet grade change. Other investigators have demonstrated the value of the VFSS in reducing the cost of care and speeding recovery (Logemann, 1997) and in guiding treatment planning (Wright & Jordan, 1997). Although the procedure is used primarily for evaluation of swallowing function, structural abnormalities often are revealed and may be the cause of the swallowing dysfunction. Currently, most VFSS are performed in an environment with both a speech-language pathologist and radiologist present. The speech-language pathologist focuses on swallowing physiology and functioning, and the radiologist makes medical diagnoses relative to anatomy. This collaboration provides a comprehensive assessment of swallowing as it relates to both physiology and anatomy and ensures better probability of an accurate diagnosis and positive outcome.

Although presence of a radiologist during a VFSS is today’s standard level of practice, more and more speech-language pathologists are being faced with the decision to perform a VFSS in an environment without a radiologist present. Members frequently contact ASHA and Division 13 to ask whether or not a radiologist must be present in the examination room when a VFSS is being conducted.

The reason why a radiologist may not be available varies. In some cases, the hospital may be a small facility and there is not a full-time radiologist available. In other cases, the radiologists are unable or unwilling to attend a VFSS because of scheduling conflicts or reimbursement issues. In most cases, a radiology technologist is present to prepare the patient for the study and operate the fluoroscopy equipment. Members often contact ASHA asking for regulatory or policy references to support the their desire to have a radiologist present during the VFSS or, conversely, to confirm that a radiologist need not be present.

Role of the Speech-Language Pathologist

The role of the speech-language pathologist in the VFSS does not change whether or not a radiologist or radiology technologist is present. In either case, the speech-language pathologist is the professional who determines the study protocol based on the individual patient’s needs, presents the liquids and food, and implements therapeutic strategies, all while assessing swallowing physiology and functioning. The speech-language pathologist ultimately makes recommendations regarding oral diets, the need for intervention, and the type of intervention that is appropriate for the patient. Depending on the setting and whether the patient is an inpatient or outpatient, the speech-language pathologist conducting the study may be the treating clinician or may make recommendations to be considered by the patient/family, physician, and the treating clinician and implemented accordingly.

When a radiologist is not present during the radiographic procedure, the speech-language pathologist assesses and comments on swallowing physiology and function only. Documentation must not discuss medical diagnoses.
ASHA’s Position

What is ASHA’s view on the practice of conducting a VFSS without a radiologist? The 2004 document, Guidelines for Speech-Language Pathologists Performing Videofluoroscopic Swallowing Studies, states that “current ASHA policy does not require that a radiologist or other physician be present in the examination room during the completion of a VFSS by a competent SLP” (ASHA, 2004, p. 84). The document goes on to note that a collaborative relationship between the speech-language pathologist and radiologist, in which the former focuses on swallowing physiology and functioning and the latter attends to anatomy and relevant medical diagnoses, is best practice. When a radiologist is not present, scope of practice limitations come into play. The speech-language pathologist cannot render medical diagnoses and, therefore, if questions arise during the study that may require a medical opinion, the speech-language pathologist must refer the patient for further testing. In many facilities, the radiologist is not present during the live study, but reviews the tape at a later time. This is also considered acceptable practice by ASHA. Readers are directed to the 2004 guidelines document (www.asha.org) for further information relative to the need for a radiologist’s presence during the VFSS procedure. The document, developed by a working group supported by Division 13, offers practitioners training guidelines to obtain competency in performing the VFSS and addresses frequently asked questions from practitioners regarding how to appropriately proceed in conducting a safe and/or ethical VFSS procedures.

Other special considerations addressed in the document include legal and ethical considerations, liquid viscosity issues, considerations for pediatric patients, pharyngoesophageal considerations, radiation safety, and the effects of medication on swallowing ability. These frequently faced issues are discussed relative to current standards and best practices in the field of speech-language pathology.

Position of the ACR

The American College of Radiology (2001) published the ACR standard for the performance of the modified barium swallow in adults. The guideline is available on the ACR Web site at www.acr.org (in 2004). The ACR notes that the study should be “performed by or under the supervision of a licensed physician at the site and interpreted by a physician with <listed> qualifications” (p. 152). The ACR document also addresses the role of radiology technologists in the performance of the modified barium swallow (MBS). ACR “approves the practice of certified and/or licensed radiologic technologists performing fluoroscopy only as a positioning or localizing procedure and then only if monitored by a supervising physician who is personally and immediately available” (p. 152). Other issues addressed by the practice guideline include indications for the MBS; qualifications and responsibilities of personnel; specifications of the examination; documentation; equipment specifications; and quality control and improvement, safety, infection control, and patient concerns. The ACR also has a practice guideline for the performance of esophagrams and upper gastrointestinal examinations in adults.

Other Considerations

Guidelines, such as those published by ASHA and ACR, are education tools designed to assist practitioners in providing appropriate, effective, and safe care. They are not inflexible rules or requirements of practice or a legal standard of care. It is expected that practitioners follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient in the delivery of care. An approach that differs from a practice guideline does not imply that the approach is below the standard of care. Numerous factors may require that the practitioner adopt a different course of action than that described in the guideline, including limitation on available resources (i.e., radiologist availability). It is recommended that practitioners who employ an approach substantially different from a practice guideline document the rationale in the patient record.
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Medicare Position

The Medicare position on the role of the radiologist is especially relevant, because most third-party payers examine Medicare policies and often adopt them. Currently, there is no national Medicare policy regarding the presence of the radiologist. Local intermediaries and carriers have the right to independently determine a wide range of coverage policies and this radiologist issue is one of them. Carriers process claims submitted by physicians and private practitioners, while intermediaries pay claims from health care facilities. These organizations are known as Medicare Administrative Contractors (MACs). MACs serving the same region may or may not be owned by the same parent corporation.

Each MAC may develop local coverage determinations (LCDs) to address requirements for coverage of certain types of treatments. Policies regarding the presence of a radiologist or physician during the VFSS would appear in an LCD. Excerpts from dysphagia LCDs are reproduced below. One can see that the radiologist’s role is a bit ambiguous and that “physician” is never substituted for “radiologist.”

The videofluoroscopic swallowing study is a collaborative study that can be performed by the speech-language pathologist and radiologist. (AdminaStar Federal, 2003, p. 4; CMS-B, 2000, p. 6; TriSpan, 2004, p. 6).

Elsewhere in the Mutual of Omaha LCD it is stated that

the MBS should be conducted and interpreted by a radiologist with the assistance and input from the physician and/or speech pathologist (CMS-B, 2000, p. 8).

TriSpan (2004) presents an additional statement in its LCD that applies to all instrumental assessments as a whole. It states that instrumental assessments used for diagnostic purposes

should be performed and interpreted by an otolaryngologist or other physician with training in these procedures, or may be performed by SLPs under the direct supervision of an otolaryngologist or other physician with training in these procedures (p. 4).

It is important for the reader to know that the Medicare Benefit Policy Manual states that “The physician supervision requirement is generally assumed to be met where the services are performed on hospital premises” (CMS-C, 2003, p. 8).

ASHA encourages state associations to meet with the medical director or medical review manager of their regional MAC to present reasons why the presence of a radiologist is not necessary. The objective of such meetings would be to remove VFSS radiologist attendance from current dysphagia LCDs or to prevent inclusion in a draft LCD. (Note: see URLs for LCDs at the end of this article.) The ACR position statement cited above may be a helpful reference to support this position. Other convincing data that should be presented is the extremely low incidence of any type of complications during VFSS studies conducted without the presence of a radiologist. There is also a statement by the Centers for Medicare and Medicaid Services (CMS) related to mobile VFSS services that is in our favor. Regarding mobile VFSS, the CMS Restricted Medicare Fraud Alert (CMS-A, 1998, p. 1) states:

Performance of these services by technicians without physician intervention is not appropriate because the safety and efficacy of the procedures may be compromised.

The above statement is helpful in that it refers to physician intervention rather than radiologist intervention.

Speech-language pathologists and the MACs should understand that while Medicare pays the hospital an average of $188 for the technician and overhead costs of the VFSS, the radiologist is paid only $27 for professional services. This amount may be reasonable for the cost of a radiologist to view the video and write a medical interpretation while referencing the speech-language pathologist’s report, but certainly does not cover the cost of a radiologist’s presence during the VFSS.

It cannot be understated that the power of your regional MAC has been enhanced since CMS removed national medical review guidelines for therapy services in June of 2003. The MAC is now guided only by little more than the concept of “reasonable and necessary.” This presents a good opportunity for state speech and hearing associations to flex their muscles. ASHA staff has often identified local Medicare speech-language pathology and dysphagia coverage policies that have been adopted because of local physician clout or simply because another MAC had
already implemented a specific policy. In other words, MAC coverage policy compared to national CMS policies is often based on less sophisticated information and development processes. Thus, there is an opportunity for lobbying the MAC based on published data and other information.

**State Regulations**

State licensure regulations for speech-language pathologists or state or local laws governing the radiology department should also be considered before conducting a VFSS without the presence of appropriate medical personnel. It is always advisable to consult with these regulatory bodies before performing a VFSS independently.

**Implications for Mobile VFSS**

ASHA is currently organizing a multi-organization appeal of several LCDs that prohibit coverage of mobile VFSS by excluding nursing home settings. A component of the appeal is the assertion that a physician or a radiologist should be required in the mobile unit. Most mobile VFSS units with which ASHA is familiar do employ a physician on site, but usually not a radiologist.

The LCDs in question state that “CMS has concerns that the use of such services in a mobile setting lacks evidence of medical effectiveness” and that “Questions of patient safety have yet to be resolved for this type of procedure when performed in a nursing home” (Louisiana Medicare Draft Policy, 2001, p. 2). ASHA has found no CMS documents that make such assertions. We have seen local Medicare coverage restrictions in the past that have been justified using similar broad quality of care concerns. However, the motivation for the restrictions was actually concerns about over-utilization rather than quality of care. In the case of mobile VFSS, there was a firm in the mid-1990s that was sanctioned by CMS for orchestrating many unnecessary mobile VFSS studies prompting a cautious attitude concerning this coverage.

**Conclusion**

More and more speech-language pathologists are being faced with the decision to perform a VFSS without a radiologist present. As outlined above, many factors must be considered when making this decision. Ultimately, the speech-language pathologist must not only be competent in performing the VFSS, which is true regardless of whether a radiologist is present or not; but, he/she must also feel comfortable being the primary professional responsible for conducting this procedure. Being aware of the issues involved in making this decision will assist the speech-language pathologist in negotiating how the VFSS will completed in his/her facility.

**Dysphagia LCDs**

Several Web addresses will assist readers in locating dysphagia LCDs that may have been issued by regional MACs.

Go to the CMS site ([www.cms.hhs.gov/mcd/search.asp](http://www.cms.hhs.gov/mcd/search.asp)) and follow these steps:

1. Select “LOCAL” policies; De-select ARTICLES; Select FINAL policies or DRAFT policies
2. Select geographic area OR name of intermediary/carer
3. Select key word or CPT code (i.e., DYSPHAGIA or 92526)

Sometimes a more accurate search is accomplished by going directly to the MACs’ Web site and then locating draft and final LCDs, usually listed under Medical Policies or Medical Review Policies. Your region’s MAC Web site may be identified by going to the CMS site ([www.com.hhs.gov/contacts](http://www.com.hhs.gov/contacts)) and following these steps:

1. Select state
2. Select type of organization (scroll to “fiscal intermediary” or “carrier”)
3. Type of contact—select “ALLCONTACTTYPES”

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References


Balance Between Radiation Risks and Obtaining a Complete Videofluoroscopic Swallow Study in Pediatric Patients

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Comprehensive evaluation of swallowing in infants and children frequently requires the use of instrumental procedures following a thorough clinical evaluation to answer specific questions through objective information (Arvedson & Lefton-Greif, 1998; ASHA, 1990, 1992, 2000, 2001; Benson & Lefton-Greif, 1994; Langmore & Logemann, 1991; Logemann, 1993). For example, children with neurologic impairment are particularly likely to have no observable clinical indications (e.g., coughing or choking) when they aspirate while eating and drinking. Thus, speech-language pathologists and other professionals need additional objective information to assist in determination of safety and efficiency for oral feeding and of the relative contribution that various structures or physiologic processes contribute to feeding and swallowing difficulties (e.g., Arvedson, Rogers, Buck, Smart, & Msall, 1994; Barbiera et al., 2004; Fung, Khong, To, Goh, & Wong, 2004; Taniguchi & Moyer, 1994). It is critical to define risks for aspiration and delineate whether those risks appear closely related to the process of swallowing liquid, food, or secretions and/or whether the child may be at greater risk due to gastroesophageal reflux, especially extraesophageal reflux with direct aspiration of acidic contents. For the purposes of this article, the focus is on videofluoroscopy, particularly the issues surrounding radiation safety and the comprehensive objective examination of swallowing.

The clinical assessment is likely to be inadequate in a high proportion of pediatric patients with a variety of etiologies of their swallowing/feeding problems. Inaccurate or incomplete information will render recommended treatment strategies to be ineffective at best and potentially harmful at worst (Arvedson & Brodsky, 2002). Most children are referred for videofluoroscopic swallow studies (VFSS) because they demonstrate clinical presentations that suggest dysphagia or they have diagnostic conditions that are associated with increased risk for dysphagia (ASHA, 2000). Major diagnostic categories associated with feeding and swallowing disorders in infants and children include, but are not limited to: neurologic, anatomic and structural, genetic, psychosocial and behavioral (oral deprivation). In addition, feeding and swallowing disorders may be secondary to systemic illness and to resolved medical conditions (iatrogenic; Arvedson & Brodsky, 2002; Arvedson & Lefton-Greif, 1998).

Videofluoroscopy continues to be the primary imaging technique for detailed dynamic assessment of oral, pharyngeal, and upper esophageal phases of swallowing (e.g., Jones, Kramer, & Donner, 1985; Palmer, Kuhlmeier, Tippett, & Lynch, 1993; Siebens & Linden, 1985). Thus, radiation safety must be a high priority, particularly for infants and young children who may need to undergo many x-rays in their first few years of life, and indeed, throughout their life time. Although it is not possible to state definite limits for duration of exposure to fluoroscopy, nor the exact intensity of the beam, it seems reasonable to make very careful considerations as to the purpose and the potential yield of pertinent information for decision making purposes.

Two rules of reason can be applied to patients undergoing radiation exposure for medical purposes (Tolbert, 1996):

1. Medical necessity considers the importance of specific information required from an imaging procedure. This rule is consistent with an emphasis on defining the questions to be answered while considering the referral of each individual for a VFSS.

2. The principle of keeping exposure levels “as low as reasonably achievable” (ALARA) means limiting exposures to that amount needed to achieve the purpose of the procedure in all instances.

Safety Considerations

Reports of harmful effects of radiation have typically been obtained at relatively high radiation levels. Risks of harm with doses typically used during diagnostic x-ray procedures cannot be defined precisely, and it is likely that they cannot be determined
Radiation Safety for Speech-Language Pathologists

with certainty (Beck & Gaylor, 1990). Dose is defined as the amount of radiant energy that gets into tissues of the body. There is never a “zero dose” to use for comparison, since all persons encounter variable amounts of natural environmental radiation.

Although specific upper limit levels of radiation cannot be determined, it makes sense to minimize the radiation dose to the patient and to all other persons in the radiology suite. The goal is to make each examination result in the highest benefit at the least risk to patients, parents, and professionals (Table 1 on page 24). Speech-language pathologists should have major input as to the time of radiation exposure, since they plan the examination and should have the questions well defined to obtain maximum information in minimum time. Other variables are not easily controlled by speech-language pathologists (e.g., the radiographic equipment in the radiology suite, collimation, or the dose decisions).

Equipment related factors may have a greater influence on patient dose than technique variations by radiologists (e.g., Martin & Hunter, 1994). The method used for recording images is the major influence on radiographic doses. The gain of the image intensifier and the exposure factors selected by the automatic exposure control are the most important factors in determination of doses for fluoroscopy. Insertion of extra tube filtration along with the removal of the antiscatter grid can reduce the total energy imparted from pediatric fluoroscopy by a factor of more than four when automatic exposure control is used (Nicholson, Thornton, & Akpan, 1995), although removal of the grid accounted for up to 40% of the reduction, while the addition of 0.7 mm steel filtration was found to account for the rest. They concluded that the reduction in image quality is considered to be small and the diagnostic information unimpaired with the filter in place for all contrast pediatric examinations. The use of shorter screening times, careful collimation of the beam to the area of interest, and reduction in the number of radiographs taken are all useful in reducing radiation dose (Beck & Gaylor, 1990). In most instances, the videotape or digital image is the record, and no radiographs are needed.

The amount of radiation exposure varies among fluoroscopy units. It is impossible to establish specific guidelines for acceptable exposure per minute of fluoroscopy to each patient. Each fluoroscopy unit should be calibrated to measure the radiation level.

Length of the Exam

Every swallow study should be monitored to conform to radiation safety standards and to minimize the duration of the study as well as the amount of surface area exposed. Guidelines of Radiation Safety issued by the National Institutes of Health (NIH) recommend 5 rem/year for all diagnostic procedures after age 18 years and 3 rem to any tissue in a 13-

### Table 1. Considerations for radiation safety during pediatric videofluoroscopic swallow studies. Adapted from Beck and Gaylor (1990) and from Arvedson and Lefton-Grief (1998, p. 77).

<table>
<thead>
<tr>
<th>Persons</th>
<th>Factors Involved in Protection</th>
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</thead>
<tbody>
<tr>
<td>Patient</td>
<td>Check equipment before bringing patient into radiology suite</td>
</tr>
<tr>
<td></td>
<td>Use gonadal shielding appropriately</td>
</tr>
<tr>
<td></td>
<td>Avoid panning</td>
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<tr>
<td></td>
<td>Limit “fluoro-on” time; intermittent as much as possible</td>
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<tr>
<td></td>
<td>Collimate x-ray field to areas of focus</td>
</tr>
<tr>
<td></td>
<td>Use magnification only when critical to findings</td>
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<td></td>
<td>Consider repeat examinations with caution</td>
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<tr>
<td>Pregnant patient</td>
<td>Lead apron of 0.5 mm lead equivalence wrapped around at waist level</td>
</tr>
<tr>
<td>Personnel</td>
<td>Shielding (e.g., lead apron, thyroid collar, lead gloves, lead glasses)</td>
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<td></td>
<td>Radiation monitor badge (per institution radiation safety guidelines)</td>
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<td></td>
<td>Limit “fluoro-on” time</td>
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<tr>
<td></td>
<td>Try to stay as far away from the radiation source as possible</td>
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<tr>
<td></td>
<td>Note: any condition resulting in higher dose to patient increases dose to others in the suite</td>
</tr>
<tr>
<td>Pregnant personnel</td>
<td>Lead apron of 0.5 mm lead equivalence of wraparound type</td>
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</table>
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week time period. Swallow studies are limited to a dosage of between 270 to 660 mrad/study, with a 10% reduction in that level recommended for children less than 18 years of age (Sonies, 1991). Differences in body size are great from infancy to 18 years of age. A question is raised as to whether the recommendation for a 10% reduction is sufficient. Careful planning will ensure that no unnecessary time is spent with the child under fluoroscopy. Most studies with infants can be completed in 60 to 90 seconds, and in some cases the examination can be performed in less time. Limiting exposure time and shielding of the reproductive organs should be routine in all examinations (Sivit, 1990).

Beck and Gaylor (1990) also stated that initial diagnostic studies should rarely exceed 2 minutes of “fluoro-on” time. Even with the most difficult older patient, clinicians are urged to keep total fluoroscopy time to no more than 2 to 3 minutes with rare exceptions. Therapeutic maneuvers that include change in head position and/or testing with different bolus consistencies and volumes take longer. Thus, therapeutic maneuvers can be used, albeit sparingly, when it is anticipated that such maneuvers are important in decision making for optimal recommendations.

Collimation

Collimation, or coning, is accomplished by reducing the diameter of the beam through shifting relationships of internal sliding lead plates. There are three primary benefits: sharper image, diminished dose, and reduced background scatter (Benson & Lefton-Greif, 1994). With magnification in older equipment, the dose is likely increased by 50% to 100%, but there is less increase with newer equipment. The fluoroscopic tube needs to encompass the lips anteriorly, the palate superiorly, the posterior pharyngeal wall posteriorly, and the bifurcation of the airway and the esophagus inferiorly. Just as with adult examinations, the field should be coned to keep the ocular lens out of the field and to minimize radiation exposure to the difficult to shield thyroid gland. Radiologists are constantly challenged by active, moving children and frequently must follow that moving target with the imaging field. Magnification at the level of the larynx and at the entrance to the esophagus is important when aspiration is suspected, but magnification is not recommended routinely for all images. The one practical way to minimize the dose to this area is to limit the fluoroscopy time. Repeat follow-up studies should be minimized, with medical necessity a primary consideration (Arvedson & Lefton-Greif, 1998).

Protective Measures

Radiation safety must also be considered for the caregiver, speech-language pathologist, radiologist, and technician when present (Table 1). In contrast to examinations with older children and adults who can follow verbal directions without additional verbal and gestural cues and can feed themselves, infants and young children typically must be fed by an adult, either a primary caregiver or a clinician. It is often preferable to have a parent feed the child since that is likely one of the best ways to have a cooperative child, although there are instances in which a child will perform better when a parent is not in the room. The presenter of the food and liquid needs to wear lead protection as do the radiologist and the speech-language pathologist. These protective garments include a lead apron, thyroid shield, and in some instances, leaded surgical gloves and protective glasses. Lead aprons should fit well and be tested at regular intervals for effective protection.

When the primary caregiver is a woman who may be pregnant, it is recommended that another person who can safely be in the radiology suite accompany the child to be a familiar feeder as needed during the study. Personnel who are pregnant and must be present for the study should use a wraparound lead apron of 0.5 mm lead equivalence (Table 1). Specific guidelines for protection may vary among institutions and are to be followed by speech-language pathologists and others involved in the examination.

Questions

When a clinician is planning a VFSS, conderating the following questions may be helpful.

1. Does the infant/child have a diagnosis that is associated with increased risk for dysphagia?

2. Has the infant/child shown ability or readiness to participate in this examination? Some areas to consider related to readiness include medical stability and the ability or willingness to cooperate on the basis of observations during a clinical feeding and swallowing evaluation. The child’s age, cognitive status, and developmental skill levels are factors in
planning the examination and in interpreting the findings.

3. Can you do a VFSS when an infant has never taken oral feeding or when a child has been NPO for some period of time? The simple answer is “no,” although there may be exceptions.

4. How much food or liquid does a child need to take in order to be ready for a VFSS? There is not a universally agreed upon amount nor duration of oral practice prior to scheduling for VFSS. This is a much needed area for research. Establishment of practice guidelines across institutions would appear to be a desirable goal. Further discussion is found in the section covering preparation for a radiographic swallow study.

5. Is there a standardized protocol for pediatric VFSS? No, unfortunately, although it also is important to be flexible to consider individual patient differences. Increased standardization is encouraged, not only for description of findings, but also for research related to a variety of areas (e.g., outcomes and efficacy of treatment).

6. Should parents bring food and liquid from home for out patients? Is there value in having the child’s utensils, cups, and favorite toys? In most institutions, parents are encouraged to bring familiar food and utensils, as well as favorite toys or blankets or other objects that help to make a child comfortable and cooperative.

Preparing Children

A child is ready for a VFSS when the study may help change the feeding routine or program, when the child has demonstrated some interest in oral feeding, and when the child has had some prior pleasurable experience with tastes. It is not uncommon for an infant or child to be referred for a radiographic swallow study before ever tasting any liquid or food by mouth or following a prolonged period of NPO status. Physicians, parents, and therapists may want to know whether it is safe to introduce taste practice or to try oral feeding. They believe that the VFSS is the first step in that determination. However, clinical experience has shown that barium impregnated food or liquid is not a desirable introduction to oral feeding. The results of examinations under such circumstances may be difficult to interpret, especially if the child is fussy or uncooperative. Exposure to radiation is not to be undertaken lightly. In most instances, the radiology suite is not the place where a child should receive an introduction to tasting food or liquid.

A child with limited or no oral intake may need some time and practice to get ready for a VFSS. It is challenging to get a child ready for a VFSS when the child does not eat by mouth because of concerns for aspiration when swallowing. The difficulty is that the child needs to take some amount of food or liquid to see if swallowing is now safe. These small tastes may put a child at risk for problems associated with aspiration. It is because of this risk that a child should be medically stable before starting tastes that in turn will lead to readiness for the examination that will provide objective findings. Such findings will aid in planning the safest and most efficient ways for each child to meet nutrition and hydration needs with oral feeding to whatever extent is possible.

Children need to take enough food or liquid for swallows to be observable on a VFSS. The exact amount of food or liquid may vary. For example, the speech-language pathologist and parents report that a child demonstrates interest when presented with about ¼ tsp puree on a spoon 5-6 times within a brief practice session. Their observation reveals that this child would keep tasting and likely would eat a full ounce (30 cc), if allowed to continue. However, given the history, developmental status, and questionable airway protection during the practice sessions, additional objective information is needed before increasing volume of oral feeding or expanding food/liquid choices (Arvedson & Lefton-Greif, 1998). It is the impression of this writer that one of the most common reasons for uninterpretable findings is that the examination was done when the child was not prepared appropriately. The second most common reason is a child’s fussiness during the examination. Radiographic studies under these circumstances are not only uninterpretable in content, they are also likely to be prolonged when attempts are made to present additional boluses with a goal to get at least one or two swallows at a time when the child is not crying. The end result will be excessive radiation time to the child and findings that are of limited value in the development of a comprehensive feeding/swallowing plan.

Personnel Requirements

Typically, the VFSS is conducted by a radiologist and a speech-language pathologist (ASHA, 1992,
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In occasional instances, another physician who is knowledgeable regarding radiation safety and techniques may be involved. An x-ray technologist may also assist. The speech-language pathologist must demonstrate appropriate knowledge and skills to ensure that every decision made will benefit each patient who undergoes a VFSS (ASHA, 1990, 2001). In some institutions, a qualified speech-language pathologist and a radiology technician conduct the study as a team with consultation as needed from the physician. However, with high risk infants and children, a physician should be directly involved in conducting this diagnostic study. The radiologist operates the fluoroscopic unit, identifies structural abnormalities, and when necessary, terminates a procedure that has unacceptable risks to the patient’s health and safety.

The American College of Radiology (2001) has developed a practice guideline for the performance of the modified barium swallow (MBS/VFSS) in adults. The practice guideline emphasized that the MBS should be performed only for a valid medical reason and with the minimum radiation dose necessary to achieve an optimal study. The indications for the radiographic swallow study for adults are essentially the same as for infants and young children. Qualifications and responsibilities of personnel are spelled out for the physician, radiologic technologist, and speech-language pathologist. In addition to specific education and training related to indications for and performance of the MBS/VFSS as well as ASHA’s Certificate of Clinical Competency, it is recommended that the speech-language pathologist have knowledge of the patient’s medical condition and current cognitive and mental status. Other recommendations that are applicable to examinations with infants and young children include:

1. Rapid spot films are not adequate for functional assessment. Spot radiographs are not needed for all patients.

2. If aspiration occurs, the patient’s response to the aspiration and ability to clear the aspirated materials are noted. In addition, the patient’s response to protective and therapeutic maneuvers should be assessed whenever possible.

3. Method of examination will vary based on patient history, clinical questions to be answered, and findings during the study. The study may need to be terminated prematurely if the patient demonstrates severe aspiration (e.g., aspiration below the sternal notch) and does not respond to protective or therapeutic maneuvers.

4. When aspiration does occur, the effect of alterations to limit or prevent aspiration may be assessed. Alterations may include changes in head and neck position, body position, or other special maneuvers. Additional consistencies of food or liquid may be assessed, usually based on the usual and expected diet.

5. Documentation: Comparison to previous examinations should be included when relevant, particularly when the study is performed to follow up previously demonstrated abnormalities. Each institution should develop a policy on retention of videotapes or digital images consistent with applicable state or federal policies.

Wright, Boyd, and Workman (1998) found a paucity of data available regarding the radiation dose to patients during pharyngeal fluoroscopy. Parents and patients often express a general concern that fluoroscopic imaging modalities are associated with significant radiation exposure. A Dose-Area Product (DAP) Meter was used by Wright and colleagues to record dose data to calculate the effective dose to patients. It is well recognized that some tissues are more susceptible to radiation damage than others. The calculation of effective dose from DAP readings accounts for differential tissue vulnerability by the use of tissue weighing factors to relate partial body radiation to the risk to the individual as a whole (International Commission on Radiological Protection, 1991). Radiation detriment associated with pharyngeal videofluoroscopy was found to be well within acceptable levels (Wright et al., 1998). Such calculations have not been reported for infants and young children. Multiple variables make the determinations difficult. These variables include differences in environmental exposure to radiation over time, duration of examinations and precise tissue that is exposed, and likely individual differences in tolerance of the equivalent doses of radiation. Radiation exposure of the thyroid gland and orbits of the eye is always the greatest concern as those structures appear more sensitive to radiation than some other body parts. However, to the knowledge of this writer, there are no accurate definitive predictors of potential for thyroid cancer in adulthood as a result of videofluoroscopic procedures. The risks are most likely related to interactive variables.
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It is hoped that, in the future, predictions related to the physiology of swallowing will be possible without requiring children to be subjected to radiation. However, in the meantime, speech-language pathologists are urged to plan each VFSS very carefully to obtain useful information in minimal time with cooperative children. They are also encouraged to carry out research that will result in improved inter-judge agreement of findings from videofluoroscopic swallow studies. Wilcox, Liss, and Siegel (1996) found that presence of aspiration was the only reliable finding among judges reviewing videotapes of examinations. In order for the results of examinations that subject infants and children to radiation exposure, it is important that the examination have strong validity and reliability.

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References


ASHA. (1990). Knowledge and skills needed by speech-language pathologists providing service to dysphagic patients. *Asha, 32* (Suppl. 2), 7-12.


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Radiation Safety During the Videofluoroscopic Swallow Study: The Adult Exam

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Introduction

Radiation safety for the dysphagia clinician conducting a video-fluoroscopic swallow study (VFSS) is an important topic that deserves our full professional attention. The basic scientific principles underlying radiation safety guidelines are not difficult to understand and should be taught during graduate dysphagia course work and reinforced in the workplace. Such educational recommendations and guidelines are now appropriately incorporated in at least two Special Interest Division 13 documents (ASHA, 2003, 2004); however, individual clinician consideration of these recommendations is difficult to determine. During a presentation on this topic during the 1998 Ohio Speech Language and Hearing Convention, a colleague and I conducted an informal polling of clinicians that revealed poor and inconsistent knowledge of basic radiation safety across the 50 participants (Kelchner & Waddell, 1998). The explanation for this was related to the number of graduate programs that had a designated dysphagia course at that time. In addition, formal training in radiation safety in the workplace was reported to be inconsistent, with some facilities providing comprehensive education and monitoring, while others did substantially less. Unfortunately, current conversations with clinicians suggest that a variation in levels of understanding and practice of radiation safety persists. The dedication of the current issue of Perspectives to this topic is timely and needed. In addition, the information and survey results reported in this issue are likely to influence future education in this area.

Safety for the Speech-Language Pathologist

Beck and Gayler (1990, 1991) wrote one of the first articles on the subject of radiation safety during the VFSS that targeted speech-language pathologists as its audience. Motivation to include that article in Dysphagia was the concern that some professionals in the fluoroscopy suite had little to no knowledge of ionizing radiation or its potential biological effects. The Dysphagia editors indicated that the nature of radiation or “invisible light” (i.e., radiation is neither seen nor felt) created a cavalier attitude towards its potential dangers, particularly in individuals such as speech-language pathologists who were not adequately trained (Donner & Jones, 1990). Although the literature refers to the need for alternate instrumental examinations to reduce our reliance on radiographic imaging (Bastien, 1993; Langmore, 2001), little else has been published that specifically addresses radiation safety and occupational exposure issues of the speech-language pathologist during the VFSS.

Articles have been published regarding radiation safety and occupational exposure during fluoroscopy for other types of radiation workers who conduct fluoroscopic procedures, such as radiology technologists, radiologists, physician specialists, and nurses (Krueger & Hoffman, 1992; Starchman & Hedrick, 1993). Important data regarding safety and occupational exposure information are available in those articles; however, direct comparisons to the situation of the speech-language pathologist during the videofluoroscopic swallow study may not always be appropriate. For example, where the speech-language pathologist stands and the frequency of exposure (number of exams conducted per week) usually differs from the other professionals in the suite.

The Comprehensive VFSS and Basic Precautions

The fundamentals of conducting a thorough VFSS in order to obtain needed diagnostic information and to identify interventional strategies for dysphagia management are well documented (American College of Radiology [ACR], 2001; ASHA, 2003, 2004; Jones, 2003; Logemann, 1998; Murray, 1999; Perlman, Lu, & Jones, 1997). The realities of implementing those fundamentals can often be challenging. Factors—including busy schedules, difficult patients, and time limits—encouraged by radiology personnel
and imposed by radiation exposure can individually or collectively influence the completeness of a study. Following is a discussion of issues related to conducting a comprehensive VFSS while implementing the tenets of radiation safety.

**Time**

The scientific principles that underlie radiation safety issues yield three basic categories of precautions that all radiation workers should observe. The first of these is reducing the time of personal exposure to ionizing radiation whenever possible (Beck & Gayler, 1990, 1991; Brateman, 1999; Bushong, 1997; Dowd, 1994; Mayhesh, Gayler, & Beck, 2003). Therefore, the first consideration in radiation safety is the rationale for conducting (or repeating) a study. The clinical utility of the VFSS is well documented and widely accepted as the preferred instrumental examination for describing and quantifying a swallowing disorder (Logemann, 1998; Martin-Harris, Logemann, McMahon, Schleicher, & Sandige, 2000). As a result, most hospital-based practices require clinicians to perform several evaluations every week. Scrutinizing the appropriateness of referrals is an important programmatic function that can ensure that time spent in fluoroscopy is necessary. Recently published Guidelines for Speech Language Pathologists Performing Videofluoroscopic Swallowing Studies (ASHA, 2004, p. 78) list six key points as the basic rationale for performing a VFSS:

1. To identify normal and abnormal anatomy and physiology of the swallow
2. To evaluate the integrity of airway protection before, during, and after swallowing
3. To evaluate the effectiveness of postures, maneuvers, bolus modifications, and sensory enhancements in improving swallowing safety and efficiency
4. To provide recommendations regarding the optimum delivery of nutrition and hydration
5. To determine appropriate therapeutic techniques for oral, pharyngeal, and/or laryngeal disorders
6. To obtain information in order to collaborate with and educate other team members, referral sources, caregivers, and patients regarding recommendations for optimum swallow safety and efficiency

As well, repeat studies may be required to assess progress or change in swallowing function over time. Accomplishing these objectives based on an examination that keeps radiation exposures As Low As Reasonably Achievable (ALARA, Brateman, 1999) required efficient planning based on experience and a thorough knowledge of normal and abnormal swallowing physiology. Times for typical VFSS are reported to range from 0.5-8 minutes (Mahesh et al., 2003; Wright, Boyd, & Workman, 1998).

After examining key anatomic structures at rest and typically starting in the lateral projection, every exam should include use of multiple trials of increasing volumes of thin liquids, pureed, solid, and mixed consistencies. If possible, once an area/event of interest is identified (e.g., timing of airway protection during the pharyngeal phase), the radiation beam can be collimated to focus on that anatomic region. Collimating the beam reduces the volume of scatter and can improve the image contrast (Brateman, 1999). If the radiologist or technician does not collimate, it is certainly appropriate for the clinician to make that request. Panning or continuous beam-on between swallows increases the amount of radiation emitted during a study and should be kept to a minimum.

Introduction of compensatory strategies, therapeutic maneuvers, sensory enhancements, and altered consistencies to facilitate swallowing efficiency and reduce or eliminate aspiration are the essential elements of a thorough examination but can be time consuming and increase beam-on time. Although guidelines are available (ACR, 2001; ASHA, 2004), the exact number, type, and sequence of bolus trials that determine the duration of any given study are dictated by what observations are needed to answer the clinical questions driven by that patient’s history and study findings. As possible, preparing for options such as orienting the patient and even practicing certain maneuvers (head turn, breath hold maneuvers, Mendolsohn maneuver) ahead of beam-on time may reduce the duration and thus the amount of radiation emitted during examination.

Fluoroscopic imaging to screen bolus clearance during the esophageal phase of swallowing is also an important component of a thorough examination, but adds to the duration and amount of radiation emitted. Since this technique typically involves panning the esophagus and does not require the clinician to be
close to the patient, this is a time when the clinician should definitely step back or stay behind a secondary barrier (technologist station).

Another method of reducing exposure is through staff assignment and rotation. Most hospital departments have competencies that must be achieved prior to a clinician’s independently performing the VFSS. Some departments require all staff to become competent, while others have a core group of clinicians who develop a dysphagia specialty. In the interest of radiation safety, the more clinicians within a department who are competent and capable of performing a VFSS, the less occupational exposure any one clinician will experience. This becomes especially important when clinicians need to cover caseloads for colleagues who are ill, on vacation, pregnant, or on extended leaves. Whether a declared pregnant speech-language pathologist continues to perform VFSS may be dictated by departmental (Radiology and/or Speech Pathology) policy or be the personal decision of the clinician. In some cases, departments include only a small number of employees, of whom several may be of child-bearing age, so it may be necessary for pregnant workers to continue to be available to conduct a study. If this is the case, close consultation with the facility’s radiation safety officer is required. Additional shielding precautions and dosimetry monitoring outside and under the leaded apron are absolutely necessary (Brateman, 1999; Bushong, 1997; Dowd, 1994). Fetal doses are reported to typically not exceed dose exposure limits when declared pregnant workers implement stringent safety guidelines (Brateman, 1999; Krueger & Hoffman, 1992).

When appropriate, using alternative instrumental examinations such as fiberoptic endoscopic evaluation of swallowing (FEES), particularly as an interval examination for the patient who requires multiple studies, may help reduce overall exposure for both the dysphagia clinician and the patient.

Distance

The second fundamental precaution—increase your distance from the source of radiation—is based on the Inverse Square Law. This means the quantity of radiation to which one is exposed is inversely proportional to the square of the distance from the source. In other words, stand back from the source to reduce radiation exposure. If the distance from the source of radiation is doubled, radiation exposure is cut in half (Brateman, 1999; Bushong, 1997). The patient is the source of radiation for the dysphagia clinician. As the beam hits the patient, some of the radiation is absorbed by the patient’s tissue, some passes through, and some interacts with the patient’s tissue and changes direction. The larger (or thicker) a patient is, the greater the amount of radiation needed to penetrate the tissue. Radiation that hits tissue, interacts, and changes direction is known as scatter (Beck & Gayler, 1990, 1991; Brateman, 1999). Performing a VFSS with most patients requires that the clinician stand in the primary scatter (which fans directly out from the patient).

If the patient has sufficient cognitive, linguistic, and postural control, the clinician should allow the patient to drink/eat the measured boluses independently and step back several feet behind the equipment or even a secondary barrier during beam-on time. Orchestrating the step back, request to the patient to drink/eat, and imaging can be accomplished with clear communication between the speech-language pathologist and radiologist. However, many patients present with challenges that increase the duration and amount of radiation needed to complete a thorough study. Patients who are medically fragile, difficult to position, and/or cognitively/linguistically impaired typically require direct assistance with feeding or positioning that can keep the clinician close to the patient during fluoroscopy. For these situations, most radiologists will be extremely careful when turning the beam on, allowing the clinician to remove his/her hand from the area and step back. But timing is key and important events can be missed (e.g., poor oral bolus control or premature bolus spillage with aspiration) if the beam is off. Taking additional steps back after the beam is on (and the monitor is being watched) will help reduce the amount of radiation exposure. The fluoroscopy suite should be organized to allow for easy clinician maneuverability during the study.

If continuous imaging is required to observe prolonged phases (e.g., increased oral phase in patients with Parkinson’s or Alzheimer’s disease), clinicians should step back while observing function. Students or clinicians in training who are present in the
fluoroscopy suite (and are not presenting the bolus trials) should stand back from the patient or behind a secondary barrier. If clinician in training is feeding the patient, the supervising clinician can stand back or behind the secondary barrier as long as communication and the view remain clear.

**Shielding**

The third fundamental precaution for radiation safety is proper shielding. Aprons with sufficient lead or equivalent composite material to filter x-rays to the radiosensitive organs of the body (e.g., bone marrow, thyroid, esophagus) are always worn (Brateman, 1999). If available, the coat or wrap around style is preferred to avoid back exposure in the event the clinician turns or bends during the fluoroscopy exam (though the apron back may have less lead content). Since the function of the aprons is to filter or attenuate x-rays, periodic inspection of their condition is important. Aprons in disrepair will be less effective in attenuating x-rays. Pregnant workers are always required to wear wrap around (coat style) aprons of the highest lead content (Bushong, 1997).

The thyroid and upper esophagus are highly radiosensitive organs and should always be protected with a thyroid shield properly fitted around the neck. The thyroid is not protected if the shield is loose and rests below it. Glasses with lead content protect the highly radiosensitive lens of the eye. The biological effect of radiation on the lens of the eye is cataract formation. Lead lined gloves can be used to protect the clinician’s hands, if they must remain close to the patient during the exam (Beck & Gayler, 1990, 1991; Brateman, 1999). However, the clinician’s hand, gloved or ungloved, should never be in the beam. In fact, use of lead content gloves in the beam is not recommended (V. Morris, RSO University of Cincinnati, personal communication, August 18, 2004). Most modern fluoroscopy equipment now has automatic control. Thus, the beam will detect the increased density of any type of material, including lead content gloves, and automatically increase the intensity and dose rate emitted. If the clinician’s patient population is such that there is a chance for repeated hand exposure, the facility’s radiation safety officer (RSO) should be contacted regarding close (ring) dosimetry monitoring and additional radiation safety precautions.

Finally, when the situation permits (high level functioning and mobile patients) the clinician should stand behind a secondary barrier (e.g., radiology tech control station or similar shield) thus reducing cumulative exposure and offsetting the times when close-in work is required.

**Equipment and Dosimetry**

Issues regarding equipment safety and dosimetry monitoring fall within the domain of the facility RSO and/or the radiology department. Radiation safety policies regarding occupational safety and equipment maintenance are regulated by federal (Nuclear Regulatory Commission), state (Departments of Health/radiation protection), and local regulatory agencies. Personnel occupational exposure monitoring is accomplished by dosimetry. The dysphagia clinician may wear up to three dosimeters (collar, waist under the apron, ring). Consistent placement, care, and use of personal dosimeters are important for accurate readings. The RSO cannot monitor exposure levels if dosimeters are not turned in on a regular basis. Each clinician should know who monitors dosimeter readings and generates monthly or quarterly reports.

**Summary**

In addition to specific strategies used in the fluoroscopy suite, radiation safety for the dysphagia clinician conducting the VFSS relies on basics: education, maintaining awareness, excellent clinical skills, and common sense. Education regarding ionizing radiation, its biological effects, use in diagnostic medicine, and safety precautions should be part of the graduate dysphagia coursework and continued at the employment setting. Speech-language pathologists are the only professionals in the fluoroscopy suite who may not have had formal radiation safety training. However, the radiologist or radiology technician may assume they know more than they do. Lack of radiation safety discussion among the different professionals within the suite does not diminish its importance.

Every state has specific regulations governing radiation workers and occupational exposure, and every medical facility has a radiation safety officer who monitors employee exposure through dosimetry readings/reports. The RSO is often the individual in charge on ongoing safety education (Orders & Wright,
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2003) for the medical facility, but it remains the responsibility of the speech-language pathologist to be informed and take a leadership role in maintaining his/her own level of understanding.

Attaining and maintaining excellent clinical skills in dysphagia is a radiation safety fundamental. The ability to plan, implement, and interpret a comprehensive VFSS is key to efficient use of beam on time and the subsequent radiation exposure of both the clinician and patient. Inappropriate, incomplete, or sub-optimal exams may be of limited value and possibly not worth the radiation exposure. Influences beyond the skills of the clinician can also influence truncated or incomplete studies. Clear, positive, confident communication with the radiologist and radiology technician is always desirable and in the best interest of an effective study. Understanding and recommending the use of videoendoscopy as an alternate, adjunct, or interval dysphagia evaluation is also a means to reduce personal and patient radiation exposure as well yield additional and complementary information regarding swallowing function.

Maintaining awareness of radiation safety issues is essential, but harder than it sounds. In the routine of a busy day, responding to the ever increasing referrals for this exam, and lack of (evidence of) apparent danger within the fluoroscopy suite, it is easy to forget the particulars. In addition, unless there is an accidental overexposure, the biological effects of environmental or occupational radiation exposure are late meaning they are not evident for years (Beck & Gayler, 1990, 1991). Such effects are not likely to occur from conducting the VFSS if basic radiation safety guidelines are followed, but research on this specific topic is needed and overdue.

Over the past 20 years, speech-language pathologists have become the acknowledged experts in swallowing and swallowing disorders. As a profession, we have worked hard to establish credibility to maintain a permanent role in dysphagia diagnosis and management. Given that our collective knowledge is based largely on dynamic radiographic imaging, it is high time that as a profession we become equally competent regarding issues of personal radiation safety.

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References


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