JOURNAL OF NUCLEAR MEDICINE 7:219-236, 1966

Detection of Bone Lesions with the Strontium-85 Scintiscan

Gerald L. DeNardo, M.D.,[1] Joseph A. Volpe, Captain, M.C.[2]

Palo Alto, California

INTRODUCTION

Since Treadwell, Low-Beer, Friedell and Lawrence (26) demonstrated concentration of ^{45}Ca and ^{89}Sr in bone tumors, radioisotopes have been used in the study of bone metabolism and disease (3,4,9-12,14,17,18,25). Calcium (^{45}Ca) and strontium (^{89}Sr) are pure beta emitters and difficult to detect externally. An ideal radioisotope for scintiscan studies of bone should emit an easily detected and collimated photon, have a half-life long enough to permit shipping and short enough to keep radiation exposure to a minimum, be nontoxic, be readily available as an inexpensive pharmaceutical, and concentrate in bone (16). Strontium (^{85}Sr) presently best fulfills these requirements. It is a pure gamma emitter with an easily detectable photon of 0.51 MeV and a physical half-life of 64 days.

The metabolism of strontium in man was studied using strontium-85. Fifty-five percent of the intravenous dose is excreted in the stool and urine within five days (3). Most of the remainder is deposited in the skeleton, which cannot readily distinguish between calcium and strontium in trace amounts (4).

Fleming, McIlraith and King (13) reported positive ^{85}Sr scintiscans in patients with metastatic bone disease and fractures. Charkes and Sklaroff have shown that this technique is useful in the detection of bone metastases before the lesions become evident roentgenographically (6-8,23,24). The scintiscan can detect bone disease earlier than the roentgenogram, because it depends only on an accelerated mineral accretion rate, whereas, 30 to 50% of the bone calcium in a local area must be altered before radiologic changes are evident (7). An increased concentration of ^{85}Sr represents increased calcium deposition. Osteo-

[1]Chief, Radioisotope Service, Veterans Administration Hospital, Stanford School of Medicine, Palo Alto, California.

[2]Resident, Internal Medicine, Fitzsimons General Hospital.

blastic and osteolytic lesions can be detected, since both may be associated with increased osteoblastic activity and accelerated calcium turnover (7). Recent studies have disclosed positive scintiscans in a variety of bone diseases including primary bone tumors, bone metastases, fractures, osteomyelitis, Paget's disease, and hyperostosis frontalis (8,16,21,22).

The purpose of this report is to present further experience with the ^{85}Sr bone scintiscan in a variety of bone lesions. Some preliminary remarks will be made on the use of the whole-body radiostrontium skeletal survey as a screening procedure.

METHODS AND MATERIALS

A total of 164 ^{85}Sr bone scintiscans in 50 patients on 59 occasions was performed in the radioisotope laboratory of Fitzsimons General Hospital between February 1, 1964, and April 15, 1965. In adult patients 50-100 μC and in children 25-50 μC of ^{85}Sr were administered intravenously. The patients were scanned 24-72 hours after injection. A Picker Magnascanner with a three inch NaI crystal and a 19 hole collimator was used. A dot scan on teledeltos paper and a photoscan on x-ray film were performed on each patient, since both methods of recording were found to be valuable.

Correct interpretation of the bone scintiscan requires knowledge of the normal sites of increased strontium concentration. There is increased radioactivity at the ends of the long bones, around the acetabula and sacroiliac joints, and in the vertebral, carpal, and tarsal bones. These sites of increased radioactivity are present in adults and children, although they are more prominent in the latter. Comparison of symmetrical areas of the skeleton or of vertebrae above and below the suspicious area assists in interpretation. If the pelvis or lumbar vertebrae are to be scanned, the bladder, rectum and colon must be evacuated because strontium is excreted in the urine and feces. A cathartic was administered to the patient the evening before and an enema the morning of the scan. The patient was requested to empty his bladder immediately before the scan.

The bone scintiscan must be carefully performed by a knowledgeable technician or physician to obtain good results. The following methods were used with the Picker Magnascanner:

The detector was moved by hand over the area in search of an obvious site of pathologically increased radioactivity as determined by an audible count rate meter signal. The CRT voltage was set at 1000V to give 2.2 x-ray film density units for the *hot spot*. This usually resulted in a CRT voltage of 700V or 0.4 x-ray film density units for normal bone. The background cutoff for the teledeltos paper record was set 10-20% below the *hot spot* count rate.

Frequently, no definite site of CRT increased radioactivity was found by hand scanning. In these situations the photocathode voltage was set at 700V for the minimum count rate obtained over presumably normal bone in the area to be scanned. The background cutoff for the teledeltos paper record was set 10-20% above this count rate. The following adjustments were relatively constant: count range differential, 30%; density, 75 to 100 microseconds; dot factor 2 to 4; pulse height analyzer window, 463 to 563 keV; scan speed, 20 to 30 cm/min; line spacing, 0.4 cm, and rate meter time constant, 0.4 seconds.

RESULTS

Thirty-two of fifty patients had an abnormal scintiscan. This included 17 with metastatic disease, nine with osteomyelitis, two with primary bone tumors, two with lymphoma, one with Gaucher's disease, and one with Paget's disease (Table I).

TABLE I

Type of Lesion	*No. of Patients*
Metastatic bone lesions	
Breast	7
Bronchogenic	6
Prostate	1
Melanoma	2
Unknown	1
Total	17
Osteomyelitis	
Pyogenic	6
Tuberculous	2
Coccidioidal	1
Total	9
Primary bone tumor	
Chondrosarcoma	1
Ewing's sarcoma	1
Total	2
Metabolic bone disease	
Gaucher's disease	1
Paget's disease	1
Total	2
Lymphomas	
Lymphosarcoma	1
Type uncertain	1
Total	2

A comparison of the scintiscan with the roentgenogram is presented in Table II. Of ten cases in the "questionably positive roentgenogram" category, two had positive scintiscans. One of these patients had carcinoma of the prostate and a sclerotic eighth thoracic vertebra on roentgenogram. The significance of this finding was questioned since he had prior trauma to this area. The bone scintiscan indicated the presence of multiple areas of increased radiostrontium concentration, in the vertebrae and sacrum. The second patient developed fever, heat, swelling and tenderness of the left ankle, and positive blood cultures. The roentgenogram was questionable and the scintiscan was consistent with osteomyelitis (Case III). Eight additional patients had roentgenographic findings of questionable significance. Four had malignant neoplasms and lucent areas in the skull, one had back pain and a questionable defect of T6; one had coccidioidomycosis and a cystic lesion in the femur; one had pulmonary tuberculosis and a cystic lesion in the ischium; and the last patient had a thyroid carcinoma and multiple round sclerotic areas involving several bones (Case IX). The negative bone scintiscans, subsequent course, and absence of roentgenographic progression in these eight patients suggested that the roentgenographic changes were of no significance.

TABLE II

Roentgenogram	*Scintiscan*	
	Positive	Negative
Positive	16	0
Negative	14*	10****
Questionably Positive	2**	8***

*Nine eventually developed lesions on roentgenogram which correlated with the scintiscan.
**Two later developed definite lesions on roentgenogram which correlated with the scintiscan.
***The subsequent clinical and roentgenographic course suggested that the roentgenographic findings were of no significance in all of these patients.
****None of these patients developed subsequent evidence of bone lesions.

The following cases illustrate the usefulness of the ^{85}Sr bone scintiscan in various bone diseases.

METASTATIC BONE DISEASE: Seventeen patients with malignant neoplasms had evidence of bone metastases on scintiscan. The lesions were osteoblastic and osteolytic. The multiplicity of lesions throughout the skeleton produced a rather characteristic pattern, although the clinical picture and the roentgenograms must be considered in the interpretation of each scan. The scintiscan can be of significant value in the evaluation of patients with suspected bone metastases, since eight of the patients had negative skeletal roentgenograms at the time of the positive scan.

Case I. A 72-year-old man developed a fever and a cough in October 1963. Chest roentgenogram revealed a cavitary lesion adjacent to the left hilus. Left upper lobectomy established the diagnosis of bronchogenic carcinoma. In April 1964, he developed pain in the left hip. Roentgenograms of the lumbar spine and pelvis were negative. A bone scintiscan revealed an abnormal concentration of radiostrontium in the left ilium lateral to the sacroiliac joint (Fig. 1a). Subsequently, bony sclerosis developed in the area roentgenographically. In July, 1964, he developed right hip pain without a corresponding roentgenographic abnormality. A scintiscan revealed increased radioactivity in the right ilium (Fig. 1b). The lesions proved to be metastases at necropsy.

This case illustrates the usefulness of this technique in the early detection of bone metastases. The patient was treated by the radiotherapist on the basis of the scintiscan and his pain was relieved. A period of two months elapsed before the lesion became roentgenographically demonstrable. A delay in the institution of therapy was avoided.

Case II. A 41-year-old woman had a right radical mastectomy for adenocarcinoma in 1956. In 1962, a left radical mastectomy and bilateral oophorectomy

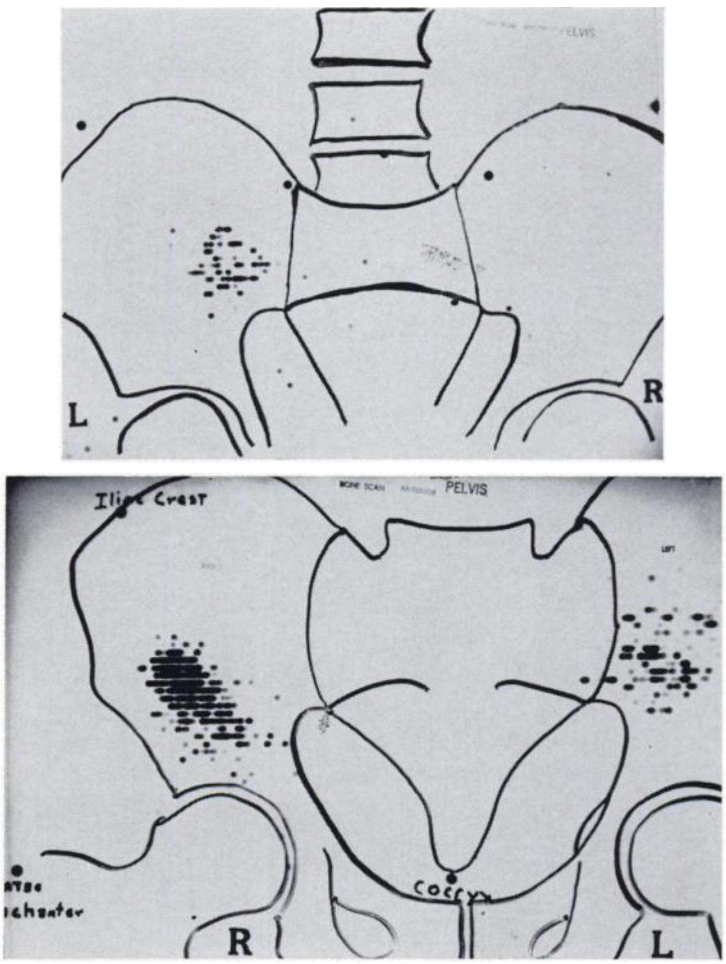

Fig. 1. Case I. Bronchogenic Carcinoma. (a) Posterior scan of pelvis in April, 1964, revealed metastasis to left ilium. (b) Anterior scan of pelvis in July, 1964, revealed metastases to the left and right ilia. Sites of metastases corresponded to areas of pain.

followed by external irradiation were performed. In December, 1963, intracranial metastases required craniotomy. In March, 1964, low back pain developed. Roentgenograms were negative but irradiation to the lower spine was instituted. Three days later scintiscan disclosed an abnormal radiostrontium concentration in the right ilium lateral to the sacroiliac joint (Fig. 2). The radiotherapist adjusted the therapy port and the patient's pain was relieved.

In this case the scintiscan correctly localized the lesion and prevented irradiation to the wrong area.

OSTEOMYELITIS: The roentgenographic changes in suppurative osteomyelitis depend upon bony destruction and new bone formation. In the initial stages of infection, there may be no radiographic abnormalities. If antibiotics are administered early, or if the infection is mild, radiographic signs may not develop. With more severe infections, antibiotics may cause a marked delay in their appearance (1). The advantage of a technique which can detect early changes is evident. Nine cases of suspected osteomyelitis had an abnormal scintiscan. Only four of the nine cases had radiographic evidence of osteomyelitis, although this was the final clinical diagnosis in all of the cases.

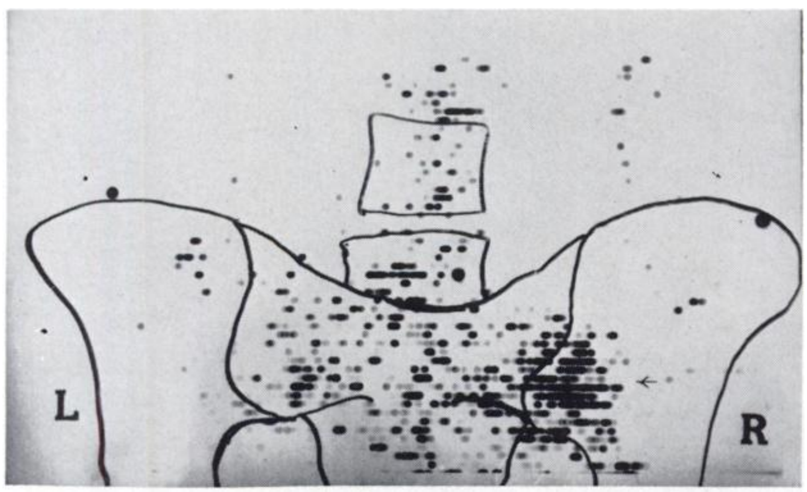

Fig. 2. Case II. Breast Carcinoma. Posterior scan of pelvis in March, 1964, revealed metastasis to right ilium adjacent to sacroiliac joint (⟶). This metastasis was outside the radiotherapy port.

Case III. An 11-year-old boy developed a fever, and pain in the left ankle. Physical examination disclosed heat, redness, swelling and exquisite tenderness of the left ankle. Three blood cultures grew *Staphylococcus aureus.* The roentgenogram revealed a small cystic lesion on the distal lateral aspect of the left tibia which was interpreted as a benign cortical defect (Fig. 3a). On scintiscan there was an abnormal concentration of radiostrontium in the distal metaphysis of the left tibia (Fig. 3b). The patient received antibiotics and improved. The roentgenograms subsequently demonstrated osteomyelitis in an area medial to the cortical defect. A follow-up scintiscan two months later was normal (Fig. 3c). This case illustrates the use of the bone scintiscan in the early diagnosis of acute osteomyelitis. There was an increased accretion of ^{85}Sr in the metaphyseal region

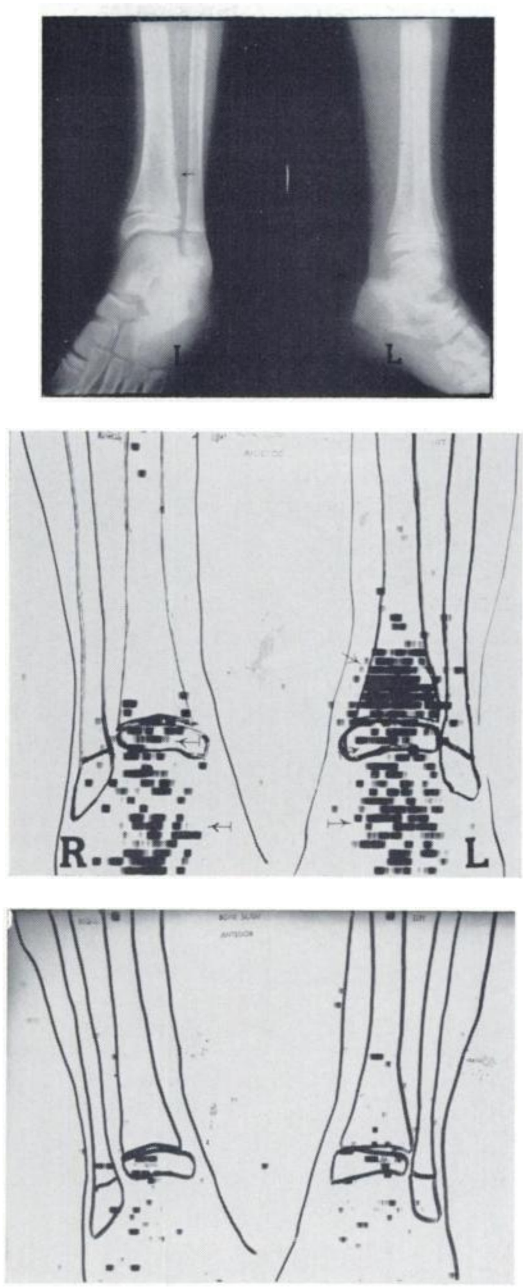

Fig. 3. Case III. Pyogenic Osteomyelitis. (a) Internal oblique and lateral roentgenogram on January 28, 1965, was interpreted as benign cortical defect (⟶) of left tibia. (b) Anterior scan of ankles on February 1, 1965, confirmed osteomyelitis of metaphysis of left tibia (⟶). Note symmetrical sites of normally increased ^{85}Sr over distal tibia and tarsal bones (↦). (c) After antibiotic therapy, anterior scan of ankles on April 5, 1965, revealed subsidence of the osteomyelitis.

which is a typical location for osteomyelitis of hematogenous origin in children (21). Early treatment prevented progression of the disease and roentgenographic changes were minor.

Case IV. A 32-year-old man had sustained fractures to the pelvis, right femur, L4 and L5 and the coccyx in an automobile accident December, 1963. He received orthopedic care and was discharged from the hospital in November, 1964. In January, 1965, his right thigh became increasingly painful, swollen, hot and tender. Physical examination revealed a temperature of 101°F, multiple areas of folliculitis on the chest and back, and a fluctuant mass over the right lateral thigh. The roentgenograms showed well healed fractures of the spine, pelvis and right femur. No definite osteomyelitis could be identified. On February 18, 1965, 2,000 cc of purulent material was drained from the right thigh. This abscess was noted to extend from the femur. Cultures grew *Staphylococcus aureus* and *Aerobacter aerogenes.* A scintiscan on March 15, 1965, disclosed an abnormal concentration of radiostrontium in the right femoral shaft distal to the callus (Fig. 4). Scintiscan of the pelvis was normal. The scintiscan in this case demonstrated osteomyelitis of the mid-shaft of the femur as noted at surgery. The area had been fractured 14 months before and was well healed. The interval between fracture and scintiscan was too long to explain the radiostrontium concentration on the basis of fracture alone. The old fractures in the pelvis and spine did not

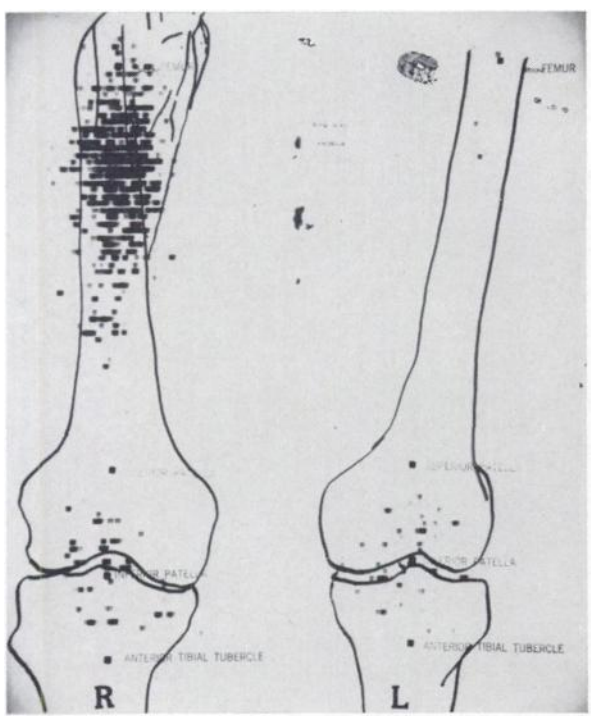

Fig. 4. Case IV. Pyogenic Osteomyelitis. Anterior scan of legs 15 months after fracture of right femur revealed osteomyelitis. Note symmetrical sites of normally increased ^{85}Sr around knees.

concentrate radiostrontium. Bauer and Wendeberg (4) found high ^{85}Sr counts over a fracture site for six to eight weeks, with subsequent gradual decrease.

Case V. A 27-year-old woman developed swelling over the manubrium, which increased in size and drained spontaneously. A biopsy of the draining lesion revealed *Coccidioides immitis.* The chest roentgenogram showed changes compatible with coccidioidomycosis. A bone scintiscan revealed an abnormal concentration of radiostrontium over the manubrium (Fig. 5).

This case illustrates the usefulness of the scintiscan in determining actual bony involvement of a draining lesion. The sternum is difficult to visualize on routine chest roentgenogram although laminography is often helpful.

Four additional cases of pyogenic osteomyelitis and two cases of tuberculous osteomyelitis were demonstrated on scintiscan. The patterns were nonspecific and interpretation required knowledge of the clinical history.

BONE TUMORS: Accumulation of radiostrontium by bone tumors is well recognized (4,22,26). Although no characteristic patterns have evolved as yet, it is possible that continued clinical experience with this technique may provide information to differentiate the individual types of bone tumors. This has been suggested by the two cases studied in this series.

Case VI. A 25-year-old man noted the onset of pain in the right calf in July, 1964. In October, 1964, the right calf began to increase in size. Physical examination was normal except for a firm, tender mass, 9 x 9 cm, in the right calf. The

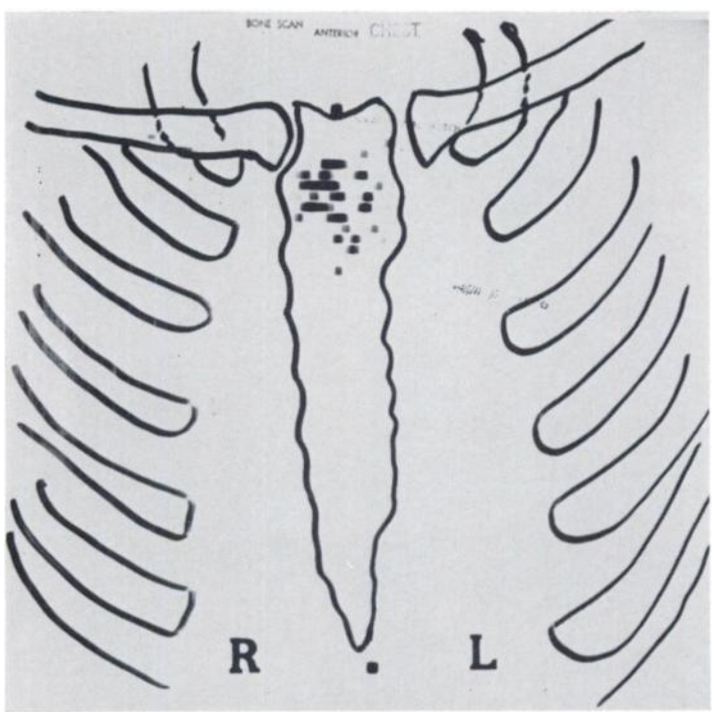

Fig. 5. Case V. Coccidioidal Osteomyelitis. Anterior scan of manubrium indicated osteomyelitis at site of draining sinus.

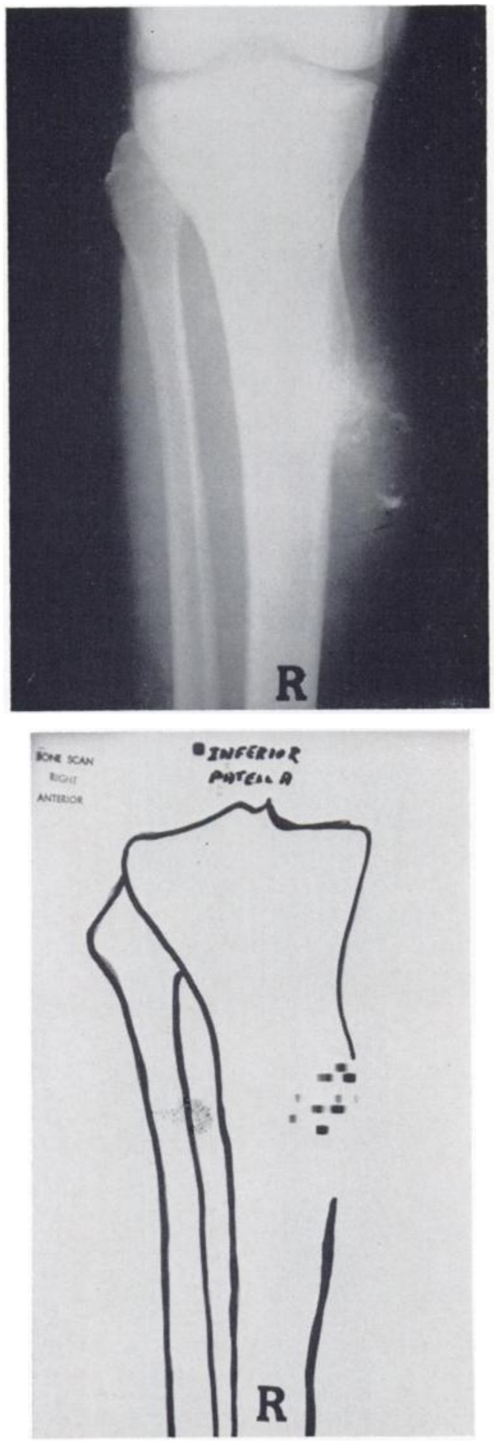

Fig. 6. Case VI. Chondrosarcoma. (a) Anteroposterior roentgenogram revealed a calcified soft tissue mass arising from the right tibia. (b) Anterior scan revealed increased ^{85}Sr only at the tumor's origin from the tibia; this is consistent with the cartilaginous nature of the neoplasm.

roentgenogram revealed a calcified soft tissue mass arising from the tibia (Fig. 6a). On scintiscan, concentration of radioactivity was noted at the tumor's origin (Fig. 6b). The lesion was surgically excised and was a chondrosarcoma arising from an osteochondroma.

Case VII. A 12-year-old girl developed pain, swelling and tenderness in the left upper tibia in January, 1964. The roentgenogram was negative. Pain and swelling persisted and a repeat roentgenogram in February, 1964, showed a small area of periosteal reaction in the left upper tibia interpreted to be a stress fracture. The symptoms subsided but in June, 1964, recurred. The roentgenogram was unchanged (Fig. 7a). A biopsy of the tibia revealed Ewing's tumor. The bone scintiscan demonstrated a diffuse intramedullary concentration of radiostrontium in the upper third of the tibia (Fig. 7b).

These cases illustrate the bone scintiscan findings in two types of primary bone tumors. The chondrosarcoma concentrated ^{85}Sr only at its origin from the tibia. The lack of radiostrontium within the tumor itself is consistent with its cartilagenous nature. Ewing's sarcoma involves the intramedullary portion of the bone, and commonly penetrates the bone without destroying its contour (1). The extensive involvement was well visualized on the scintiscan.

METABOLIC BONE DISEASE: The role of radiostrontium scintiscans in the evaluation of metabolic bone disease is undetermined. Metabolic bone disease represents a heterogenous group. Some of these diseases are difficult to detect by bone scintiscan because of uniform involvement. The bone scintiscan is better able to detect localized abnormalities. Quantitative radiostrontium kinetics may be of value in these disorders. This report includes a patient with Gaucher's disease. The patient had extensive bone disease roentgenographically, but only minor abnormalities on scintiscan.

Although Paget's disease is disseminated, it tends to localize in membranous bone resulting in an uptake of radiostrontium five to seven times normal (16). Figure 8a, b, c illustrates the abnormalities in a patient with Paget's disease. Bone scintiscans revealed involvement of the skull not evident on roentgenograms. Otherwise, there was good correlation between the two methods.

LYMPHOMAS: Lymphomas commonly involve bone in the latter stages of the disease. Klein and Lund (16) scanned a patient with Hodgkin's disease who had a diffuse, irregular, pattern involving the ilium. In our series two patients with lymphoma demonstrated this pattern. One of the patients had normal skeletal roentgenograms.

Case VIII. A 55-year-old man was admitted to the hospital because of low back pain, and bilateral axillary and hilar adenopathy. Roentgenograms revealed probable metastatic lesions of T11, L4, the skull, left ilium and left femur. The lesions were osteoblastic and osteolytic. Superior mediastinal exploration and node biopsy revealed metastatic disease initially interpreted as anaplastic carcinoma. The scintiscans of the skull were negative. Scintiscan of the pelvis showed an irregular increase in the radiostrontium concentration in the ilia and vertebrae (Fig. 9). The pattern suggested Paget's disease rather than a localized metastatic lesion. At necropsy the patient had a malignant lymphoma.

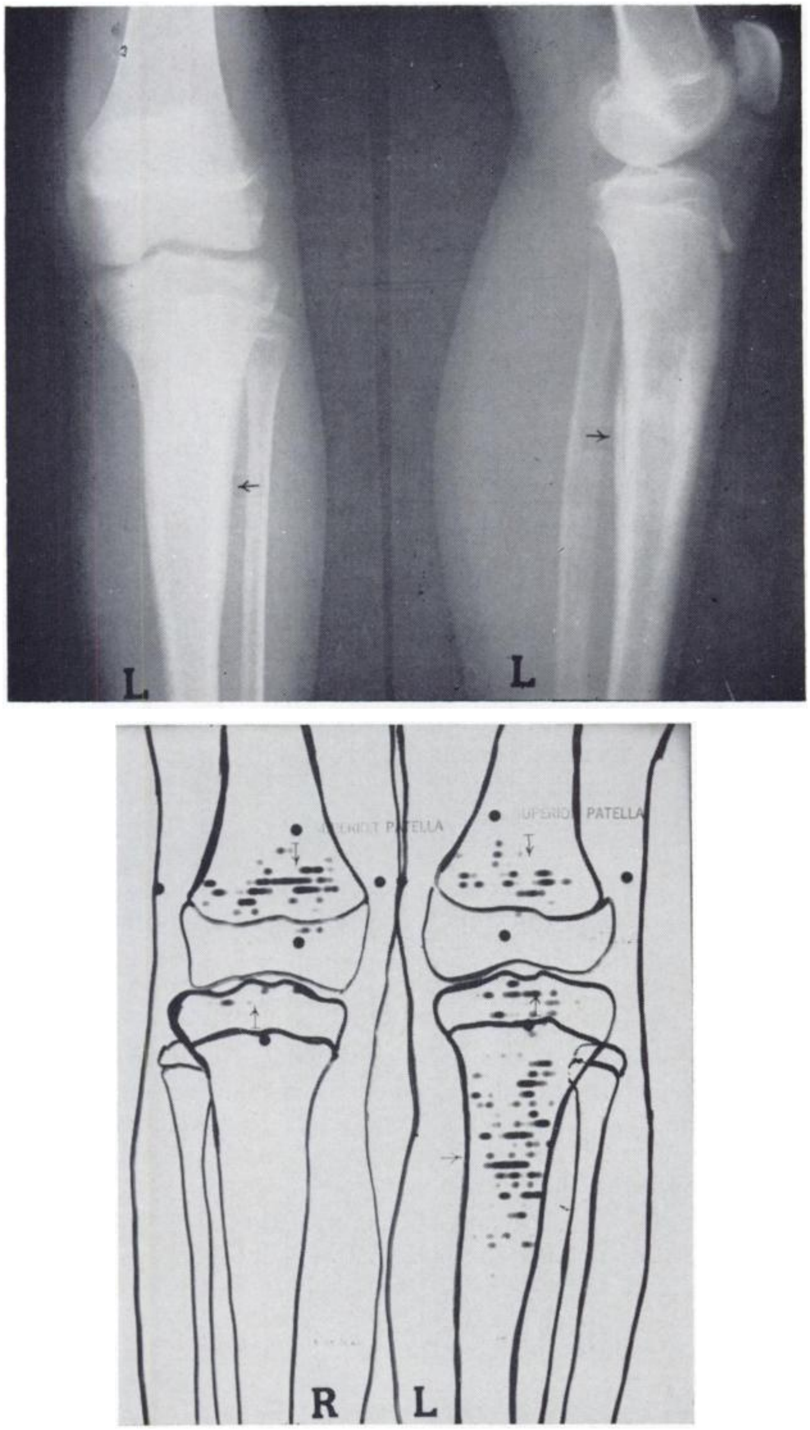

Fig. 7. Case VII. Ewing's Sarcoma. (a) Anteroposterior and lateral roentgenogram revealed a broad tibial shaft with periosteal elevation (⟶). (b) Anterior scan indicated normal symmetrically increased ^{85}Sr around knees (⟶) and asymmetrically increased ^{85}Sr over the proximal shaft of the left tibia (⟶).

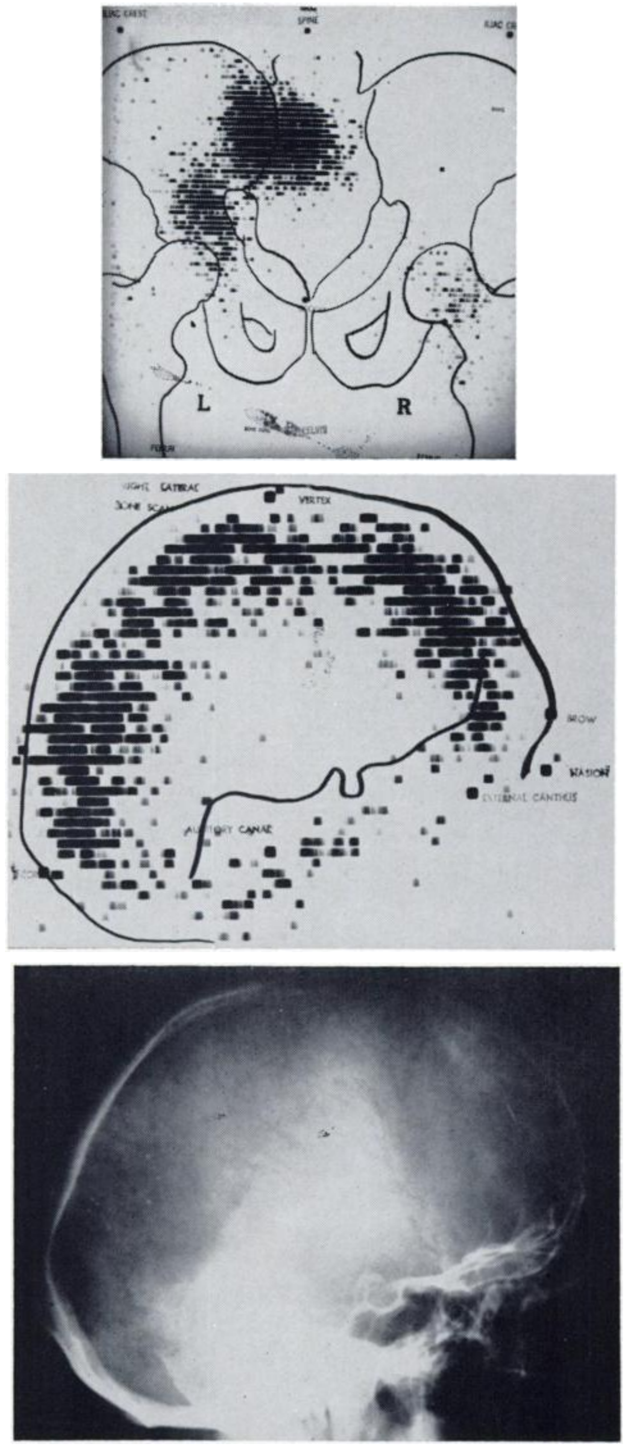

Fig. 8. Paget's Disease. (a) Posterior scan of pelvis demonstrated large localized areas of increased ^{85}Sr in the sacrum, ilium, and proximal femur, which correlated well with the roentgenogram. (b) Right lateral scan of skull demonstrated increased ^{85}Sr with a markedly thickened calvarium not evident on roentgenogram. (c) Right lateral roentgenogram of skull interpreted as normal.

Hodgkin's disease and other lymphomas usually produce osteolytic lesions (19). Less frequently an osteoblastic response occurs and when it does, the roentgenographic differentiation from the sclerotic form of Paget's disease may be difficult or impossible (19). The scintiscan in this case and in the patient reported by Klein and Lund (16), had an appearance similar to Paget's disease. The irregularity of the increased ^{85}Sr concentration may be of differential value and has been a consistent feature of the scintiscans.

BONE ISLANDS: Bone islands are rounded areas of compact bone, usually less than two centimeters in diameter, occurring within any bone except the skull (15). On the roentgenogram they are ovoid, homogeneously dense, and remain unchanged for many years. Their only clinical significance is that they are occasionally indistinguishable from osteoblastic metastases (15).

Case IX. A 42-year-old man had a subtotal thyroidectomy and left radical neck dissection in 1951 for a mixed papillary-follicular thyroid carcinoma. A skeletal survey showed round, sclerotic lesions in the pelvis and femurs. In 1961 he developed a mass in the right neck which on thyroid scan proved to be the right lobe of the thyroid. Repeat skeletal survey demonstrated round sclerotic lesions in the femurs, ilia, sacrum and right ulna. These were interpreted to be metastases and the patient received cancer chemotherapy. The lesions were unaffected by the therapy. In February, 1964, he was referred to Fitzsimons General Hospital. He was asymptomatic and the multiple sclerotic lesions were unchanged. They did not concentrate radiostrontium (Fig. 10). Biopsy and histologic examination of one of the lesions showed compact bone. The patient is alive and well.

This patient could have been spared unnecessary cancer chemotherapy if bone scintiscan had been available.

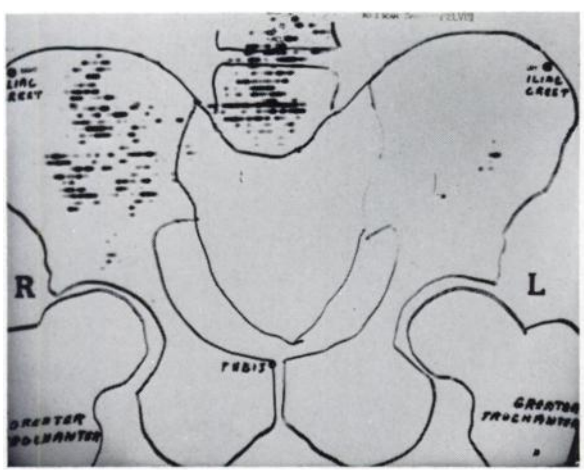

Fig. 9. Case VIII. Lymphoma. Anterior scan of the pelvis demonstrated irregularly increased concentration of ^{85}Sr in the lower lumbar vertebrae and more marked in the right ilium than in the left ilium.

DISCUSSION

A study of 164 ^{85}Sr bone scintiscans indicated that the procedure has definite clinical usefulness. Its major application is in the early detection of metastatic bone lesions and osteomyelitis. It is also valuable in determining the significance of suspicious roentgenographic abnormalities. It can accurately localize a metastatic lesion for the radiotherapist before the roentgenogram becomes positive and the extent of bone involvement can be determined. With more experience it may be possible to differentiate various types of primary bone tumors by scintiscan pattern.

Charkes and Sklaroff (20) found metastases on bone scintiscan without roentgenographic abnormalities in 28 out of 118 patients. Many of these metastases were confirmed by biopsy. Fourteen of 50 patients in this report had abnormalities on scintiscan without roentgenographic changes. However, some of the patients were referred specifically because they had bone pain with normal skeletal roentgenograms. The scintiscan is not a substitute for careful clinical and roentgenographic evaluation, but it is a useful adjunct.

There are definite limitations to the bone scintiscan as currently performed. It is technically difficult to perform and too time consuming for screening purposes. The abnormalities demonstrated are frequently nonspecific. Scintiscanning depends upon uneven bone involvement and is poorly suited to the evaluation of uniform metabolic bone disease. Radiostrontium turnover studies, the Anger scintillation camera (2) or the auto fluoroscope (5) may resolve these problems.

Studies utilizing a whole-body profile scanner as a screening procedure were initiated at this laboratory. This scanner consists of four scintillation detectors which move as a unit: two above and two below a table upon which the patient reclines. The patient receives ^{85}Sr and is subsequently "scanned" from head to toe. A count-rate profile is recorded and an area of increased ^{85}Sr concen-

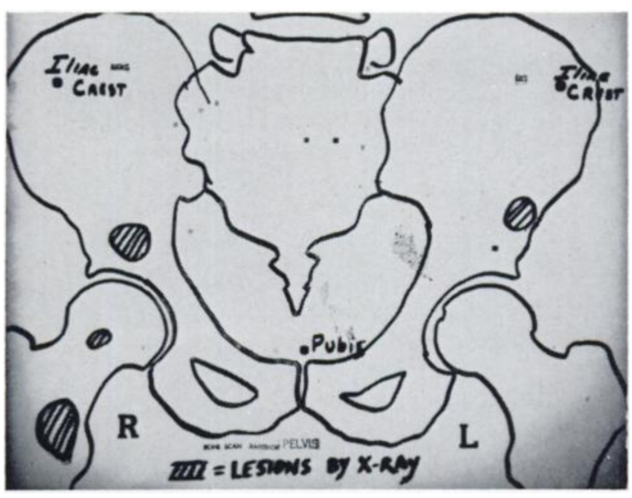

Fig. 10. Case IX. Bone Islands. Anterior scan of pelvis revealed no areas of increased ^{85}Sr concentration indicating no active bone lesions. Roentgenogram had suggested the possibility of osteoblastic metastases to the areas marked on the scan.

tration can be lateralized and its depth determined (Fig. 11). The procedure requires only a few minutes. If there is asymmetry of ^{85}Sr concentration, the particular area can be studied in detail with the standard scanner. Preliminary studies correlate well with the detailed scintiscan and this technique may prove to be an excellent screening method for localized bone disease.

SUMMARY AND CONCLUSIONS

Experience with 164 ^{85}Sr bone scintiscans in 50 patients has been reviewed. The advantages and disadvantages of the procedure have been discussed. The technique proved valuable in the study of localized bone disease, especially the early detection of bone metastases and osteomyelitis. Preliminary remarks have been made on the use of the whole body profile scanner as a repaid screening method for skeletal disease.

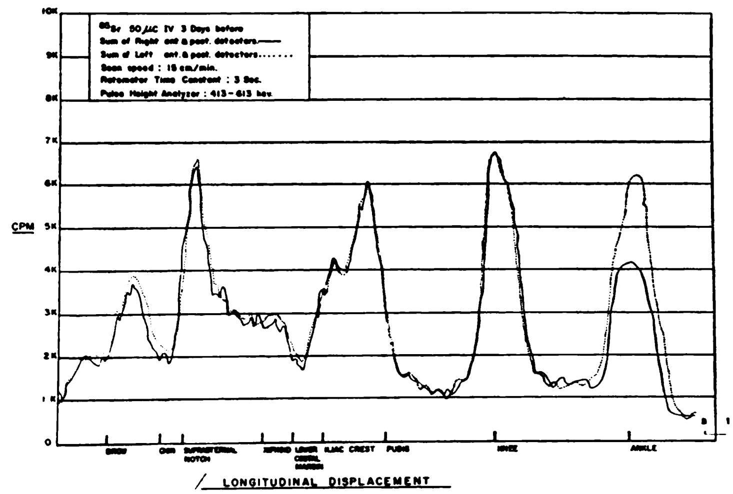

Fig. 11. Case III. Pyogenic Osteomyelitis. Whole body profile scan indicated abnormally increased ^{85}Sr concentration over the left ankle. The normal sites of increased ^{85}Sr concentration are present over the proximal humeri (suprasternal notch area), pelvis, knees and ankles; these areas are symmetrical. Photoscan is demonstrated in Figure 3.

ABSTRACT

One hundred and sixty-four ^{85}Sr bone scintiscans were performed in 50 patients on 59 occasions. Correct interpretation of the bone scan required knowledge of the normal sites of increased radioactivity at the ends of the long bones, around the acetabula and sacroiliac joints, over the vertebrae, carpal and tarsal bones.

Thirty-two of fifty patients had an abnormal scan including 17 with metastases, nine with osteomyelitis, two with primary bone neoplasms, two with lymphoma, one with Gaucher's disease and one with Paget's disease. Fourteen of these patients had negative roentgenograms at the time of the scan. The bone scan was particularly useful in the early diagnosis of osteomyelitis and metastases, and in differentiating bone islands from osteoblastic metastases.

ACKNOWLEDGEMENT

The authors wish to thank Colonel Edwin L. Overholt, Major Paul E. Siebert, Major James J. Bergin, and Mrs. Buelah K. Kelly for assistance in the preparation of the manuscript, and Mrs. Emily C. Slocum and Mr. Gilbert Herring for assistance with the illustrations.

REFERENCES

1. AEGERTER, E., AND KIRKPATRICK, J. A.: W. B. Saunders Co., Philadelphia. *ORTHOPEDIC DISEASES*, 1958.

2. ANGER, H. O.: Scintillation cameras with multichannel collimators. *J. Nucl. Med.* **5**:515-531, 1964.

3. BAUER, G. C. H., AND RAY, R. D.: Kinetics of strontium metabolism in man. *J. Bone and Joint Surg.* **40-A**: 171-186, 1958.

4. BAUER, G. C. H., AND WENDEBERG, B.: External counting of Ca^{47} and Sr^{85} in studies of localized skeletal lesions in man. *J. Bone and Joint Surg.* **41-B**:558-580, 1959.

5. BENDER, M. A., AND BLAU, M. The autofluoroscope. *Nucleonics.* **21**:10-52, 1963.

6. CHARKES, N. D., AND SKLAROFF, D. M.: Early diagnosis of metastatic bone cancer by photoscanning with strontium-85. *J. Nucl. Med.* **4**:194, 1963.

7. CHARKES, N. D., AND SKLAROFF, D. M.: Early diagnosis of bone cancer by photoscanning with strontium-85. *J. Nucl. Med.* **5**:168-179, 1964.

8. CHARKES, N. D., SKLAROFF, D. M., AND BIERLY, J.: Detection of metastatic cancer to bone by scintiscanning with strontium-87^m. *Am. J. Roent., Rad. Therapy and Nuclear Med.* **91**:1121-1127, 1964.

9. COHN, S. H., SPENCER, H., SAMACKSON, J., AND ROBERTSON, J. S.: The turnover of strontium-85 in man as determined by whole-body counting. *Rad. Research,* **17**:173-185, 1962.

10. COMAR, C. L., WASSERMAN, R. H., ALLBERG, S., AND ANDREWS, G. A. Strontium metabolism and strontium-calcium discrimination in man. *Proc. Soc. Exper. Biol. and Med.,* **95**:386-391, 1957.

11. COREY, K. R., AND KENNY, P., GREENBERG, E., AND LAUGHLIN, J. S.: Detection of bone metastasis in scanning studies with calcium-47 and strontium-85. *J. Nucl. Med.* **3**:354-371, 1962.

12. DOW, E. C., AND STANBURY, J. B.: Strontium and calcium metabolism in metabolic bone diseases. *J. Clin. Invest.,* **39**:885-903, 1960.

13. FLEMING, W. H., MCILRAITH, J. D., AND KING, E. R.: Photoscanning in bone lesions utilizing strontium-85. *Radiology.* **77**:635-636, 1961.

14. GYNING, I., LANGELAND, P., LINDBERG, S., AND WALDESKOG, B.: Localization with strontium-85 of spinal metastases in mammary cancer and changes in uptake after hormone and roentgen therapy. *Acta Radiol.* **55**:119-128, 1961.

15. KIM, S. K., AND BARRY, W. F.: Bone island. *Am. J. Roent., Rad. Therapy and Nuclear Med.* **92**:1301-1306, 1964.

16. KLEIN, E. W., AND LUND, R. R.: Strontium-85 photoscanning in Paget's disease. *Am. J. Roent., Rad. Therapy, and Nuclear Med.* **92**:195-201, 1964.

17. KOFMAN, S., SKY-PECK, H. H., THIBAUDEAU, Y., RAY, R. D., AND TAYLOR, S. G.: The use of strontium-85 in the evaluation of bone metastasis: a preliminary report. *J. Nucl. Med.,* **4**:9-17, 1963.

18. MACDONALD, N. S.: Kinetic studies of skeletal metabolism by external counting of injected radioisotopes: the radioisotope osteogram. *J. Lab. and Clin. Med.,* **52**:541-558, 1958.

19. PUGH, D. G.: Roentgenologic diagnosis of diseases of bone, The Williams and Wilkins Co., Baltimore, 1951.

20. QUINN, J.: Scintiscanning in clinical medicine, W. B. Saunders Co., Philadelphia, 1962.

21. Rosenthall, L.: The use of strontium-85 for the detection of bone lesions. *J. Canad. Ass. Radiol.*, **15**:53-59, 1964.

22. Rosenthall, L.: The role of strontium-85 in the detection of bone disease. *Radiology*. **84**:75-82, 1965.

23. Sklaroff, D. M., and Charkes, N. D.: Studies of metastatic bone lesions with strontium-85. *Radiology* **80**:270-272, 1963.

24. Sklaroff, D. M., and Charkes, N. D.: Diagnosis of bone metastases by photoscanning with strontium-85. *JAMA*, **188**:1-4, 1964.

25. Spencer, H., Laszlo, D., and Brothers, M.: Strontium-85 and calcium-45 metabolism in man. *J. Clin. Invest.*, **36**:680-688, 1957.

26. Treadwell, A. DeG., Low-Beer, B.V.A., Friedell, H. L., and Lawrence, J. H.: Metabolic studies on neoplasm of bone with the aid of radioactive strontium. *Am. J. Med. Sci.* **204**:521-530, 1942.

New England Chapter *Call For Abstracts*

The New England Chapter of the Society of Nuclear Medicine will meet Friday, October 28, 1966, in Boston for its Annual Scientific Program on "Isotopes in Medicine". This conference will include lectures on basic as well as applied investigations relating radioisotopes to diagnosis and treatment in medical practice.

The Program Committee is now accepting abstracts of papers for this meeting. The final date for submission of abstracts is August 1, 1966. Authors will be notified of acceptance on the program by September 1, 1966. Abstracts should be typewritten, double spaced and should not exceed 200 words. An original and three copies should be mailed to:

Herbert A. Selenkow, M.D.
Program Chairman
New England Chapter,
Society of Nuclear Medicine
Peter Bent Brigham Hospital
721 Huntington Avenue
Boston, Massachusetts 02115