# Computer-Assisted Diagnosis for the Interpretation of Bone Scintigraphy
## A new approach to improve diagnostic accuracy

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**Abstract**

The most common cancers in the western countries are breast cancer in women and prostate cancer in men, and these cancer types, together with lung cancer, often metastasise to the skeleton. Bone scan is used to determine whether metastases are present, and the result of the examination serves as a guide in the choice of treatment strategy. Correct interpretation is, therefore, of great importance. The primary aim of this thesis is to investigate whether diagnostic accuracy of planar whole-body bone scan interpretations can be improved with the aid of a computer-assisted diagnosis ($CAD_x$) system. This is accomplished by four separate studies, of which the first shows that an automated $CAD_x$ system is possible to develop for the interpretations of bone scans regarding the presence or absence of metastases. In the second study we investigated, in a nation-wide survey, the physicians' performance and the interpretive variations between readers for bone scan examinations. The physicians were asked to classify 59 images regarding the presence or absence of bone metastases. The images were selected to reflect the spectrum of pathology found in everyday clinical work. The physicians' interpretations were compared with final clinical assessment based on a 4.8 year follow-up period, and they were also compared pairwise with each other. The results showed a sensitivity ranging from 52% to 100%, with an average of 77% and a mean specificity of 96%. In addition, moderate agreement was found between readers. The experience from these studies resulted in the development of a second $CAD_x$ system (third study) based on improved image processing and artificial neural network techniques and a larger database of whole-body bone scans. The $CAD_x$ performance when tested on the 59 bone scans showed a sensitivity and a specificity of 90% and 89%, respectively. In the final study 35 physicians with varying levels of experience, working at 18 of the 30 nuclear medicine departments in Sweden interpreted the 59 bone scan images again, this time with the aid of the $CAD_x$ system. The results showed a significant increase in sensitivity (88%) ($p<0.001$) without significant loss of specificity (94%). The area under the ROC curve increased from 0.925 without $CAD_x$ to 0.961 ($p=0.005$) with $CAD_x$. The variation in interpretations decreased with $CAD_x$. In conclusion, a $CAD_x$ system can improve diagnostic accuracy and reduce interpretive variations between physicians for bone scan examinations.

**Key words:** Diagnostic accuracy – Radionuclide imaging – Bone metastases – Breast cancer – Prostate cancer

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The thesis is based on the following papers:

I. Sadik M, Jakobsson D, Olofsson F, Ohlsson M, Suurkula M, Edenbrandt L. **A new computer-based decision-support system for the interpretation of bone scans.** *Nucl Med Commun.* 2006; 27:417-423

II. Sadik M, Suurkula M, Höglund P, Järund A, Edenbrandt L. **Quality of planar whole-body bone scan interpretations-a nationwide survey.** *Eur J Nucl Med Mol Imaging.* 2008; 35:1464-1472

III. Sadik M, Hamadeh I, Nordblom P, Suurkula M, Höglund P, Ohlsson M, Edenbrandt L. **Computer-assisted interpretation of planar whole-body bone scans.** *J Nucl Med.* 2008; 49:1958-1965

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