ABSTRACT
Every 3 minutes a woman in the United States is diagnosed with breast cancer. That means 1 out of every 8 women will be diagnosed with breast cancer in their lifetime. Since there is no way to prevent breast cancer, attention has been focused on early detection. Computer aided detection is new technology used for the early detection of breast cancer. I believe the CAD system, a radiologist, a mammography technologist and a student would diagnose calcifications with the same accuracy rate. Each participant examined 10 samples for calcifications. The hypothesis was inconclusive, with the student and CAD system having the same accuracy rate and the mammography technologists and radiologist having a lower accuracy rate overall. Further study is necessary.

INTRODUCTION
It is estimated that there are approximately 2 million women in the United States that have been diagnosed with breast cancer. Another 1 million women in the United States have breast cancer, but haven’t been diagnosed. The statistics are surprising. Every woman is at risk for breast cancer. The cause of breast cancer is not known. There are many risk factors that may increase a woman’s risk of being diagnosed with breast cancer, including heredity, obesity, smoking, and late childbearing, but the biggest risk factor is growing older. Women over 50 years of age are at increased risk. There isn’t a way to prevent breast cancer, but early detection can save lives.

Digital mammography is the newest development in early diagnosis. It is especially useful in women under 50 years of age, whose breast tissue is more dense than older women. Digital mammography has the potential to allow better cancer detection for all women. A mammography technologist specializes in taking mammograms. The technologist is trained in proper positioning and techniques to acquire the images that the radiologist needs. The radiologist is a medical doctor who is trained to identify abnormal or suspicious areas on a radiological exam.
Breast cancer is often diagnosed by the presence of calcifications in the breast. Calcifications are common and usually harmless. Calcifications are evaluated based on shape, size, density number, distribution and location. Of these characteristics, the shape is the most important. There are two types of calcifications. Macro-calcifications are coarse calcium deposits, which look like large white dots on a mammogram. They are found in about half of women over 50 years of age. Micro-calcifications are less than 1mm in size and appear as small white specks on a mammogram. Clusters of micro-calcifications may be a sign of early breast cancer. Irregularly shaped micro-calcifications are the most concerning for cancer.

Computer aided detection (CAD) is another advancement in the field of mammography. It is a computer system that acts like a second set of eyes to review a patient’s mammogram. Some have referred to CAD as the “spell checker” of mammography. If the CAD system finds an abnormality, it will mark the film, so the radiologist can review this area again. The radiologist can decide if the area needs further follow-up, or if it is a normal finding.

Breast cancer will affect every person. Everyone will have a family member or a friend that is diagnosed with breast cancer. Since there is no way to prevent breast cancer, early detection is the best protection. Hopefully, as the tools for diagnosing breast cancer improve, the deaths from breast cancer will decrease.

The experimenter has already been affected by breast cancer. Both of the experimenter’s grandmothers have been diagnosed with breast cancer. For this reason, the experimenter chose to study advancements in mammography.
MATERIALS AND PROCEDURES

The material used for this experiment were paper plates, canned dough for large biscuits, calcium carbonate tablet, sandwich bags, a CT scanner, a digital mammography machine and a mammogram viewing station with computer aided detection software.

The paper plates were numbered 1-10. A calcium carbonate tablet was crushed to the size of grains of sand. Assorted amounts of crushed calcium were placed on the plates by an assistant. These plates were then placed through a CT scanner and images were obtained. The biscuit dough was then divided into 11 sandwich bags, with 3 biscuits in each bag. The biscuit dough was kneaded until smooth. Each dough ball was used to blot the calcifications from a plate and the bag was closed again. One dough ball was used as a control, with no calcifications placed in it. The bag was kneaded for 10 seconds to distribute the calcifications. A mammography technologist took a 2 view digital mammogram of each dough sample. (10 samples and a control). The radiologist, mammography technologists, and student independently analyzed the control sample without calcifications then each of the other 10 samples on the mammography viewing station and documented the number of calcifications noted in the biscuit dough. Each sample was viewed in the regular mode, the magnification mode and triple magnification mode, though for comparison reasons, only the results of the magnification mode was used for the experiment.
RESULTS

The CAD system was 100% accurate in identifying the correct number of calcifications in three of the samples. The student was also 100% accurate for three of the samples. Both the radiologist and one of the technologists were 100% accurate in identifying the correct number of calcifications in two samples. Sample number 8 had an accuracy rate of 100% by the radiologist, student and both technologists. The CAD system had an accuracy rate of 70% in sample number 8. The radiologist and both technologist had at least one sample with a false positive, meaning they identified more calcifications in a sample than were actually contained in the sample. Of the 67 calcifications contained in the 10 samples, the student and the CAD system identified 39, which is an accuracy rate of 58.21%. Technologist 1, Technologist 2 and the Radiologist all identified 36 of the 67 calcifications, after removing false positive numbers, for an accuracy rate of 53.73%.

CALCIFICATIONS IDENTIFIED PER SAMPLE

<table>
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<tr>
<th>Sample #</th>
<th># of Calcifications</th>
<th>Student</th>
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<th>Technologist 2</th>
<th>Radiologist</th>
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(False positives are shown in red. Most accurate shown in blue)
CALCIFICATIONS IDENTIFIED

![Graph showing the identification of calcifications by different professionals.]

SAMPLE

% CORRECTLY IDENTIFIED

![Graph showing the percentage of calcifications correctly identified across different samples.]

Legend:
- Student
- Tech 1
- Tech 2
- Radiologist
- CAD
- # in Sample
CONCLUSION

The hypothesis, “I believe that a computer aided detection device, a radiologist, a mammography technologist and a student will identify calcifications with the same accuracy rate” is inconclusive. Though the student and the CAD system were 100% accurate on 3 of the samples, it wasn’t the same 3 samples. In 5 of the samples, the student and the CAD system were the most accurate, but again, they were not the same 5 samples. In addition, the CAD system is programmed to identify “suspicious” calcifications, based on criteria, instead of simply identifying all calcifications, which could alter the accuracy rate of identification. The radiologist is also trained to identify “suspicious” calcifications or clusters of calcifications, which could have impacted his accuracy rate in this experiment. The false positives by the technologists and radiologist could be due to them being trained to error on the side of caution. Given the results of the experiment, it is decided that further testing is needed to further evaluate the accuracy rates of computer aided detection in comparison with radiologists, technologists and students.

Since patient mammograms are interpreted with the use of triple magnification, or the use of a magnifying glass by the radiologist, the examiner collected additional data at triple magnification. At triple magnification, the radiologist accuracy rate increased from 53.73% to 71.64%. The student’s accuracy rate increased from 58.21% to 64.18%. The technologist’s accuracy rate stayed the same at 53.73%. The CAD system is currently not able to evaluate samples in the triple magnification mode.
Since there is no cure for breast cancer, *early detection is the best protection.* Advancements in mammography could lead to improved outcomes for women who are diagnosed with breast cancer. Additional research is needed to fully understand the impact of computer aided diagnosis.

Further study could include increasing the sample size, documenting the position of the calcifications each person identified, and comparing the sizes of the calcifications identified.
Works Cited


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