# Circadian Biometric Recorder (CBR): A wearable breast health monitoring device – A technology review

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## Abstract (300 word limit)

Preamble: The most common breast cancer screening and diagnostic modalities are generally limited by radiation exposure, discomfort, high costs, low sensitivity in screening dense breast tissue, and inter-observer variabilities in image interpretation. There is a clear need for an affordable and effective adjunct modality that can address these limitations. Such a modality would reduce the number of unnecessary biopsies, health care costs, and patient anxiety. The Circadian Biometric Recorder (CBR) is a non-invasive, non-compressive, and non-radiogenic wearable device developed as an adjunct to current diagnostic and screening methods to assist in the early detection of breast tissue abnormalities. Methods: The CBR records thermodynamic metabolic data from the breast skin surface over a period of time using two wearable biometric patches and a data recording device. The data is analyzed a using predictive analytics software to determine the presence of breast tissue abnormalities. This talk includes a review of the scientific literature on which the CBR technology is based and describes the history around the design and development of the CBR technology, the results of the clinical studies, and the predictive analytics framework used. Results: The CBR system has been developed and its efficacy has been evaluated using data from several clinical studies. 24-hour long breast skin temperature circadian rhythm data was collected from 93 benign and 108 malignant female study subjects in the initial clinical studies. The predictive model developed using these data could predict breast tissue abnormalities with an accuracy of 78% accuracy, 83.6% sensitivity and 71.5% specificity. To validate this predictive model in an independent test population, a pilot study of 173 female study subjects was conducted, and preliminary analysis of data from this study indicates a high prediction accuracy of 81.82%. Additionally, data from the study was also used to develop a predictive model that could detect abnormalities in a 2-hour wear data with an accuracy of 86.70% and a significant performance in dense breast tissue. Conclusions: The results from these studies indicate that the CBR could be efficiently used in the privacy of home or office for breast health monitoring leading to early detection of any abnormal changes. Further, the CBR system represents a potentially excellent secondary diagnostic modality for breast health monitoring in dense breast tissue. This is significant, considering women with dense breast tissue represent up to 50% of the population (40% to 80% internationally).

## Image

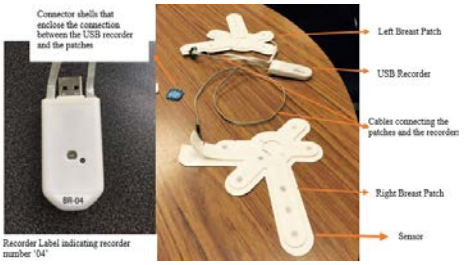



Fig. 1: 2nd generation CBR system: USB DRD; Patches

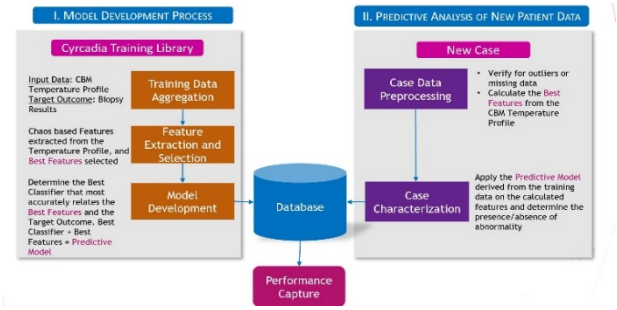



Fig. 2: 3rd-generation CBR system: Patch design

## Recent Publications

1. E.Y.K. Ng, S. Vinitha Sree, K.H. Ng, G. Kaw, The Use of Tissue Electrical Characteristics for Breast Cancer Detection: A Perspective Review, Technol. Cancer Res. Treat. 7 (2008) 295–308. doi:10.1177/153303460800700404.
2. S. Vinitha Sree, E.Y.K. Ng, U.R. Acharya, W. Tan, Breast imaging systems: a review and comparative study, J. Mech. Med. Biol. 10 (2010) 5–34. doi:10.1142/s0219519410003277.
3. E.Y.K. Ng, A review of thermography as promising non-invasive detection modality for breast tumor, Int. J. Therm. Sci. 48 (2009) 849–859. doi:10.1016/j.ijthermalsci.2008.06.015.
4. J.M.Y. Tan, E.Y.K. Ng, U.R. Acharya, L.G. Keith, J. Holmes, Comparative Study on the Use of Analytical Software to Identify the Different Stages of Breast Cancer Using Discrete Temperature Data, J. Med. Syst. 33 (2009) 141–153. doi:10.1007/s10916-008-9174-4.
5. L.G. Keith, R. WH, J. Holmes, U.R. Acharya, E.Y.K. Ng, Methods for collecting and analyzing thermal data based on breast surface temperature to determine suspect conditions, 2012.
6. L.G. Keith, R. WH, J. Holmes, U.R. Acharya, E.Y.K. Ng, Device for analyzing thermal data based on breast surface temperature for the detection for use in determining cancerous conditions, US 8185485, 2012.
7. L.G. Keith, R. WH, J. Holmes, U.R. Acharya, E.Y.K. Ng, System for

analyzing thermal data based on breast surface temperature to determine suspect conditions, US 8231542, 2012.

8. E.Y.K. Ng, J.M.Y. Tan, S. Lockwood, L.G. Keith, ANN based classification of breast cancer with discrete temperature screening: facts and myths, in: R.M.R. and S.L. J.S. Suri (Ed.), Emerg. Technol. Breast Imaging Mammogr., American Scientific Publishers, 2006: pp. 403–439.
9. E.Y.K. Ng, U.R. Acharya, L.G. Keith, S. Lockwood, Detection and differentiation of breast cancer using neural classifiers with first warning thermal sensors, Inf. Sci. (Ny). 177 (2007) 4526–4538. doi:10.1016/j.ins.2007.03.027.

**Photograph**



## Biography

Ng obtained Ph.D. at Cambridge Univ. He is Fellow of American Society of Mechanical Engineers. His expertise is in commercial and in-house developed software to perform numerical simulation in the biomedical engineering (BME), thermal-fluid and health-related diagnosis fields. He was Editor-in-Chief for 2 ISI-journals which were captured by the JCR within 2-years of their inauguration. He has been recognized internationally for academic excellence. He received service awards and has graduated 23 PhD and 26 Master students. He was awarded the SPRING-Singapore Merit Award for his work in thermal imagers to screen SARS fever and contributions to the Singapore Standardization Program. Being a co-inventor of 3 US patents on software classifiers to identify the different stages of breast cancer development in iTBra-system, he was accoladed with equity in a listed company. His ongoing work on non-contact screening for carotid artery stenosis and superficial vein-finder has resulted in 3 filing patents. He has notable citations in the field of infrared physics & technology in BME research.

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