**Objective**

Because it is known that as cells transform from benign to cancerous they are increasingly disorganized, based on the optical scattering data for cells from colon, pancreas, and breast, 

- Which in turn causes electrical polarization of the cells contents to decrease, based on experiments with breast tissue cell suspensions ([1],[9] and [4]), and,
- Further, based on the Fiedler Cancelation theory ([7]) this may well be a universal property of cells as they transform regardless of origin of origin of the cells [4].

We then hypothesize: The probable outcome and the risk of metastasis for the cancer surgery patient can be predicted from knowledge of the original value of $F_{\text{cole}}$, at the time of the operation, as a measure of the progression in the transformation of the organ’s cells from benign to cancer up to that time.

We present data from breast cancer cases in this paper in support of this hypothesis.

**Method and Materials**

146 subject research with 150 suspicious findings or biopsy proven cancer (in one or more breast) reported to surgical excision and the following criteria were reviewed: (1) had impedance measurements taken with the same apparatus [2], (2) had outcome information available from the Aurora St Luke’s Comprehensive Breast Center (Table 1, [3]), and (3) as a data quality control criterion discussed in [1], had a measurement that was taken in the Cole Polder with a Pearson Correlation Coefficient ($\rho_{\text{cor}}$)$>0.9$. This yielded a total of 28 patients. 27 patients were stage 1 or 2 breast cancer, 81 had breast cancer, but no recurrence, 29 and recur and of those, 15 developed metastases. The data was stage 4 before surgery. The time releance [4] for further details of the sample acquisition, maintenance and preparation.

These CFM measurements can be expressed as the ratio of $C_{\text{spread}}$ to $C_{\text{plated}}$.

We call this dimensionless ratio the Electrical Transformation Age ($\text{ETA}$) since the following transformation age disorder is assessed. Knowing the age at which the cell is an ETA less than 1, and cancerous was used to answer the question posed in the Objective.

**Background**

- **The Cole relaxation frequency as a parameter to identify cancer in breast tissue**
- **MCF-10A vs. MDAMB-435s**
- **Electrical properties of breast cancer cells from impedance measurement of cell suspensions, MDAMB-435s**

**Charging Relaxation**

The cell membrane has the characteristics of an electrical capacitor (Figure 1). For example, positive charges are outside the membrane and negative charges are on the interior. But this excess charge distribution is not always constant, since intermembrane structures in the membrane protein, sodium dexamethasone (SDM) creates a reactive pathway for charges to re-distribute the excess charge that is present (see text in Figure 1). This process is called relaxation and takes place in a characteristic time $t_{\text{relaxation}}$, where $\text{relaxation}$ is the electrical resistance of the system and $\text{transverse}$ is the electrical capacitance $t_{\text{transverse}}$ of the membrane. This process to changes in the electrical impedance of tissue at a relaxation frequency given by $C_{\text{transverse}}$ as $C_{\text{transverse}}^{-1}$ is an example of the fitting parameters to the data. With no post-acquisition data processing, the statistics obtained from the ETT1 study of breast surgery patients [1] were Sensitivity=100% and Specificity=85%. With mathematical optimization statistical analysis, 50% of the same data, the Sensitivity remains at 100% and Specificity improves to 100%.

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