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# Stochastic Modeling for Using an Extended Reliability Growth Model for Survival Outcomes in Black And White Breast Cancer Patients

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**ABSTRACT:** To evaluate weight change patterns over time following the diagnosis of breast cancer and to examine the association of post-diagnosis weight change and survival outcomes in Black and White Patients. BMI loss is a strong predictor of worse breast cancer outcomes, growing prevalence of obesity may hide diagnosis of cancer cachexia, which can occur in a large proportion of breast cancer patients long before death.The most widely used traditional reliability growth tracking model andreliability growth projection model are both included as International Standard and National Standard models. These traditional models address reliability growth based on failure modes surfaced during the test. This paper presents and Extended Model that addresses this practical situation and allows for primitive corrective actions.

**Keywords:** Breast Cancer, Stress Management,Stress, Body Mass index(BMI), Extended reliability growth model.

## I. INTRODUCTION

Obesity is a common health problem in the USA with its prevalence increasing in the past few decades [1]. Obesity is associated with not only an increased risk of many cancers [2], including postmenopausal breast cancer, but may also impact cancer prognosis and treatment [3], Body size before or at diagnosis and survival has been studied extensively. A Recent meta-analysis reported that for a 5 kg/m$^2$ increase in body mass index (BMI) before diagnosis. However, relatively few studies have investigated the relationship between weight change after diagnosis and survival outcomes in breast cancer patients, with heterogeneous results [4,5], Several studies found an association of weight loss with increased risk of mortality. While some studies found and association of weight gain with increased risk of mortality, other studies did not find an association between weight gain and survival.

In the test-fix-test strategy problem modes are found during testing and corrective actions for these problems are incorporated during the test. For the test-find-test strategy problem modes are found during testing but all corrective actions for these problems are delayed and incorporated after the completion of test. This paper presents an extended reliability growth model that provides assessments for the test-fix-find-test strategy and also allows for preemptive corrective actions. The Extended Model preserves the properties of the traditional models and reduces to backgroundthese models and strategies as special cases. The model also provides extensive metrics useful for managing the reliability program.

## II. BACKGROUND ON THE WIDELY USED TEST-FIX-TEST MODEL

Tolay the groundwork for the Extended Model we first give some background on the two widely used basic models. For reliability growth during test-fix-test development testing states that the instantaneous system MTBF at cumulative test time t is

$$M(t) = [\lambda \beta t^{\beta-1}]^{-1} \quad (1)$$

where $0 < \lambda$ and $0 < \beta$ are parameters. The Non- homogeneous Poisson Process with intensity in [9] is defined by

$$r(t) = \lambda \beta t^{\beta-1} \quad (2)$$

thus allowing for statistical procedures based on this process for reliability growth analyses. This model is applicable to text-fix-test data not test-fix-find-test. Estimation procedures, confidence intervals, etc, in [10]. The parameter $\lambda$ is referred to as the scale parameter and $\beta$ is the shape parameter. For $\beta=1$, there is no reliability growth.For $\beta<1$, there is positive reliability growth. That is, the system reliability is improving due to corrective actions. For $\beta>1$, there is negative reliability growth. The basic model the achieved or demonstrated failure intensity at time $T$, the end of the test, is given by $r(T)$. We denote the achieved failure intensity by

$\lambda_{CA}=r(T)$ (3)

Suppose a development testing program begins at time 0 and is conducted until time $T$ and stopped. Let $N$ be the total number of failures recorded and let

$0<X_1<X_2<.........\,..<X_N<T$ denote the $N$ successive failure times on a cumulative time scale. We assume that the NHPP assumption applies to this set of data in [8]. Under the basic model the maximum likelihood estimates for $\lambda$ and $\beta$ (numerator of MLE for $\beta$ adjusted from $N$ to $N-1$ to obtain unbiased estimate) are

$$\hat{\lambda}=\frac{N}{T^{\hat{\beta}}},\hat{\beta}=\frac{N-1}{\sum_{i=1}^{N}\log\frac{T}{X_i}}. \quad (4)$$

And

$$\lambda^{\bullet}=\frac{N}{\hat{T}^{\beta^{\bullet}}} \quad (5)$$

$$\beta^{\bullet}=\frac{N-1}{\sum_{j=1}^{n}\log\frac{T}{X_j}} \quad (6)$$

If it is assumed that no corrective actions are incorporated into the system during $\beta<1$ the test and then this is equivalent to assuming that for $\lambda_{CA}$ and $\lambda^{\bullet}_{CA}$ is estimated in [5,6]. The estimated projected failure intensity

$$\lambda_p=\lambda_{AT}+\sum_{i}^{N}(1-E_i)+\hat{E}\,h(T/AT) \quad (7)$$

$$\lambda^{\bullet}_p=\lambda^{\bullet}_{AG}+\sum_{i}^{N}(1-E^{\bullet}_i)+\hat{E}\,h(T/AG) \quad (8)$$

The extended model projected failure intensity is

$$\lambda_{EM}=\lambda_{CA}-\lambda_{AT}+\sum_{i}^{N}(1-E_I)\frac{N_i}{T}+\hat{E}\,h(T/AT)$$

(9)

$$\lambda^{\bullet}_{EM}=\lambda^{\bullet}_{CA}-\lambda^{\bullet}_{AT}+\sum_{j}^{N}(1-E^{\bullet}_j)\frac{N_j}{T}+\hat{E}\,h(T/AG)$$

(10)

The extended model projected MTBT is

$$M_{EM}=\frac{1}{\lambda_{EM}} \text{ and } M^{\bullet}_{EM}=\frac{1}{\lambda^{\bullet}_{EM}} \quad (11)$$

## III. EXTENDED RELIABILITY GROWTH MODEL FOR TEST-FIX-FIND –TEST MODEL

In order to provide the assessment and management metric structure for corrective actions during and after a test.Estimating this increased reliability during the test and this is the same for management strategy. This reliability with test-fix-find-test data is the objective of this paper.

For the Extended Model we assume that the achieved MTBF, before delayed fixed, based among datashould be exactly the same as the achieved MTBF from the data. If $K$ is the total number ofdistinct modesthen, the intensity to be estimated is

$$\lambda_p=\lambda_s-\lambda_B+\sum_{i=1}^{K}(1-d_i)\lambda_i+dh(T). \quad (12)$$

To allow for BC failure modes in the extended model we replace $\lambda_s$ by $\lambda_{CA}$ in (12). Also, let $\lambda_{BD}$ be the constant failure intensity for the failure modes, and let $h(t/BD)$ be the first occurrence function for the failure modes.

The extended Model projected failure intensity is

$$\lambda_{EM}=\lambda_{CA}-\lambda_{BD}+\sum_{i=1}^{K}(1-d_i)\lambda_i+dh(T/BD).$$

(13)

The Extended Model projected MTBF is $M_{EM}=1/\lambda_{EM}$. This is the MTBF after the incorporation of the delayed BD failure modes that we wish to estimate.Under the Extended Model the achieved failure intensity, before the incorporation of the delayed BD failure modes, is the first term $\lambda_{CA}$. The achieved MTBF at time T before the BD failure modes is $M_{CA}=[\lambda_{CA}]^{-1}$.

## IV. EXAMPLE

Compared to non-HispanicWhite, Black women were older, more likely to smoke currently, receive Medicare or Medicaid benefits, and have comorbidities. As expected, Black women were more likely to have triple-negative breast cancer.

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The distribution of tumor stage was similar among the groups. Black women had the highest BMI at diagnosis with 30.9% being overweight and 51.8% obese, followed by Hispanic, and non-Hispanic whites, while Asian Americans had the lowest BMI. While body weight did not change substantively in other racial/ethnic groups.Patients younger than 50 gained weight after diagnosis, while older patients lost weight. Patients with atleast one, comorbidity lost substantial weight after diagnosis. In the multivariable analysis using a mixed-effects linear model, we found that Black patients had higher BMI at diagnosis but had significance weight loss after cancer diagnosis compared with Whites.(see Fig. 1).

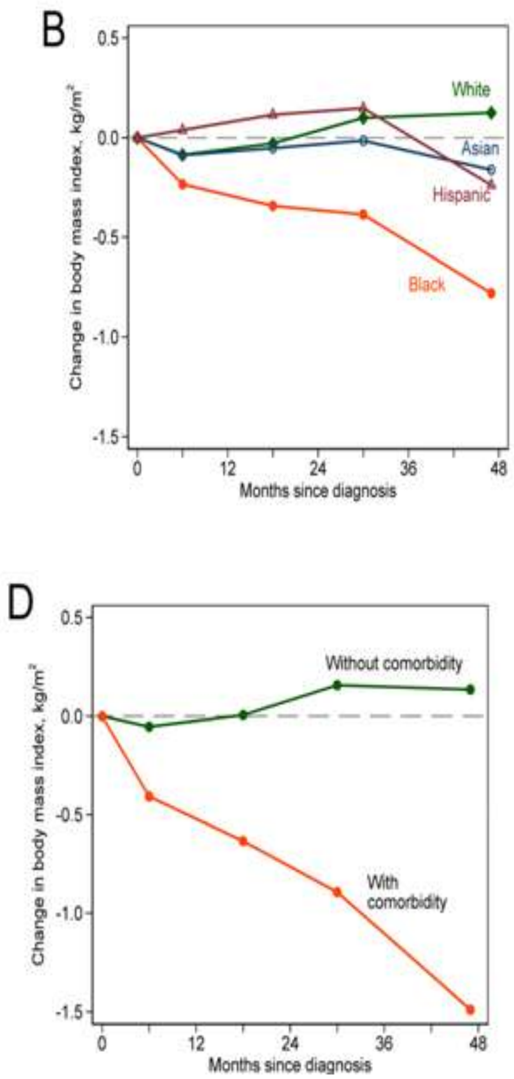

Fig (1)

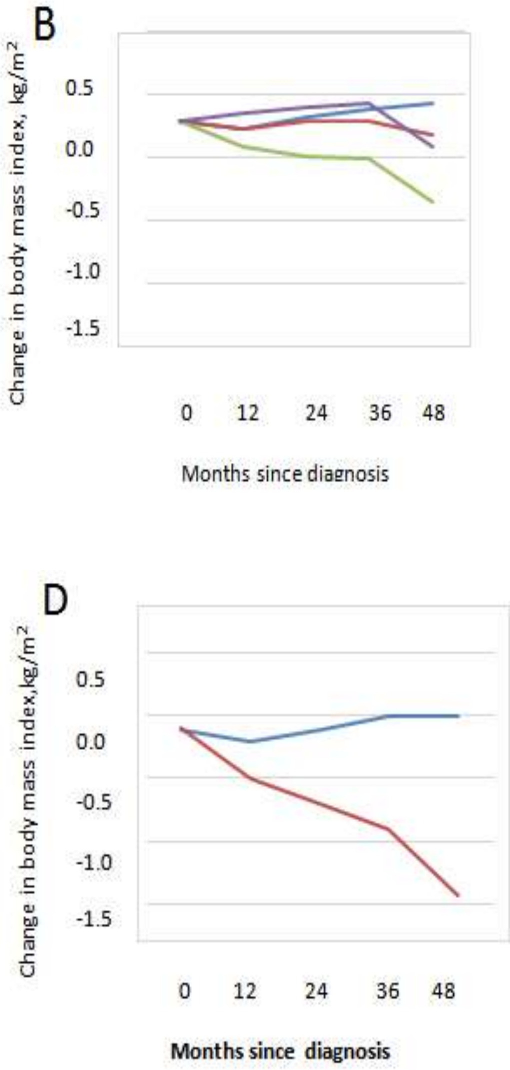

Fig (2)

## V. CONCLUSION

The paper is rigorously defined the background on the widely used traditional reliability growth tracking model and reliability growth projection model are both included as Test-Fix-Test and Test-Find-Test models. Distribution of body mass index at baseline by race/ethnicity of Black, White women of Asian and Hispanic (B) and comparison of comorbidity status (D) of tumor stageas in fig (1). At the completion of the process, it concludes that from fig (2) with the reliability growth test. We conclude that the results coincide with the mathematical and medical report.

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