A Mathematical Reliability Growth Model using for Acute HPA Axis Responses, Heart Rate and Mood Changes to Psychosocial Stress in Human at Different Times of Day

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ABSTRACT:

There is evidence showing that HPA axis responses to pharmacological provocation depend on time of day with larger cortisol responses in the afternoon and evening compared to the morning hours. However, it is still unknown whether HPA axis responses to psychological stress are affected by time of day and whether they can be assessed with equal reliability in the morning and afternoon, respectively. Software Reliability Model is categorized into two, one is static model and the other one is dynamic model. Dynamic models observe the temporary behavior of debugging process during testing phase. In Static Models, modeling and analysis of program logic is done on the same code. A Model which describes about error detection in software Reliability is called Software Reliability Growth Model. This paper reviews various existing software reliability models and their failure intensity function and the mean value function. On the basis of this review a model is proposed for the software reliability having different mean value function and failure intensity function. Finally we conclude our Mathematical results in the (4.1.figure) are well fitted with the Reliability Growth model and the maximum value of ACTH, Salivary cortisol, Total plasma cortisol, at the time has been obtained. This will be helpful for the medical professional.

Key words: HPA axis; psychosocial stress; salivary cortisol; Social Stress Test (TSST); ACTH

Mathematical subject classification: 62 Hxx ; 62NO5; 90B25

1. INTRODUCTION:

Software reliability is about to define the stability or the life of software system with different properties. These properties include the trustfulness of software system, software cost, execution time, software stability etc. The aspects related to these software system includes the probability of software faults, frequency of fault occurrence, criticality of fault, associated module with respective fault etc. In a software development process, the pre estimation of software reliability is required to deliver the software product. According to the required level of software quality estimation of software cost, development time is also estimated. There are number of quality measure that approves the software reliability [16]. Each stage of software life cycle itself takes some time quantum to deal with software reliability. Higher the software quality, lesser the software maintainability. Software reliability growth models, refers to those models that try to predict software reliability from test data [17]. These models try to show a relationship between fault detection data (i.e. test data) and known mathematical functions such as logarithmic or exponential functions. The goodness of fit of these models depends on the degree of correlation between the test data and the mathematical function [10]. The software reliability is defined as the probability that the software will operate without a failure under a given environmental condition during a specified period of time [2]. The software reliability assessment is one of the most important processes during the software development. Since 1970, many software reliability growth models (SRGMs) have been proposed. In general, there are two major types of software reliability models: the deterministic and the probabilistic. The deterministic one is employed to study the number of distinct operators and operands in the program. The probabilistic one represents the failure occurrences and the fault removals as probabilistic events [14].

2. LOGISTIC GROWTH CURVE MODEL:

In general, software reliability tends to improve and it can be treated as a growth process during the testing phase. That is, the reliability growth occurs due to fixing faults. Therefore under some conditions, the models
developed to is, predict economic population growth could also be applied to predict software reliability growth. These models simply fit the cumulative number of detected faults at a given time with a function of known form. Logistic growth curve model is one of them and it has an S-shaped curve. Its mean value function and intensity functions are [13]

\[ m(t) = \frac{a}{1 + k \cdot \exp(-bt)}, \quad a > 0, b > 0, k > 0, \]

\[ \lambda (t) = \frac{ab \exp(-bt)}{(1 + k \cdot \exp(-bt))^2}, \quad a > 0, b > 0, k > 0 \]

Where \( a \) is the expected total number of faults to be eventually detected and \( k \) and \( b \) are parameters which can be estimated by fitting the failure data.

3. PROPOSED MODEL:
On the basis of the model discussed the logistic growth curve model seems perform better than the other models. The model can be designed on the basis of the tangential function. The tangential model must be drawn in the positive axis. It detection as the no of fault detection decrease the reliability increases. The zero fault detection means the infinite reliability and the zero software reliability means the infinite faults. The proposed model suits the behavior of the software reliability so fits to the software reliability.

In the beginning of testing, there is exponential number of faults in the software code. The number of faults is unknown but they are fixed in number. All faults are of same type. Each fault can be detected independent of each other. The remaining number of fault and the remaining time is useful to determine the other parameters. The probability of occurring of each fault is same. Each fault occurred can be removed instantaneously. The mean value function can be given as

\[ m(t) = \left( f \cdot \nu \right) = \left( 1 - \exp(-\phi t) \right) \quad > 0 \quad f \cdot \nu : 0 - - - - - - - - - (1) \]

The failure intensity can be expressed as

\[ \lambda (t) = \frac{d m(t)}{d(t)} \quad - - - - - - - (2) \]

According to the failure intensity of the software at time \( t \) is proportional to the expected number of faults remaining in the software.

4. APPLICATIONS:
Stress responses were analyzed following the out-lined ANCOVA procedure. The TSST induced significant net increases in salivary free cortisol (F (6, 1026) = 75.2; p < 0.0001), total plasma cortisol (F (6,960) = 126.0; p < 0.0001), ACTH (F (3,501) = 92.6; p < 0.0001) and heart rates (F (4,636) = 74.6; p < 0.0001; see Figs. 4.1(a) – (c). For salivary free cortisol a significant main effect of time of day (morning versus afternoon) could be observed (F(1,169) = 6.3; p < 0.01) while the interaction time of day by trial samples did not reach significance (F(2.1,363.3) = 2.3; p = 0.10; see Fig.4.1(c)).
Fig 4.1 (c) Mean (± SEM) ACTH responses (pg/ml), Fig.4.1 (b) total plasma cortisol responses (nmol/l) and Fig.4.1 (c) free salivary cortisol (nmol/l) in the morning and afternoon before and after stress. The shaded area indicates the period of stress exposure

5. DISCUSSION:

The results show that the ACTH, total plasma cortisol, and salivary cortisol stress responses to the TSST are comparable (pattern as well as net increase) when the stress test is performed between 0945 and 1900 h. This may be somewhat surprising given the higher pre-stress baseline levels for cortisol in the morning. Analyses of the test power for the parameter net increase confirmed that the probability of revealing an effect of time of day was satisfactorily high (>90%) and underlines that medium to large effects of time of day could have been discovered with the present sample. It is still possible that small differences between morning and afternoon sessions may exist, since the test power of the present analysis was below 30% for small effects of interest. Furthermore, there seems to be a difference in the adrenal cortex sensitivity to ACTH signals in relation to time of day. In the present data, comparable ACTH stress responses (overall pattern, net increase and AUC) in the morning and afternoon led to a larger salivary cortisol AUC response in the morning compared to the afternoon (see Fig. 4.1(a) and (c)). In contrast, [6], [19] observed higher adrenal cortex sensitivity in the afternoon.

One possible explanation for the results obtained with CRF might be that endogenous CRF levels at the level of the pituitary are high in the morning, so that additional exogenously administered CRF causes little further HPA axis responses [18] (Furthermore, the TSST is a central stimulus, whereas CRF acts at the pituitary level. It is possible that glucocorticoid negative feedback may operate differently for a central stimulus than for a pituitary stimulus [20], [9] thereby making it possible to elicit a stress response despite heightened cortisol levels. Also, vasopressin might play an important role in centrally activated HPA axis responses, like a confrontation with the TSST. Finally, it is unlikely that a difference in metabolic clearance rate (MCR) of total plasma cortisol is responsible for the present finding of higher pre-stress total cortisol levels, since MCR is, if at all, higher in the morning, and only pre-stress total cortisol levels differed according to the time of day [7], [6] & [5].

Furthermore, mood appeared to be differentially affected by time of day. Ratings of elevated mood and calmness were higher in the morning compared to the afternoon before stress but comparable after cessation of the TSST. We suggest considering this observation as preliminary result that needs further exploration because this topic is until now seldom addressed in the literature. Furthermore, more elaborated measures are warranted. Stress responses to the TSST can be assessed with comparable reliability in the morning or afternoon. However, stress-related mood changes might be easier detectable in the morning but this topic needs much further exploration. In terms of practical recommendations, one might prefer to conduct a stress study in the late afternoon to minimize minor (but in correlation analyses detectable) effects of baseline values on stress responses during the morning, unless there are other restrictions concerning study implementation. Researchers should be aware of possible meal-induced cortisol increases [3] (meal and stress responses are not additive) and heart rate or mood changes [4], [11] & [1]. In the morning, any interference with the subjects cortisol response to awakening should be avoided [15], [12] & [8]. This could be guaranteed by fixed awakening times and/or extended resting periods before onset of the stress procedure.
6. MATHEMATICAL RESULTS:

Mean value function for ACTH

Mean value function for salivary free cortisol

Mean value function for Total plasma cortisol
Intensity function for ACTH

Intensity function for Salivary free cortisol

Intensity function for Total plasma cortisol
7. CONCLUSIONS:
There is evidence showing that HPA axis responses to pharmacological provocation depend on time of day with larger cortisol responses in the afternoon and evening compared to the morning hours. However, it is still unknown whether HPA axis responses to psychological stress are affected by time of day and whether they can be assessed with equal reliability in the morning and afternoon, respectively. When a software system is designed, the major concern is the software quality. The quality of software depends on different factors such as software reliability, efficiency, cost etc. This journal study various existing software reliability model with there failure intensity function and the mean value function. This journal also proposes a new model for software reliability having different failure intensity function and mean value function. In future the proposed can be implemented and results of the model can be compared with the existing model results. Finally we conclude our Mathematical results in the (4.1.figure) are well fitted with the Reliability Growth model and the maximum value of ACTH, Salivary cortisol, Total plasma cortisol, at the time has been obtained. This will be helpful for the medical professional.

8. REFERENCES: