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Stochastic Model of Vasopressin by the Effect of Age

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ABSTRACT
The neurohypophysial hormone vasopressin contributes to control of urine output and, while urine flow shows a clear daily rhythm, there has been debate as to whether this is true of neurohypophysial hormones. A study was performed on fifteen adult males, with a mean age of 25 years, over a 24 h period. Vasopressin concentrations were inversely correlated with packed cell volume, indicating that the altered hormone release was affecting fluid retention. Consistent with this was the observation that the relationship of plasma osmolality to vasopressin depended on the time of day. To determine the effect of ageing, a similar study was performed on nine healthy elderly subjects with a mean age of 70 years. The nocturnal peak of vasopressin was markedly attenuated, while oxytocin release was similar to that in the younger group. We use the availability of system with distributed outages to check the hormone levels.
Keywords: Stress, System availability, Vasopressin, Oxytocin.

I. MATHEMATICAL MODEL

For some electronic components, the hazard function of TTF has a bathtub curve is a monotonically decreasing function initially, eventually becoming a constant, and finally changing to a monotonically increasing function after sufficient time elapses. In other words, an exponential distribution (constant hazard function) holds only during one particular phase of the component life. For the planned outage, e.g., upgrading the hardware or software of the computer systems, the time between two consecutive upgrades is nearly deterministic, and even the time used to upgrade the system is nearly deterministic.

1) A general closed-form formula for the availability of a System with multiple outages of arbitrary distributions;
2) Availability bounds for a system with unplanned exponentially Distributed failure times, and planned outages with bounded distributions;
3) Explicit criteria to verify the applicability of exponential models when applied to systems with outages of general distributions, of which only their two-sided bounds are known.

System with planned and unplanned outages

The system has 2 types of outages: planned and unplanned.

Unplanned outages could be caused by unanticipated system failures.

Planned outages can be system upgrades, maintenance, configuration change, etc., that are scheduled to enhance system functionalities. TTP and TTU can follow general distributions. The objective is to derive a general formula of A, and to obtain availability bounds when TTP Distributions are given with insufficient information[5 ,6 ,7].

Theorem 1: The steady-state availability of a system with unplanned and planned outages is:

$$A = \left[1+\frac{\lambda}{\mu}+ \frac{\lambda}{\mu_2}\cdot \frac{\alpha(\lambda)}{1-\alpha(\lambda)} \right]^{-1} = \left[1+\frac{\lambda}{\mu}+\theta(\lambda) \cdot \frac{\lambda}{\mu_2} \right]^{-1}$$

$$\alpha(\lambda) \equiv \int_0^\infty \exp(-\lambda.x)\, dF(x) \quad \theta(\lambda) \equiv \frac{\alpha(\lambda)}{1-\alpha(\lambda)}$$

$$\mu^{-1} \equiv MTTU = \int_0^\infty x dG(x).$$

This shows that any distribution of G(x) of TTU with the same MTTU= μ_2^{-1} , results in the same steady-state system availability . However, the distribution of TTP does affect system availability through θ(λ), in which α(λ) is the Laplace–Stieltjes transform of TTP evaluated

at s= λ, α(λ) = F~(λ),

$$F\tilde{}(s) \equiv \int_0^\infty \exp(-\lambda.s)\, dF(s)$$

Now, the Availability formula for the distribution of TTP is deterministic

Let TTP = T,

$$A_D(T) = \left[1+\frac{\lambda}{\mu}+ \frac{\lambda}{\mu_2}\cdot \frac{\exp(-\lambda.T)}{1-\exp(-\lambda.T)} \right]^{-1}$$

$$= \left[1+\frac{\lambda}{\mu}+ \frac{\lambda}{\mu_2}\cdot \frac{1}{\exp(-\lambda.T)-1} \right]^{-1}$$

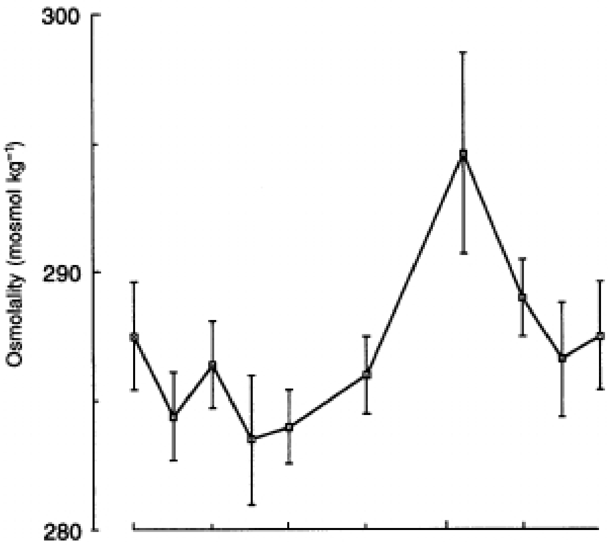
also,let TTP ∈ [T_1,T_2](0< T1<T2);the pdf of TTP is defined in such a way that f(x) =0,for x not in [T_1,T_2] and $\int_{T1}^{T2} f(x)dx = 1$.

II. APPLICATION

Changes in circulating vasopressin concentrations have obvious implications for fluid balance,but recent evidence suggests that oxytocin may also play a role in sodium balance. Many of the circadian changes are predictive in nature serving to switch on a function of importance for anticipated demands, so that if vasopressin does contribute to the nocturnal fall in urine flow in man, one would expect to see an increase in plasma vasopressin concentrations, unrelated to plasma osmolality, in the early part of the night.The plasma concentrations of the hormones increase during the hours of daylight, falling again during the hours of darkness. A daily rhythm of vasopressin secretion with a nocturnal rise has been observed in humans. The increased susceptibility of the aged human to significant derangement of water balance could result from a number of factors including altered thirst sensation, altered synthesis and release of vasopressin and altered renal concentrating ability. There is no loss of vasopressin-producing cells in the hypothalamic magnocellular nuclei in man. Ageing affects the circadian pattern of many functions, but no observations have been performed on this aspect of the neurohypophysial system[1,2,3,4]. In order to determine whether neurohypophysial hormones show a daily rhythm under normal conditions, a study has now been performed on the daily pattern of neurohypophysial hormone release in a young group of men carrying out their normal daily activities, the changes being related to indices of fluid balance. The pattern of neurohypophysial hormone secretion was compared with that in a fully active, healthy group of elderly men.

Observations were performed on fifteen healthy male subjects in the age range 22-40 years and nine healthy male subjects in the age range 60-75. All subjects were normotensive with normal renal function, with no significant past or current medical history and on no regular medication. Each was studied over a single 24 h period. The subjects spent the 36 h prior to the study following their normal daily routine and during both this period and during the study the subjects abstained from alcohol, tobacco and vigorous exercise. The meal times were standardized, and the subjects kept a diary of their activities and fluid and food intakes and were weighed. At 16.30 h a forearm vein was cannulated and after about 30 min of recumbent rest 12 ml of blood were withdrawn through the cannula. Over the following 24 h, eight further blood samples were taken (seven in the elderly subjects), each after 30 min recumbency, for the determination of packed cell volume, plasma osmolality, sodium, potassium, vasopressin and oxytocin. All subjects went to bed at 23.30 h when the lights were switched off and rose at 08.00 h the following day when lighting was restored.

The results showed a clear pattern of vasopressin release over the 24 h in studies in the young group of subjects studied while in fluid balance and undergoing their normal activities. Plasma concentrations tended towards a maximum at midnight and fell to a minimum in the late afternoon[8 ,9]. There was, however, some variation between individuals, with differences both in the magnitude and the timing of the peak concentration also noted such variation between individuals, and indicated that there was marked variation in the same individual over successive days and nights. Such variation in the pattern of release could account for the failure of some observers to detect a significant change in circulating concentrations of the hormone. A similar pattern of release was seen with oxytocin, suggesting that a similar mechanism may control the patterns of release of both neurohypophysial hormones.



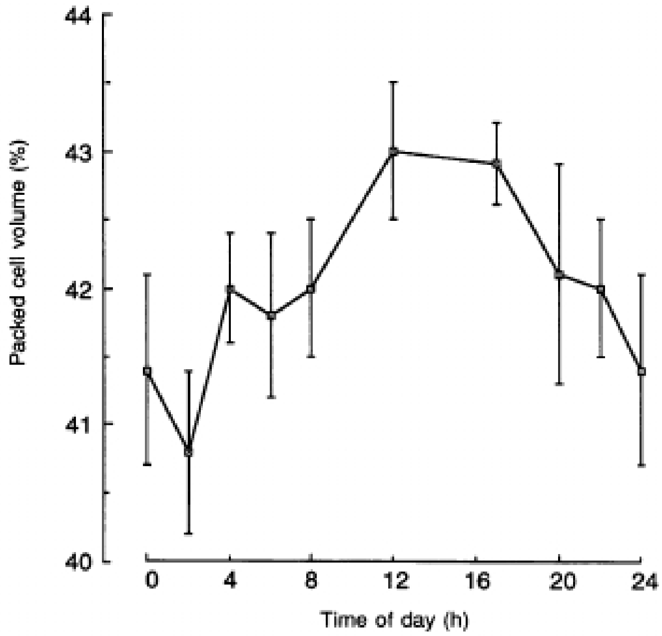
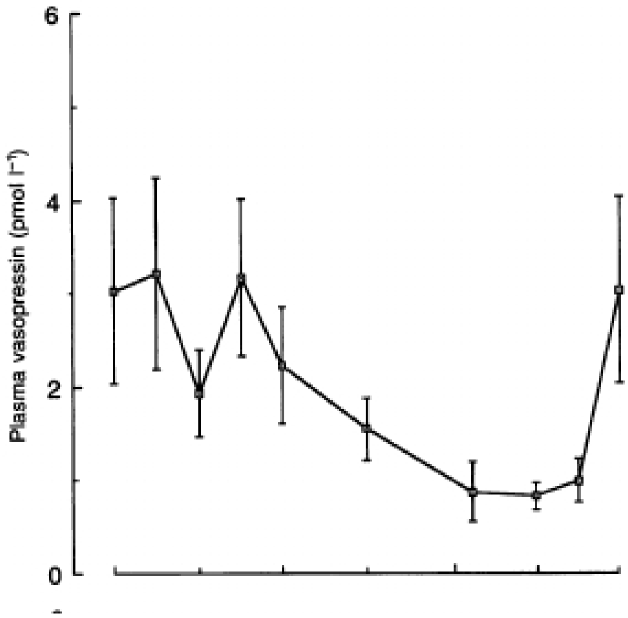


Fig. 1. Plasma osmolality and packed cell volume over 24 h in a group of 15 young subjects.

A



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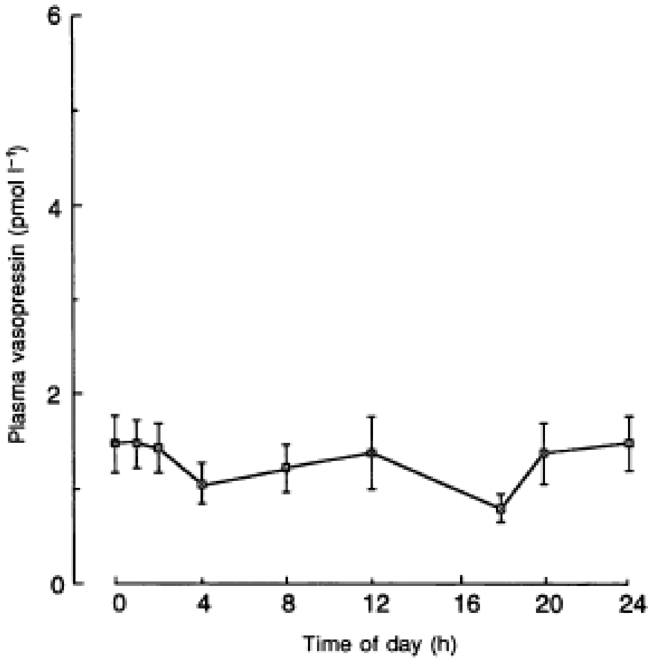
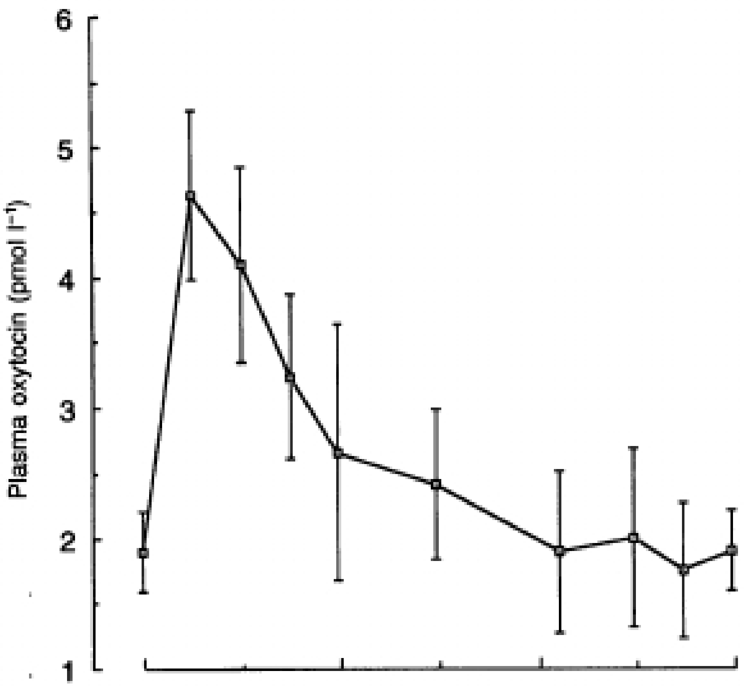


Fig. 2. Plasma vasopressin concentrations over 24 h in a group of 15 young subjects (A) and 9 Elderly subjects(B).

A



B

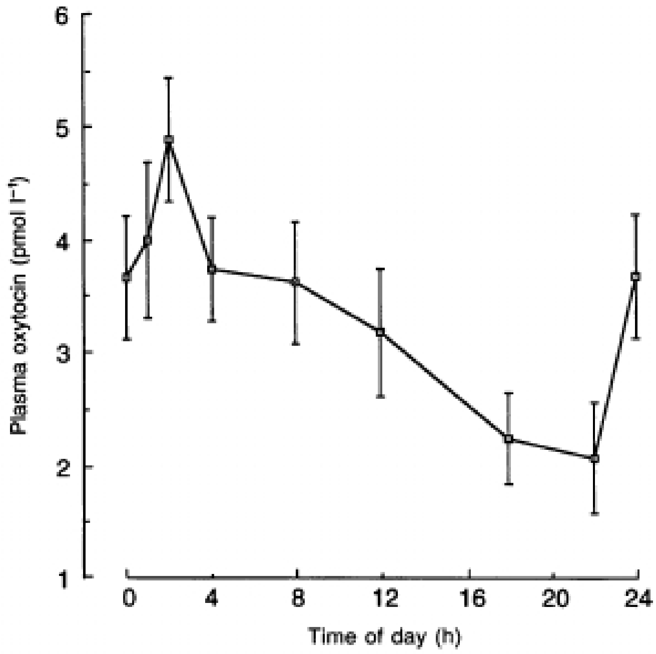
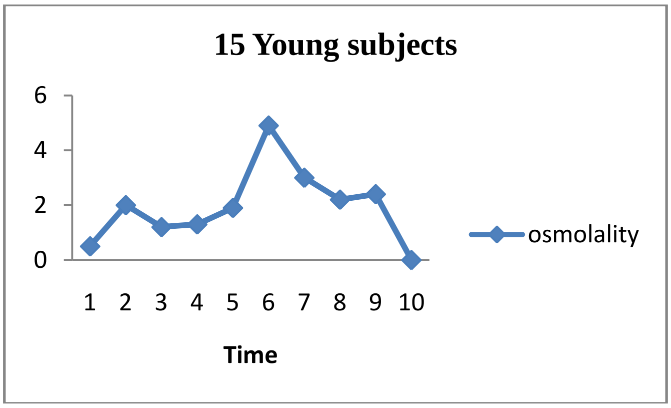
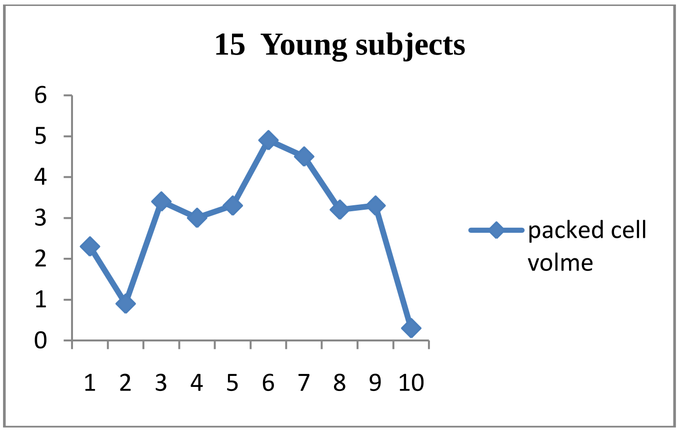


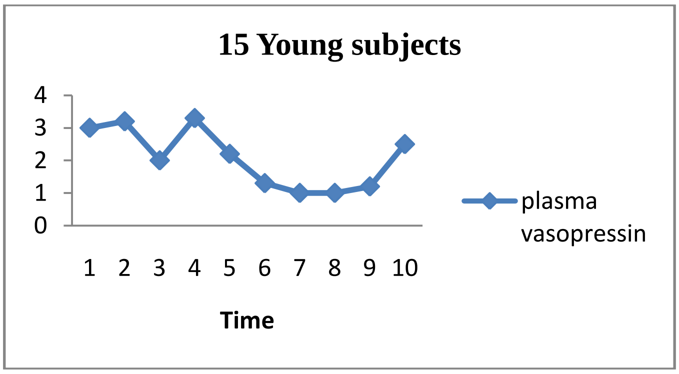
Fig. 3. Plasma oxytocin concentrations over 24 h in a group of 15 young subjects (A) and 9 Elderly subjects (B).

III. MATHEMATICAL RESULTS

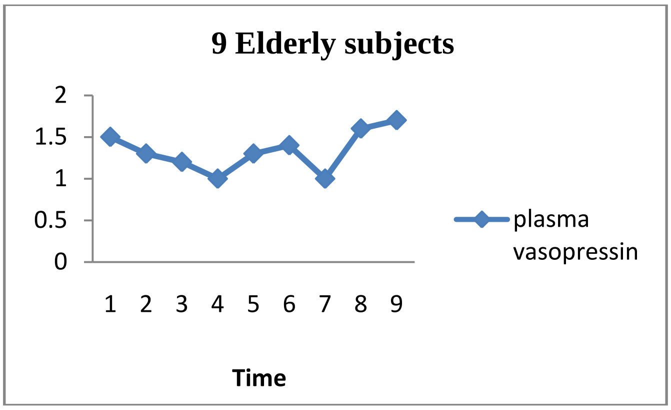




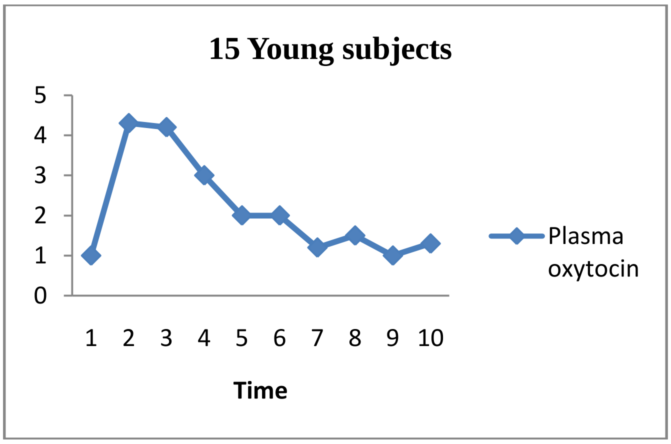
A


15 Young subjects
4
3
2
1
0
1 2 3 4 5 6 7 8 9 10
Time
plasma vasopressin

B


9 Elderly subjects
2
1.5
1
0.5
0
1 2 3 4 5 6 7 8 9
Time
plasma vasopressin

A


15 Young subjects
5
4
3
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1
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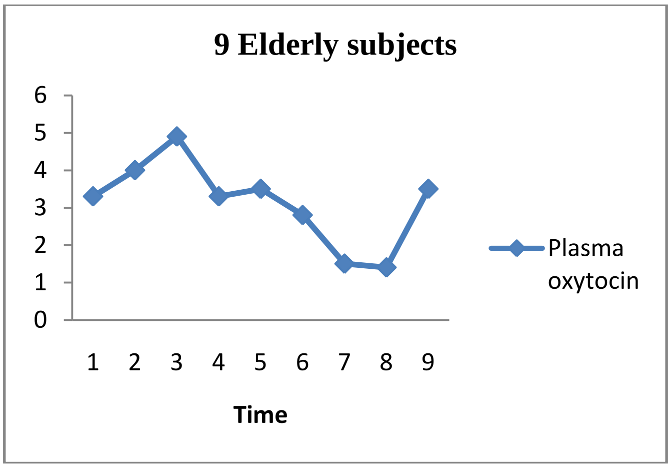
1 2 3 4 5 6 7 8 9 10
Time
Plasma oxytocin

B


9 Elderly subjects
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Time
Plasma oxytocin

IV. CONCLUTION

The nocturnal peak of vasopressin was markedly attenuated, while oxytocin release was similar to that in the younger group. These observations confirm the existence of a daily rhythm in the plasma concentrations of neurohypophysial hormones and indicate that the amplitude of the vasopressin change decreases with age. We found that the level of vasopressin decreased in young subjects than elders.

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