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# A STUDY ON FUZZY EXPECTED VALUE FOR THE EFFECT OF OXYTOCIN USING GENERALIZED GAMMA DISTRIBUTION

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**Abstract:**

Weconsider a fuzzy generalized gamma distributionand is used to study the effect of different dosages of oxytocin in during caesarean section. The exhaustive testing phases are follows: the mean values of the fuzzy generalized gamma distribution for different doses oxytocin (5u and 10 u) were calculated.Testing hypothesis were used to find the preeminent doses was conversed. This investigate confirmations that mean of oxytocin 5u dose has significant effect than the 10u dose.

**Key Words:** Oxytocin, Generalized Gamma Distribution & Testing Hypothesis

## 1. Introduction:

The generalized gamma distribution (GGD) waspresented by Stacy and Mihran [10] in an effort to pool together the supremacy of two distributions: the Gamma distribution and the Weibull distribution. It is a novel distribution (1962) than the normal distribution (1774). The generalized gamma distribution relics a distinguished distribution asthis onestandsremarkablyadjustable. This distribution is tooadvantageousfrom the time when it consists of as special cases of quite a number of distributions: the exponentialdistribution, the log-normal distribution, the Weibull distribution, the Levy distribution.

All together the exponential in addition to the Weibull distributions have extensiverange ofusages in the assessment of engineering data.It is independently common habitation, however,to come acrossfacts which arediscordantthrough these distributions and furtheraccustomed probability models. Such data set alightimplicationconcerning to the letdownsystemsbesidesaddedcorporealmarvels which may be involved. It also emboldensexploration to expand the group of distributions which areuseful to the enthusiastic statistician. Stacy and Mihran [9], O. Gomes et al. in 2008 [5] discussed the parameter estimation of the generalized distribution, the scheme of Parameter Estimation and its application was discoursed by Gui Gao et al. [6].

The release of oxytocin by the pituitary gland acts to regulate some female reproductive functions.Stretch of the uterus and the uterine cervix or stimulation of the breasts nipples increases action potentials in axons of oxytocin – secreting neurons.Action potentials are conducted by sensory neurons from the uterus and breast to the spinal cord and up ascending tracts to the hypothalamus.Action potentials are conducted by axons of oxytocin – secreting neurons in the hypothalamohypophysical tract to the posterior pituitary, where they increase oxytocin secretion.Oxytocin enters the ciruclation, increasing contractions of the uterus and milk ejection form the lactating breast.In addition its role of delivery promotion,OT can also be espoused in the pain factor in the backbone and the periaqueductal gray of the brain, [14]. Habenular nucleus (Hb) is extensive in the dorsal diencephalon of vertebrates, and as an important nucleus which participates in analgesia in central nervous system, it can be divided into medial habenular nucleus (MHb) and lateral habenular nucleus (LHb) (Fu et al., 2010 [4]; Huang et al., 2011[7]; Fu,2006 [3]), in which LHb, as the junction of limbic system like amygdale, hippocampus, preoptic area, etc. and midbrain, can regulate sleep and physiological process of cardiovascular activity (Zhao and Wang, [13]).

## 2. Materials and Methods:

### Generalized Gamma Distribution:

The random variable X follows GGD with real positive parameters $\lambda,\mu,\varphi$ such that $\lambda-$ is the scale parameter, $\mu$ and $\varphi$ are the shape parameters is symbolized by $X \sim GGD(\lambda,\mu,\varphi)$. The probability density function (p.d.f.) of GGD is given by

$$f(x)=\frac{\lambda x^{\lambda\varphi-1}e^{-\left(x/\mu\right)^{\lambda}}}{\mu^{\lambda\varphi}\Gamma(\varphi)},\quad x>0.$$

The expected value and variance value of X are given by

$$E[X]=\frac{\mu\Gamma\left(\varphi+1/\lambda\right)}{\Gamma\varphi},\quad V[X]=\mu^{2}\left(\frac{\Gamma\left(\varphi+2/\lambda\right)}{\Gamma\varphi}-\left(\frac{\Gamma\left(\varphi+1/\lambda\right)}{\Gamma\varphi}\right)^{2}\right).$$

**Fuzzy Generalized Gamma Distribution:**

In many life timeapplications, randomness is not the only characteristic of improbability. In numerous fields of application, remaining the fuzziness of environment and the laxity of observers, it is from time to timefarfetched to get hold ofprecise observationsof lifetime. The obtained lifetime data may be “polluted” and imprecise most of the time. Besides, controlled byhuman and further resources in research, exclusively for new equipment’s, exceptionally long-life equipment’s, and non-mass manufacturemerchandises, for which there is no comparative reliability information available, more often thannot, the lifetime is based upon subjective evaluation or rough estimate. That leads to the fuzziness of lifetime data.

Now consider the GGD with fuzzy parameter $\bar{\lambda},\bar{\mu},\bar{\varphi}$ that is switched with the parameters $\lambda,\mu,\varphi$. The probability of a random variable X follows Fuzzy Generalized Gamma distribution (FGGD) is symbolized by $X \sim FGGD\left(x;\bar{\lambda},\bar{\mu},\bar{\varphi}\right)$. The fuzzy p.d.f. of a random variable $X \sim FGGD\left(x;\bar{\lambda},\bar{\mu},\bar{\varphi}\right)$ is defined by

$$f\left(x;\bar{\lambda},\bar{\mu},\bar{\varphi}\right)=\left\{f(x)[\alpha],\mu_{f(x)}\,\middle|\,f(x)[\alpha]=\left[f_L(x)[\alpha],f_U(x)[\alpha]\right],\mu_{f(x)}=\alpha\right\}$$

$$f_L(x)[\alpha]=\inf.\left\{f\left(x,\bar{\lambda},\bar{\mu},\bar{\varphi}\right)(\alpha)\,\middle|\,\lambda\in\bar{\lambda}(\alpha),\mu\in\bar{\mu}(\alpha),\varphi\in\bar{\varphi}(\alpha)\right\},$$

$$f_U(x)[\alpha]=sup.\left\{f\left(x,\bar{\lambda},\bar{\mu},\bar{\varphi}\right)(\alpha)\,\middle|\,\lambda\in\bar{\lambda}(\alpha),\mu\in\bar{\mu}(\alpha),\varphi\in\bar{\varphi}(\alpha)\right\},$$

$$f\left(x;\bar{\lambda},\bar{\mu},\bar{\varphi}\right)=\frac{\bar{\lambda}x^{\bar{\lambda}\bar{\varphi}-1}e^{-\left(x/\bar{\mu}\right)^{\bar{\lambda}}}}{\bar{\mu}^{\bar{\lambda}\bar{\varphi}}\Gamma\left(\bar{\varphi}\right)},\quad x>0,\ \lambda\in\bar{\lambda}(\alpha),\mu\in\bar{\mu}(\alpha),\varphi\in\bar{\varphi}(\alpha).$$

The expected value of $X \sim FGGD\left(x;\bar{\lambda},\bar{\mu},\bar{\varphi}\right)$ is given by

$$\bar{E}(X)=\left\{E(X)[\alpha],\mu_{E(X)}\,\middle|\,E(X)[\alpha]=E_L(X)[\alpha],E_U(X)[\alpha],\mu_{E(X)}=\alpha\right\}$$

$$E_L(X)[\alpha]=\inf.\left\{E(X)\,\middle|\,\lambda\in\bar{\lambda}(\alpha),\mu\in\bar{\mu}(\alpha),\varphi\in\bar{\varphi}(\alpha)\right\}$$

$$E_U(X)[\alpha]=\sup.\left\{E(X)\,\middle|\,\lambda\in\bar{\lambda}(\alpha),\mu\in\bar{\mu}(\alpha),\varphi\in\bar{\varphi}(\alpha)\right\}$$

$$\bar{E}[X]=\frac{\bar{\mu}\Gamma\left(\bar{\varphi}+1/\bar{\lambda}\right)}{\Gamma\bar{\varphi}},\quad \lambda\in\bar{\lambda}(\alpha),\mu\in\bar{\mu}(\alpha),\varphi\in\bar{\varphi}(\alpha).$$

The variance value of $X \sim FGGD\left(x;\bar{\lambda},\bar{\mu},\bar{\varphi}\right)$ is given by

$$\bar{V}(X)=\left\{V(X)[\alpha],\mu_{V(X)}\,\middle|\,V(X)[\alpha]=V_L(X)[\alpha],V_U(X)[\alpha],\mu_{V(X)}=\alpha\right\}$$

$$V_L(X)[\alpha]=\inf\left\{V(X)\,\middle|\,\lambda\in\bar{\lambda}(\alpha),\mu\in\bar{\mu}(\alpha),\varphi\in\bar{\varphi}(\alpha)\right\}$$

$$V_U(X)[\alpha]=\sup\left\{V(X)\,\middle|\,\lambda\in\bar{\lambda}(\alpha),\mu\in\bar{\mu}(\alpha),\varphi\in\bar{\varphi}(\alpha)\right\}$$

$$V[X]=\bar{\mu}^{2}\left(\frac{\Gamma\left(\bar{\varphi}+2/\bar{\lambda}\right)}{\Gamma\bar{\varphi}}-\left(\frac{\Gamma\left(\bar{\varphi}+1/\bar{\lambda}\right)}{\Gamma\bar{\varphi}}\right)^{2}\right)$$

**3. Result and Discussion:**

Consider the randomized, double blind experiment presented by A.J. Pinder et al. [8] for haemodynamic effects triggered by rapid bolus of 5 or 10 units of oxytocin in thirty-four patients at caesarean unit beneath backbone anaesthesia. After administration of oxytocin the stroke volume (SV) was measured and is shown in the figure figure 1.

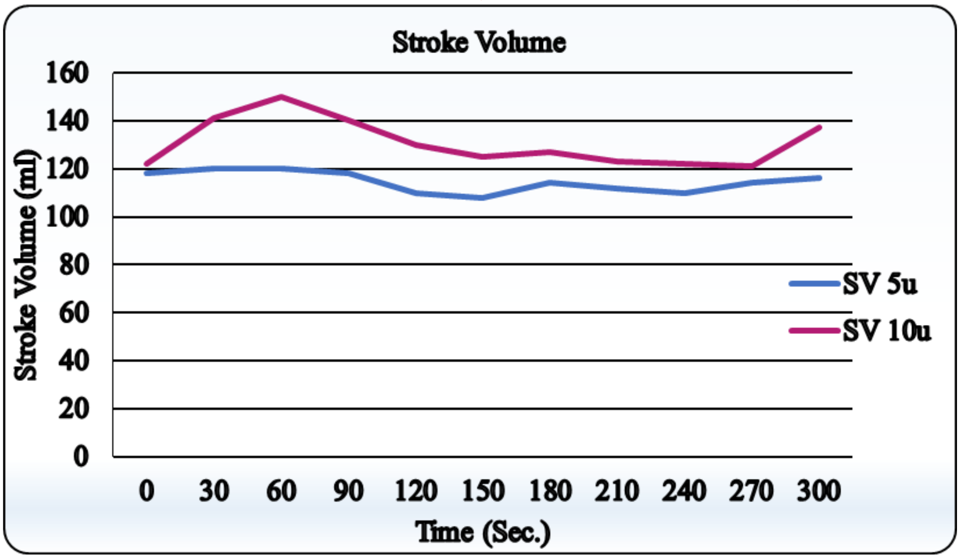


Figure 1: Cardiac output after administration of oxytocin

The parameters of stroke volume after 5u dose of oxytocin: GGD parameters are 1.175, 677.46, 0.2. The fuzzy triangular numbers of the GGD parameters are $\overline{\lambda}=$ [1.1079, 1.1750, 1.2596], $\overline{\mu}=$[676.1781, 677.4600, 678.8345], $\overline{\varphi}=$[0.1973, 0.2000, 0.2045], and the corresponding $\alpha$–cuts are $\overline{\lambda}(\alpha)=$ [1.1079+0.0671α, 1.1750, 1.2596-0.0846α], $\overline{\mu}(\alpha)=$[676.1781+1.2819α, 677.4600, 678.8345-1.3745α], and $\overline{\varphi}(\alpha)=$. [0.1973+0.0027α, 0.2000, 0.2045-0.0045α]. The parameters of stroke volume after 10u dose of oxytocin: GGD parameters are 0.7314, 195.33, 1.0171 The fuzzy triangular numbers of the GGD parameters are $\overline{\lambda}=$ [0.6643, 0.7314, 0.8160], $\overline{\mu}=$[194.0481, 195.3300, 196.7045], $\overline{\varphi}=$[1.0144, 1.0171, 1.0216].The corresponding $\alpha$–cuts are $\overline{\lambda}(\alpha)=$[0.6643+0.0671α, 0.7314, 0.8160-0.0846α], $\overline{\mu}(\alpha)=$ [194.0481+1.2819α, 195.3300, 196.7045-1.3745α], and $\overline{\varphi}(\alpha)=$. [1.0144+0.0027α, 1.0171, 1.0216-0.0045α].

**4. Testing of Hypothesis:**

Testing of statistical hypothesis has been established in diversemethodologies since fuzzy sets were introduced by Zadeh [12] (1965).Buckley (2005, 2006) [1], [2] introduced and developed anapproach to the estimation of unknown parameters in statistical models. Testing statistical hypotheses is one of the most important parts of statistical inference.

Table 1: Fuzzy mean values and variance of lower and upper alpha cuts after administration of 5u and 10u dose of oxytocin

| **Alpha** | **5u** | | | | **10u** | | | |
|---|---|---|---|---|---|---|---|---|
| | $E_L(X)[\alpha]$ | $E_U(X)[\alpha]$ | $V_L(X)[\alpha]$ | $V_U(X)[\alpha]$ | $E_L(X)[\alpha]$ | $E_U(X)[\alpha]$ | $V_L(X)[\alpha]$ | $V_U(X)[\alpha]$ |
| 0 | 115.8494 | 109.763 | 10723.546 | 7137.2159 | 108.5703 | 98.7289 | 4740.3328 | 2919.0764 |
| 0.1 | 115.489 | 110.0091 | 10504.62 | 7280.4611 | 108.0207 | 99.1581 | 4626.716 | 2989.7319 |
| 0.2 | 115.1401 | 110.2652 | 10293.305 | 7428.8986 | 107.4868 | 99.6015 | 4517.4207 | 3063.2507 |
| 0.3 | 114.8023 | 110.5317 | 10089.248 | 7582.7892 | 106.9682 | 100.0595 | 4412.2343 | 3139.7881 |
| 0.4 | 114.4753 | 110.809 | 9892.1191 | 7742.41 | 106.4643 | 100.5327 | 4310.9565 | 3219.51 |
| 0.5 | 114.1588 | 111.0974 | 9701.6036 | 7908.0562 | 105.9747 | 101.0218 | 4213.3991 | 3302.5935 |
| 0.6 | 113.8524 | 111.3974 | 9517.4059 | 8080.0417 | 105.4989 | 101.5272 | 4119.3848 | 3389.2282 |
| 0.7 | 113.5559 | 111.7094 | 9339.2464 | 8258.7016 | 105.0365 | 102.0496 | 4028.7462 | 3479.6166 |
| 0.8 | 113.2688 | 112.0339 | 9166.8604 | 8444.393 | 104.587 | 102.5896 | 3941.3259 | 3573.9758 |
| 0.9 | 112.991 | 112.3713 | 8999.9978 | 8637.4972 | 104.1501 | 103.148 | 3856.9752 | 3672.5383 |
| 1 | 112.7221 | 112.7221 | 8838.4214 | 8838.4214 | 103.7254 | 103.7254 | 3775.5536 | 3775.5536 |

In the statistical decision theory we deal with various amounts which may be vague and imprecise. First, our observation may be imprecise, described in linguistic terms. In such a case we deal with imprecise (fuzzy) statistical data. Many books and papers have been written on the statistical analysis of fuzzy data.For applying the test of significance, we first set up of a hypothesis – a definite statement of the population parameters. Such a hypothesis is usually denoted by $H_0$. Here we define the $H_0$ as follows,

$H_0$: $\overline{\mu_1} - \overline{\mu_2} > 0$ there is a significant difference in $\overline{\mu_1}$ than $\overline{\mu_2}$, $H_1$: $\overline{\mu_1} \leq \overline{\mu_2}$. Applying the t-test for the FGGD mean values and using the Null hypothesis the results are given in the table 4.1.

| Paired Samples Test | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | Lower 5u - Lower 10u | 8.1657 | 0.5694 | 0.1717 | 7.7831 | 8.5482 | 47.561 | 10 | .000 |
| Pair 2 | Upper 5u - Upper 10u | 10.0516 | 0.6754 | 0.2036 | 9.5979 | 10.5053 | 49.362 | 10 | .000 |

If Sig. value (p) > .05 – $H_o$ rejected, $H_1$: there is no significant difference in $\overline{\mu_1}$ than $\overline{\mu_2}$, $\overline{\mu_1} \leq \overline{\mu_2}$.

If Sig. value (p) ≤ .05 – $H_o$ accepted, there is a significant difference in $\overline{\mu_1}$ than $\overline{\mu_2}$, $\overline{\mu_1} > \overline{\mu_2}$.

From the sig. value in the table 4.1., there was a significant difference in 5u dose than 10u dose [t(10)=47.561, p<0.05], [t(10)=49.362, , p<0.05] for lower and upper alpha cuts respectively.

**5. Conclusion:**

In this work the FGGD was successfully established and using the FGGD the changes of SV during caesarean sectionfor dissimilar doses OT was analysed. The mean values were calculated for SV after administration of oxytocinfor the doses of 5u and 10u. Fuzzy mean values and variance are decreasing in the lower alpha and increasing for upper alpha cuts for the 5u and 10u doses of oxytocin. Testing of hypothesis for the mean values indications that mean of oxytocin dose 5u dose has significant effect than the dose of 10u.

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