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RATES OF INTRAVESICAL PRESSURE IN NEWBORNS ON INTENSIVE CARE

Research article

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**Abstract**

The purpose of this study was to determine intravesical pressure parameters in neonatal intensive care infants. The prospective study included 80 newborn children (42 boys and 38 girls) without respiratory disorders and 30 patients (16 boys and 14 girls) on mechanical ventilation. It was established that in newborn children without respiratory disorders, physiological indicators of intravesical pressure averaged 5.2 (4.7-5.3) mmHg, while there were no significant differences in pressure levels in boys and girls – 5.1 (4.8-5.2) mmHg and 4.8 (4.4-5.1) mmHg, respectively. Intravesical pressure in children on mechanical ventilation was 5.2 (4.8-5.5) mmHg. There were no statistically and clinically significant differences between these values ( $p = 1.00$ ).

**Keywords:** newborns, intravesical pressure, intra-abdominal pressure, intensive care.

ПОКАЗАТЕЛИ ИНТРАВЕЗИКАЛЬНОГО ДАВЛЕНИЯ У НОВОРОЖДЕННЫХ ДЕТЕЙ, ПОЛУЧАЮЩИХ ИНТЕНСИВНУЮ ТЕРАПИЮ

Научная статья

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**Аннотация**

Целью данного исследования являлось определение показателей интравезикального давления у новорожденных детей, получающих интенсивную терапию. В проспективное исследование включены 80 новорожденных детей (42 мальчика и 38 девочек), не имеющих дыхательных расстройств и 30 пациентов (16 мальчиков и 14 девочек), находящихся на ИВЛ. Установлено, что у новорожденных детей, не имеющих респираторных расстройств, физиологические показатели интравезикального давления в среднем составили 5,2 (4,7– 5,3) mmHg, при этом существенных различий в уровнях давления у мальчиков и девочек не выявлено – 5,1 (4,8 – 5,2) mmHg и 4,8 (4,4 – 5,1) mmHg соответственно. Показатели интравезикального давления у детей, находящихся на ИВЛ, составил 5,2 (4,8 – 5,5) mmHg. Статистически и клинически значимых различий между этими величинами не выявлено ( $p=1.00$ ).

**Ключевые слова:** новорожденные дети, интравезикальное давление, внутрибрюшное давление, интенсивная терапия.

**Introduction**

Determination of intravesical pressure (IVP) is a generally recognized as a "Gold Standard" for the observation of intra-abdominal pressure [1], [6], [11], [15]. The influence of increased intra-abdominal pressure (IAP) on the function of organs and systems is widely known today, but in newborns it is not well understood, especially when they undergo restructuring and adaptation to postnatal life, as well as concomitant respiratory, renal and cardiovascular dysfunction [2], [3], [8]. To date, in pediatric clinical practice, especially related to the treatment of newborns, there is no proper attention to the problem of intra-abdominal hypertension (IAH). Diagnosis occurs subjectively, mainly by physical examination, which often leads to underestimation of the level of IAP and untimely detection of complications [4].

The purpose of this study was to determine the rates of intravesical pressure in neonatal infants on intensive care.

**Research methods and principles**

The prospective study included 80 newborn children (42 boys and 38 girls) without respiratory disorders and 30 patients (16 boys and 14 girls) on mechanical ventilation. All children were in the intensive care unit of newborns "Kuzbass Regional Children Clinical Hospital named U. A. Atamanov" in the period from 2009 to 2021 years.

In the group of patients without respiratory disorders, three subgroups were distinguished in severity from body weight. The 1st subgroup ( $n = 26$ ) included newborns weighing up to 2000 grams, the 2nd subgroup ( $n = 28$ ) included patients weighing from 2000 grams to 2500 grams, the 3rd subgroup ( $n = 26$ ) included children weighing more than 2500 grams.

In the group of newborns in need of mechanical ventilation, respiratory support was carried out in the IMV mode – Intermittent Mandatory Ventilation of the lungs with pressure-cyclized ventilators. Synchronization of patients was achieved by selecting the parameters of mechanical ventilation, prescribing Fentanyl, in some cases in combination with Promedol. The pressure measurement was conducted through a Foley urethral catheter standing in the bladder.

The pressure measurement was carried out with a sterile water pressure gauge connected to the urinary catheter at the patient's position horizontally on the back. The middle axial line was taken as the zero mark. Considering the recommendations

of the International Group of Experts on Intra-abdominal Hypertension and Abdominal Compartment Syndrome, according to which it is necessary to present the results of intra-abdominal and intravesical manometry in millimeters of mercury (mmHg), the readings of the water manometer were converted into mmHg at the rate of: 1 mmHg = 1.36 cm H<sub>2</sub>O [12].

The data was processed by non-parametric statistics methods. To determine the nature of the distribution, the Shapiro-Wilk criterion was used. Due to the fact that most of the studied quantitative features did not have an approximately normal distribution, the median (Me) was a measure of the central trend, and the scattering measure was an interquartile range in Me format (LQ-UQ). The Mann-Whitney test and the Kraskel-Wollis method were used to compare groups by quantitative features. Analysis of the relationship between the two features was carried out using Spearman's method. Differences were considered statistically significant at  $p < 0.05$ . Statistical analysis of the data was carried out using Stat Soft Inc's application software package "STATISTICA 10.0." (USA) for a personal computer.

### Main results

It was found that in newborn children without respiratory disorders ( $n = 80$ ), physiological indicators of intravesical pressure averaged 5.2 (4.7-5.3) mmHg and ranged from 2.9 to 9.5 mmHg. At the same time, there were no significant differences in pressure levels in boys and girls - 5.1 (4.8-5.2) mmHg and 4.8 (4.4-5.1) mmHg, respectively.

Considering that many physiological parameters in newborn children can vary greatly depending on the child's body weight, comparison of intravesical pressure in children with different body weights was made [7], [10], [14].

Data obtained during the measurement of intravesical pressure in children in subgroups isolated by newborn body weight are presented in Table 1.

Table 1 - Intravesical pressure in subgroups

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Indicator	Subgroup 1 (n=26)	Subgroup 2 (n=28)	Subgroup 3 (n=26)
Age, days	7.0 (4.0 – 10.0)	3.0 (1.5 – 7.0)	2.0 (1.0 – 3.0)
Body weight, grams	1500.0 (1370.0 – 1795.0)	2330.0 (2060.0 – 2590.0)	3280.0 (2950.0 – 3550.0)
Gestation period, weeks	30.0 (29.0 – 31.0)	34.5 (31.0 – 35.5)	38.0 (37.0 – 38.0)
Intravesical pressure, mmHg	4.5 (4.4 – 4.8)	4.8 (4.4 – 5.2)	5.2 (4.8 – 5.2)

We were unable to identify statistically and clinically significant pressure differences in children in subgroups, which also found support in missing the correlation between body weight and intravesical pressure scores ( $r = 0.09$ ;  $p = 0.98$ ).

It is known that mechanical ventilation of the lungs leads to an increase in intrathoracic pressure; this in turn can affect intra-abdominal pressure and, accordingly, the pressure in the bladder [8], [12], [13], [16]. The average airway pressure in the group of patients on mechanical ventilation ( $n = 20$ ) was within 9.0 (7.0-11.0) mbar, while the intravesical pressure index was 5.2 (4.8-5.5) mmHg. There was no correlation between these values ( $r = 0.11$ ;  $p = 1.00$ ). The obtained pressure level also did not have statistically and clinically significant differences with the pressure value detected in the group of newborn children who did not have mechanical ventilation ( $p = 1.00$ ).

### Discussion

Given the literature, normal IAP in adults is within 5-7 mmHg, in men it is 2-3 mmHg more than in women [6]. The presence of IAH is indicated by a prolonged or repeated increase in abdominal pressure, up to 10 mmHg or more [5]. Abdominal compartment syndrome, as a rule, develops against the background of IAH over 15 mmHg and is characterized by the appearance of multiple organ failure [12].

In children, measurement of IAP in order to diagnose various pathological conditions is used much less often than in adults, especially in newborns. However, recently there have been reports indicating the possibility of developing IAH and abdominal compartment syndrome in newborn children [4], [8]. In newborn patients, an increase in pressure can occur in the postoperative period, as well as against the background of somatic pathology [2], [15].

Thus, there is a need to monitor IAP as an objective method in the complex diagnosis of IAH and abdominal compartment syndrome in newborn children.

In adults, recommendations and definitions given by an International Experts of Intra-abdominal Hypertension are used in clinical practice regarding the control of abdominal pressure [5], [12]. Measurement of bladder pressure with preliminary introduction of 25 ml of sterile physiological solution is standard. This is the so-called intravesical or "bladder" technique for measuring of IAP [11], [12].

Due to the ease of execution and strong correlation with true IAP, indirect measurement of pressure in the bladder cavity through the urinary catheter is now considered the "Gold Standard" for monitoring of IAP and diagnosing IAH [10], [11]. Since 2007, for the convenience of comparing the results of various studies, it is recommended to take the middle axillary line as the zero mark when measuring by the above method, and the obtained data are given in millimeters of mercury [5], [12]. The position of the patient at the time of measurement should be strictly horizontal on the back, since it was found that in the case of an elevated position of the head end of the body, the level of pressure in the bladder increases significantly [6], [13].

In children, especially in newborns, physiological indicators of intravesical pressure remain debatable to date, this is dictated by the small number of studies and the lack of a unified approach to measuring pressure in them [16].

According to P.J. Davis et al., IAP in children, measured directly through a catheter for peritoneal dialysis, averages 4 mmHg and ranges from 1 to 8 mmHg [7]. The authors examined intra-abdominal, intragastric and intravesical pressure in 20 children whose mean age and mean body weight was 10 days (3 days - 14 years) and 3.9 kg (1.5 kg - 42 kg) accordingly, it was found that IAP values of IVP with the preliminary introduction of physiological saline in the volume of 1 ml/kg of the child's body weight into the bladder most accurately correspond to IAP.

P.R. Suominen et al. it is indicated that in direct measurement the level of IAP in children is within 0-10 mmHg, and it is confirmed that the greatest correlation with pressure in the bladder cavity is achieved when filling the latter at the rate of 1 ml/kg of the patient's body weight [15].

In J.C. Ejike et al. data of IAP in children determined by indirect method in the bladder equal to  $7 \pm 3$  mmHg are given [9]. They also investigated IVP depending on body weight in patients weighing 0-10 kg, > 10-20 kg, and > 20-50 kg, while the authors did not obtain significant differences in the level of IAP.

In our investigation, we tried to take into account the recommendations of the International Experts in the field of Intra-abdominal Hypertension in order to most accurately determine the level of intravesical pressure in newborn children and the possible use of the results in clinical practice.

### Conclusion

The physiological levels of intravesical pressure in newborn children were 5.2 (4.7-5.3) mmHg. The obtained values probably do not have a significant dependence on the sex, body weight of the child and performed in the modes of IMV, mechanical ventilation.

### Конфликт интересов

Не указан.

### Рецензия

Сообщество рецензентов Международного научно-исследовательского журнала <text:line-break/>DOI: <https://doi.org/10.23670/IRJ.2023.131.44.2>

### Conflict of Interest

None declared.

### Review

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