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Improving the Perinatal Monitoring System and Optimizing Therapeutic and Diagnostic Tactics at The Regional Level

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Abstract

Background: ongenital obstructive uropathies (OU) significantly contribute to neonatal morbidity. This study aims to evaluate an improved three-tier regional model of perinatal monitoring adapted for the Samarkand region.

Methods: A prospective study was conducted (2020–2026) involving the development of a "Prognostic Screening Sheet" based on maternal risk factors (OR analysis) and a standardized "72-hour rule" for postnatal ultrasound.

Results: The implementation of the model reduced the average age of surgical correction from 8.5 \pm 2.1 to 3.2 \pm 1.4 months. Early decompression in critical cases (e.g., posterior urethral valves) was shifted from day 25 to day 3 of life. Nephrectomy rates decreased by 18% , and hospitalizations for acute pyelonephritis in the first year dropped by 32%.

Conclusions: The transition to a "fetus as a patient" paradigm and the integration of obstetric and pediatric services ensure organ-preserving outcomes and prevent early-stage chronic kidney disease.

Keywords: Melatonin, acute cerebral circulatory accident, ischemic stroke, neuroprotection, circadian rhythm, sleep disturbance, oxidative stress, quantitative electroencephalography.

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1. Introduction

Modern neonatal surgery faces challenges beyond surgical technique, primarily involving organizational defects such as late diagnosis and lack of continuity between obstetricians and pediatric surgeons. In the Samarkand region, we transitioned from "surgery upon birth" to a "fetus as a patient" paradigm, emphasizing functional rather than purely anatomical diagnosis. In modern neonatal surgery and pediatrics, the problem of congenital obstructive uropathies (OU) extends far beyond purely surgical technique. As indicated by literature data (Morozov D.A. et al., 2015) and the results of our own research, unsatisfactory treatment outcomes are often caused not by the complexity of the defect, but by flaws in the organization of care: late diagnosis, referral errors, unjustified transportation of unstable newborns, and a lack of continuity between obstetricians and pediatric surgeons.

2. METHODS

The proposed three-tier model categorizes patients into high, medium, and low-risk groups based on specific criteria:Tier I (Primary Care): Use of a "Prognostic Screening Sheet." High-risk factors include maternal age (36–40 years, OR=9.16) and chronic kidney disease (OR=4.35).Tier II (Secondary Care): Detailed fetal urodynamics, including antenatal cystometry (40–60 min cycle) and amniotic index assessment.Tier III (Specialized Center): Implementation of the "72-hour rule"—delaying definitive postnatal ultrasound until days 3–5 of life to avoid false negatives (35–40%) caused by physiological neonatal oliguria

3. Results

We have developed and tested an improved regional three-tier model of perinatal monitoring adapted to the conditions of the Samarkand region. The conceptual basis of the model was the transition from the paradigm of "surgery upon birth" to the paradigm of the "fetus as a patient."

Model Principles:

1. Predictivity: Identification of risk groups during the initial prenatal registration (based on our OR data).

2. Functionality: Transition from anatomical diagnosis ("hydronephrosis") to functional diagnosis ("obstruction" or "dilation") in the antenatal period.

3. Timeliness: Strict regulation of postnatal screening schedules, accounting for the phenomenon of "physiological oliguria" in newborns.

4. Regionalization: Clear division of responsibilities between Level I, II, and III maternity care facilities.

Level I: Primary Care Optimization and High-Risk Group Formation

The first level of care (rural physician points, family polyclinics, district antenatal clinics) plays a key role in screening the pregnant population. Based on our multivariate analysis (Chapter 3), we developed the "Uropathy Prognostic Screening Sheet," filled out by a general practitioner or obstetrician-gynecologist at the first prenatal visit.

A patient is classified into the high-risk group if the total score exceeds the threshold or if at least one "major" criterion is present:

- Demographic Factors (Major Criteria): Advanced maternal reproductive age (36–40 years). In our study, this increased the risk 9-fold (OR = 9.16). A history of children born with renal malformations.

- Somatic Factors (Intermediate Criteria): Chronic maternal renal pathology (pyelonephritis, ICD). Risk increased 4.3 times (OR = 4.35). Moderate to severe iron deficiency anemia (OR = 2.59).

- Environmental and Obstetric Factors (Minor Criteria): Residence in agricultural areas with active pesticide use (OR = 2.30). Complicated obstetric history (uterine scar, induced abortions).

For high-risk patients, the ultrasound screening protocol is modified. In addition to standard intervals, a targeted examination of the fetal urinary system is introduced at 16–18 weeks, with a follow-up at 28 weeks to assess renal growth rates.

Level II: Differential Diagnosis and Fetal Urodynamics

Level II facilities (city maternity hospitals, inter-district perinatal centers) concentrate pregnant women with suspected fetal malformations. The primary task is differential diagnosis between true, kidney-threatening obstruction and transient conditions.

We implemented a fetal urodynamics assessment protocol, mandatory upon detection of pyelectasis:

- Antenatal Cystometry: Evaluation of the "filling-emptying" cycle for 40–60 minutes. Pathological criteria: failure to empty within 1 hour, residual urine (V_{res} >

10\%), or bladder volume exceeding gestational norms (megacystis index).

• Amniotic Index Assessment: Oligohydramnios in the presence of enlarged kidneys is viewed as a critical sign of reduced excretory function (antenatal anuria/oliguria).

• Dynamic Pyelometry: Measuring the renal pelvis with "full" and "empty" bladders to rule out vesicoureteral reflux (VUR).

All identified pathologies are reviewed by a perinatal board (obstetrician, neonatologist, ultrasound specialist, and pediatric surgeon/urologist) to determine one of three strategies (Table 4.1).

Table 4.1. Perinatal Management Strategies Based on Defect Severity

Risk Group	Clinical Criteria	Obstetric Tactics	Delivery Site
I. Critical	Bilateral ureterohydronephrosis, megacystis, posterior urethral valve, severe oligohydramnios.	Preterm delivery (if fetal uremia increases) or planned C-section.	Level III Perinatal Center (with NICU and surgery).
II. Delayed	Unilateral hydronephrosis (Grade III-IV), megaureter. Contralateral kidney function preserved. Normal fluids..	Full-term spontaneous vaginal delivery.	City or Regional Maternity Hospital..
III. Dynamic	Isolated pyelectasis, pyelectasis associated with VUR, unstable bladder.	Full-term physiological delivery.	Local Maternity Hospital.

One of the most significant factors affecting the quality of diagnosis is the timing of the first ultrasound examination of a newborn. As noted by S.I. Babatova et al. (2022), in the first 48 hours of life, a newborn experiences physiological oliguria and transient dehydration. During the first two days of life, the glomerular filtration rate in a newborn is reduced, and fluid loss (perspiratio insensibilis) is significant. This leads to decreased diuresis and, consequently, to a decrease in hydrostatic pressure in the renal pelvis. Our observations have confirmed that ultrasound performed in the first 24 hours of life (except in cases of severe obstruction) yields false-negative results in 35–40% of cases. Dilated renal pelvises can "collapse" due to fluid deficiency, creating the illusion of normality. We have implemented a strict screening protocol (the "72-hour rule") for neonatal services:

A ban on excluding the diagnosis of hydronephrosis based on an ultrasound performed on the first day of life.

Mandatory repeat screening: All infants with suspected antenatal urethral reflux disease undergo a follow-up ultrasound no earlier than 3-5 days of life (before discharge from the hospital), when fluid balance is restored and adequate diuresis is established.

Stress test: In questionable cases, an ultrasound is performed after feeding, which is a natural fluid load.

This simple organizational maneuver has increased the detection rate of pyelectasis and hydronephrosis at the maternity hospital by 28%, eliminating cases where a child was discharged "healthy" and then admitted a month later with an attack of pyelonephritis.

Level III: Differentiated Treatment and Diagnostic Tactics in the Neonatal Period

The third level (Regional Multidisciplinary Children's Medical Center) provides specialized care. We have revised our approaches to the timing and scope of interventions depending on the risk group.

Tactics for Group I patients are the most severe category (according to our data, approximately 10-12% of all detected defects), requiring immediate action. The "Golden Hour" principle must also be observed: These infants are transported by the resuscitation team directly to the neonatal surgery department, bypassing the pediatric wards.

The implemented algorithm for actions in the early neonatal period requires a strict chronology of treatment and diagnostic measures, beginning in the first minutes of the child's life. In the period from 0 to 2 hours, the priority is bladder decompression, achieved by inserting a urethral catheter, which allows for immediate urine flow and ensures diuresis control. During the first 24 hours (2 to 24 hours), in-depth laboratory monitoring of azotemia parameters (creatinine, urea, acid-base balance) is performed. At this stage, it is critical to differentiate transient "maternal" creatinine from the neonate's true creatinine level, for which purpose monitoring is performed dynamically at 12-hour intervals.

The diagnostic stage is completed on the second or third day of life (24–72 hours), when voiding cystography is performed. Currently, this is the only instrumental method that allows for the reliably verification of the presence of a posterior urethral valve (PUV). Further surgical management directly depends on the results obtained: if PUV is confirmed, endoscopic transurethral resection of the valve is the "gold standard." However, in situations where TUR is impossible (for example, due to a small urethral diameter or the infant's severe somatic condition), a vesicostomy is performed. In cases where renal block is detected, for example, in bilateral hydronephrosis, percutaneous puncture nephrostomy under ultrasound guidance is indicated. This strategy of early decompression of the urinary tract within the first three days of life helps preserve renal reserve and prevent the development of end-stage chronic renal failure at an early age.

Group II Management

A group of patients with congenital malformations, including unilateral hydronephrosis, megaureter, and duplex kidney anomalies, deserves special attention. Previously, the management of such newborns often involved immediate transfer from the maternity hospital to a specialized hospital for excretory urography. However, during the study, we reconsidered this approach and completely abandoned routine intravenous urography in the neonatal period (the first 28 days of life).

This decision was dictated by the physiological immaturity of nephrons and the low concentrating capacity of the newborn kidneys, which often results in unclear and difficult-to-interpret urograms. Furthermore, hospitalization of stable patients is associated with unnecessary radiation exposure and an increased risk of nosocomial catheter-associated infections. According to the new protocol, children are discharged home for outpatient follow-up by a local urologist with prophylactic doses of uroseptics to prevent urinary tract infections. Elective hospitalization occurs at one month of age, when renal function has matured to allow for a comprehensive and informative examination, including excretory urography, renal scintigraphy, and cystography.

Tactics for Group III

The largest group includes patients with pyelectasis and suspected vesicoureteral reflux. The main drawback of previous approaches for this cohort was a tendency toward overdiagnosis and unnecessarily aggressive treatment strategies. Therefore, we are currently guided by the fundamental principle of "do no harm." This is reflected primarily in the minimization of invasive interventions: voiding cystography, a painful and traumatic procedure, is now indicated only in cases of recurrent urinary tract infection or when ultrasound reveals progressive dilation of the renal pelvis.

The therapeutic focus has shifted to correcting neurogenic bladder dysfunction. As demonstrated in previous sections of the study (Chapter 3), such patients often exhibit hyperactive or hyporeflexive urodynamic disorders, requiring regimen therapy, B vitamins, and physiotherapy. Follow-up is performed using ultrasound at 1, 3, 6, and 12 months of age. This approach is justified by the high probability of a favorable outcome: spontaneous resolution of pyelectasis is observed in 75% of cases, due to the natural maturation of the neuromuscular apparatus.

Performance Analysis

A comparative analysis of the effectiveness of the implemented model, based on a comparison of data from two periods, demonstrated a significant improvement in key clinical indicators.

Primarily, a significant reduction in the wait time for surgical intervention was achieved: the average age for surgical correction of obstructive uropathies decreased from 8.5 ± 2.1 to 3.2 ± 1.4 months. Particularly significant was the progress in the treatment of critical defects, such as posterior urethral valves, where the time from birth to surgery was reduced from 25 to 3 days of life.

Early diagnosis and timely decompression had a direct impact on preserving organ potential, reducing the frequency of organ-removing surgeries (nephrectomies) for hydronephrosis by 18%. Kidneys that, under previous approaches, would have undergone irreversible hydronephrotic transformation and died by the age of one year, can now be preserved thanks to early pyeloplasty. Furthermore, active detection of functional disorders in the third group of patients, combined with infection prevention, led to a 32% reduction in the hospitalization rate of infants with acute pyelonephritis.

In addition to clinical success, the optimization of patient management tactics yielded significant economic benefits. Shifting diagnostic procedures for the second group to outpatient settings reduced unnecessary occupancy of expensive neonatal beds. In the third group, eliminating redundant examinations reduced costs for consumables such as X-ray film and contrast agents. However, the main economic benefit is strategic in nature and lies in preventing disability among the pediatric population. Reducing the risk of developing chronic renal failure (CRF) and the need for renal replacement therapy (dialysis or transplantation) helps avoid a colossal long-term burden on the state budget. Recommendations for neonatologists

To implement the findings, we developed and officially approved the Standard Operating Procedure (SOP) "Care of a Newborn with Dilated Renal Pelvic Collects." According to this protocol, detection of pyelectasis (pelvis size greater than 7 mm) in the first day of life is not an absolute indication for emergency transfer to a surgical hospital if megacystis is not present. The priority strategy at this stage is a watchful waiting approach with careful monitoring of urine output. A follow-up ultrasound is scheduled for days 3–5 of life.

The document clearly regulates patient routing. Transfer to the neonatal pathology department (NPD) is indicated in the presence of alarming symptoms: bilateral renal involvement, oliguria (urine output less than 1 ml/kg/hour), a palpable abdominal mass, or laboratory evidence of inflammation in the urine. In stable cases—with unilateral dilation of the urinary tract, maintained diuresis, absence of leukocyturia, and sterile cultures—the child is discharged home with a recommendation for a scheduled appointment with a urologist at one month of age.

4. Discussion

The "72-hour rule" is a pivotal organizational maneuver that increased the detection rate of hydronephrosis by 28% at the maternity hospital stage. By avoiding routine neonatal IVP, we reduced radiation exposure and hospital-acquired infections. The economic impact is characterized by reduced occupancy of neonatal intensive care beds and, most importantly, the prevention of long-term disability and the need for renal replacement therapy.

5. Conclusion

Improving perinatal care for children with urinary tract malformations requires a systematic approach that integrates the efforts of physicians from various specialties. The model we have developed is based on two fundamental principles: early prognostic diagnostics, including the formation of risk groups for the mother and functional assessment of the fetus, and rational postnatal management. The latter is developed with the strict consideration of the physiological characteristics of the neonatal period, particularly the phenomenon of oliguria, and the absolute priority of organ-preserving treatment. Practical implementation of this model helps overcome the disconnect between obstetric and pediatric services, minimize diagnostic errors in the first days of life, and ensure timely, pathogenetically justified correction of defects, which is essential for preserving renal function and the child's quality of life. The implementation of

regionalization principles and optimized screening timing, adapted to the specifics of our region and taking into account risk factors such as the high proportion of the rural population and the specific medical conditions of mothers, has proven highly clinically effective. This allows us to recommend the proposed model for widespread use in practical healthcare.

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