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**ANALYSIS OF THE EFFECTIVENESS OF
AN OBSTETRIC INTENSIVE CARE CENTER FOR
CRITICALLY ILL PATIENTS WITH MODS**

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**АНАЛИЗ ЭФФЕКТИВНОСТИ РАБОТЫ ЦЕНТРА ИНТЕНСИВНОЙ
ТЕРАПИИ АКУШЕРСКОЙ ПОЛИОРГАННОЙ НЕДОСТАТОЧНОСТИ**

Актуальность. В статье аргументируется необходимость создания в урбанизированном регионе специализированного центра оказания помощи при акушерской полиорганной недостаточности, приводятся примеры его организации и структуры.

Цель. Провести анализ эффективности работы Центра интенсивной терапии акушерской полиорганной недостаточности с позиции материнской смертности.

Результаты. Дан анализ эффективности работы с позиции материнской смертности, структуры и причин развития полиорганной недостаточности у беременных. Показаны положительное значение центра для лечения акушерского сепсиса и отдельные фармакоэкономические позиции.

Выводы. Таким образом, создание регионального специализированного центра помощи беременным, роженицам и родильницам доказало свою эффективность не только за счет концентрации сил и средств, но и, по нашему мнению, за счет приобретения непрерывного опыта всех участников медицинского процесса.

Ключевые слова: полиорганная недостаточность, беременность, роженицы, сепсис.

ANALYSIS OF THE EFFECTIVENESS OF AN OBSTETRIC INTENSIVE CARE CENTER FOR CRITICALLY ILL PATIENTS WITH MODS

Actuality. The WHO includes maternal mortality in a number of integrating indicators relevant to reproductive health. The article describes the objectives to organize the Obstetric Intensive Care Center for Critically Ill Patients with MODS in the urban region to facilitate and ensure provision of advanced clinical care. The example of its organization and structure is provided.

Aim. The analysis of its effectiveness and efficiency of the Obstetric Intensive Care Center for Critically Ill Patients with MODS organization.

Results. The analysis of its effectiveness and efficiency was performed, including the assessment of maternal mortality rate, structure and causes of multiple organ dysfunction syndrome in pregnant and parturient women. Positive effects of the Center on the treatment of obstetric sepsis as well as some pharmacoeconomic parameters are presented.

Conclusions. Thus, the development of Regional Obstetric Intensive Care Center for critically ill pregnant and parturient women proved its effectiveness and efficiency, not only due to advanced treatment modalities and financial support, but also due to opportunity to receive continuous experience for all participants in this treatment process.

Key words: multiple organ dysfunction syndrome, pregnancy, parturient women, sepsis.

Introduction

The WHO includes maternal mortality in a number of integrating indicators relevant to reproductive health. Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. Despite significant advances in medicine, the incidence of obstetric complications remains significantly high and ranges from 2.5–12 cases per 1000 births [Greibenkin. B. E. New method for the diagnosis of multiple organ failure in severe pre-eclampsia. / B. E Grebyonkin M. L Melnikova O. R. Perevyshena, G. K. Sadykova, LP. Palakyan // Medical Almanac number 4-2010 p. 119-121]. According to recent studies, 0.1–0.9% of women develop significant complications of pregnancy that require admission to the intensive care unit [Janota J., Simak J., Stranak Z., Matthews T., Clarke T., Corcoran D. Critically ill newborns with multiple organ dysfunction: assessment by NEOMOD score in a tertiary NICU. *Ir. J. Med. Sci.* 2008; 177 (1): 11-7]. 65% of obstetric patients transferred to the ICU suffered from altered function of one or more organ systems [Multiple organ dysfunction syndrome Frederic P. Miller, Agnes F. Vandome, John McBrewster 2010, p. 88]. Thus, obstetric sepsis remains a major challenge for intensive care, since the mortality rate in these patients ranges from 30 to 70%, whereas the development of septic shock is associated with 100% mortality, which does not tend to decrease [Greenfield N, Balk RA. Evaluating the adequacy of fluid resuscitation in patients with septic shock: controversies and future directions. *Hosp Pract (Minneapolis)*. 2012 Apr; 40 (2): 147-57]. Multiple organ dysfunction syndrome (MODS), exacerbating the clinical state of parturient women, prevents the use of conventional treatment and contributes to the mortality rate in this group of critically ill patients which reaches 2.4–39.3% [Perman SM, Goyal M, Gaijeski DF. Initial Emergency Department Diagnosis and Management of Adult Patients with Severe Sepsis and Septic Shock. *Scand*

J Trauma Resusc Emerg Med. 2012 Jun 27; 20 (1): 4]. According to statistical data [Obstetric and gynecological care / Ed. IN AND. // M. Kulakov, MEDpress. — 2000 — . 320], more than half of maternal deaths could have been prevented due to early diagnosis of severe complications during pregnancy, labor and post-partum period. MODS in these critically ill patients is considered to be a key event in the thanatogenesis process. The true incidence of MODS among obstetric patients is unknown. Moreover, the differences in the MODS course between obstetric and non-obstetric patients are poorly understood. Therefore, there is a number of limitations and a wide range of indicators that do not allow to perform the comparative analysis of different studies. In addition, one should take into account that morbidity and mortality rates are greatly affected by poor continuity of care at all stages to pregnant and parturient women, high prevalence of obstetric pathology, less specialized hospital as well as the whole level of social and healthcare development.

The Kemerovo region (Kuzbass) is one of the most urbanized regions of the Russian Federation with a population of 2,742,450 people at a density of 28.65 people/km², with the proportion of urban population of 85.51% — 23 cities, 11 out of which are with a population of > 50,000. In the early 2000s, the maternal mortality rate in the Kuzbass exceeded by 1.5–2 times the overall Russian value. High mortality rate was caused by the large distances between towns, poor quality of communication (patient transfer to the hospital from another city would take 4–8 hours); different and / or a lack of organization and material supply of medical centers at various levels, non-staged health care provision to obstetric patients, a lack of specialized intensive care beds, a lack of knowledge in medical personnel to provide care to such critically ill patients; a lack of sufficient equipment for high-tech methods of treating MODS. In 2007, Regional Obstetric Intensive Care Center for Critically Ill Patients with MODS was founded to provide specialized medical care and facilitate the development and introduction of novel treatment options in obstetric intensive care unit.

Purpose: To assess the effectiveness and efficiency of the Obstetric Intensive Care Center.

Material and Methods

The Intensive Care Center for 3 beds with a specific nurse station was established on the basis of the intensive care unit (ICU) of the Regional Clinical Hospital with highly qualified multidisciplinary team. The medical services include regular physician and nursing rounds, ambulatory and in-hospital specialist consultations, multidisciplinary team (intensivist, obstetrician, midwife nurses, and certified registered nurse anesthetist), specialized ambulance able to transfer critically ill patients to the Intensive Care Center, drug and medical supplies in stock. The Center is equipped by extracorporeal blood purification modalities, circulatory support devices, including extracorporeal membrane oxygenation. The annual budget is at least \$100,000, i. e. the medication costs per patient are \$4500–10,500 (compared to standard costs of obstetric care \$350–1150). The main goals of the Intensive Care Center are 1) research and methodical management activities, 2) control and maintenance of the development of the structural divisions, 3) emergency obstetric and intensive care in the regional health care institutions (HCI), 4) participation in certification and licensing procedures; 5) treatment and medical care for critically ill patients, including prehospital, emergency and semi-urgent interhospital transportation, 6) organization of staged advanced medical care, 7) timely, highly qualified and specialized medical care for patients with extragenital pathology and complications

during pregnancy and delivery, transferred from the referring regional hospitals with life-threatening illnesses, 8) temporary life support for potentially reversible vital organs failure until their recovery in patients with complications during pregnancy and delivery, 9) research, improvement and development of medical technologies in critical care.

544 medical records of patients admitted to the Intensive Care Center were retrospectively reviewed using maternal mortality rate criteria with MODS, its causes and structure for two eight-year periods. During the first period from 1999–2006 (n=281) before the Intensive Care Center was founded, 205 (73%) patients were treated in 19 district and regional hospitals (the mean ICU stay was 3–5 days; the average annual caseload per physician — 2.5 cases), and 76 patients (27%) were treated in the intensive care unit of the regional clinical hospital (the average annual caseload per physician — 6 cases). During the second period from 2007–2014, 263 patients were treated the Intensive Care Center (the average annual caseload per physician — 23 cases). The initial severity was assessed using the APACHE II scale. The severity of MODS was assessed using the SOFA scale. In case of septic shock, additional measurements were performed, including the assessment of general clinical and biochemical parameters, systemic hemodynamics using a transpulmonary thermodilution system (PiCCO Plus) with the invasive measurement of central venous pressure (CVP) and blood pressure (BP), blood oxygen transport (BOT), the laboratory evaluation of endotoxemia with a spectrophotometric assay for low and medium molecular weight in red blood cells, plasma and urine, and the calculation of endogenous intoxication index (EII), necessary for the comparison of conventional treatment methods and early initiation of extracorporeal blood purification (CVVH, continuous veno-venous hemofiltration, or, CVVHD, continuous veno-venous hemodiafiltration). The analysis of pharmacoeconomic parameters was also performed.

Results. The main aim of the Intensive Care Center was to reduce maternal mortality in the Kemerovo region (Fig. 1). The main causes of high mortality rates were sepsis (33.8%), extragenital pathology (27.6%), gestosis and bleeding (12.4%) resulting in MODS (57.3% out of all cases).

There were no significant differences between initial severity and MODS causes between two periods (Table 1). All patients were comparable in age and standard ICU treatment. However, significant differences were found in patients with sepsis.

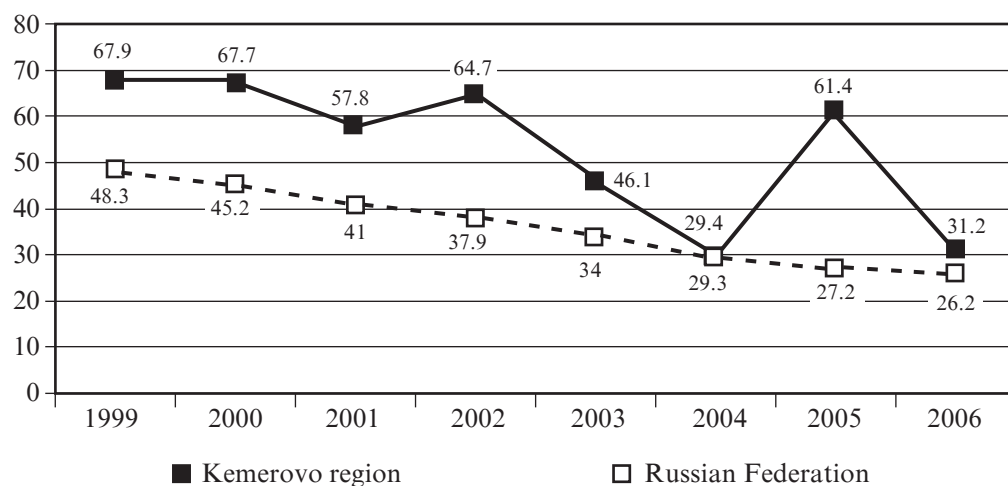


Fig. 1. Maternal mortality in the period 1999–2006

Table 1

Clinical and Demographic Data of Patients

Parameters	1999–2006	2007–2014
Age, years, $M \pm \sigma$	27.7 \pm 13.5	28.0 \pm 15.2
APACHE II, scores, $M \pm \sigma$	29.1 \pm 9.8	27.7 \pm 8.4
Causes of MODS, %:		
Sepsis	33.8	34.1
Extragenital pathology	27.6	29.1
Gestosis	12.4	11.9
Bleeding	12.4	13.1
Anesthesia-related complications	4.8	2.6*
PE	3.5	3.3
Ectopic pregnancy	2.1	1.9
Anaphylaxis	1.4	0.7*
Others	1.4	2.6*
AFE	0.6	0.7

Note. MODS — multiple organ dysfunction syndrome; PE — pulmonary embolism; AFE — amniotic fluid embolism; * — $p < 0.05$, the increase is associated with exogenous factors (alcohol abuse, opiates).

Table 2

Dynamic Changes in the Main Indicators of Obstetric Sepsis Severity, $M \pm \sigma$

Years	Days				
	1	2	3	4	5
SOFA, scores					
1999–2006	13.6 \pm 6.3	13.1 \pm 5.5	12.1 \pm 6.2	10.2 \pm 6.1	9.8 \pm 4.8
2007–2014	12.8 \pm 7.1	8.1 \pm 4.9*	7.3 \pm 4.1*	5.5 \pm 3.3*	5.2 \pm 3.8*
EII, a. u.					
1999–2006	17.1 \pm 4.1	16.2 \pm 6.2	14.1 \pm 6.1	10.4 \pm 5.3	9.9 \pm 4.5
2007–2014	16.8 \pm 3.9	10.3 \pm 5.1*	10.1 \pm 4.9*	7.8 \pm 4.0*	6.8 \pm 3.7*
CI, l/(min·m ²)					
1999–2006	2.1 \pm 1.15	2.29 \pm 1.15	2.3 \pm 1.3	2.3 \pm 1.4	2.45 \pm 1.7
2007–2014	2.0 \pm 1.05	2.69 \pm 0.9	3.15 \pm 0.95*	3.2 \pm 1.05*	3.5 \pm 1.1*
Epinephrine, mcg/(kg·min)					
1999–2006	0.12 \pm 0.07	0.15 \pm 0.05	0.07 \pm 0.05	0.065 \pm 0.05	0.055 \pm 0.03
2007–2014	0.11 \pm 0.09	0.06 \pm 0.02*	0.03 \pm 0.01*	0.03 \pm 0.01*	0*

Note. * — $p < 0.05$ for the comparative analysis of the studied periods; EII — index of endogenous intoxication syndrome; CI — cardiac index; Epinephrine — a dose for inotropic support.

The early initiation of EBP allowed to improve hemodynamic and biochemical parameters, to reduce the EII and the severity of patient's state by day 5 according to the reassessment with the SOFA scale (Table. 2). The first significant changes were obtained 12 hours after the EBP initiation and were mainly related to the clinical and laboratory parameters of cardiac hemodynamics and BOT. A significant decrease

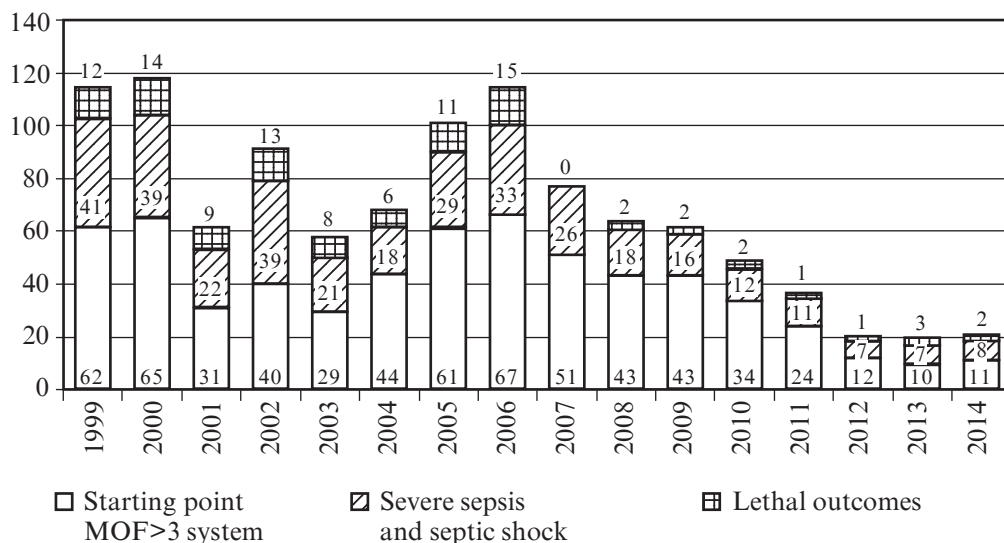


Fig. 2. MODS structure and mortality rates in the studied periods

in plasma osmolality was observed within 36 hours after adequate treatment of hypernatremia and hyperasotemia, and reduced the EII. At this stage, we were able to stop or reduce the infusion of catecholamines in the vast majority of patients due to significantly increased cardiac index, mean arterial pressure, and oxygen delivery index.

Respiratory support decreased as patients' PaO₂/FiO₂ ratio significantly increased. After 65±4 hours of EBP therapy, basic clinical and laboratory homeostasis parameters improved. Moreover, the regression of encephalopathy and increased diuresis rates were observed. Nevertheless, all patients underwent surgical interventions aimed at the sanitation of the infection focus in the abdominal cavity using different surgical techniques, depending on its localization and surgical protocol adopted in the hospital. The changes in the ICU management strategy resulted in significant changes in the severity of patients' state and reduced mortality rate (Fig. 2).

The 8-year mortality rate in the Intensive Care Center included 13 deaths. In 2008, 1 patient died because of acute poisoning, which led to a massive haemolysis; and 1 patient died because of MODS and opiate overdose, leading to acute posthypoxic encephalopathy, cerebral edema, and coma. In 2009, 2 patients died due to community-acquired viral and bacterial necrotizing pneumonia. In 2010, 2 patients died because of hemorrhagic stroke during eclampsia, and dilated cardiomyopathy; In 2011, 1 patient with 6 organ system failures died because of the blood loss (20 liters). In 2012, 1 patient died due to the bilateral community-acquired necrotizing pneumonia. In 2013 and 2014, 5 patients with MODS and abdominal sepsis, 3 out of 5 patients had obstetric sepsis. It should be noted that there was no mortality rate related to obstetric sepsis up to 2012. Later, it was primarily associated with the shift to the organ-preserving surgeries, resulted in an inadequate sanitation of the infectious focus leading to exacerbate of MODS and death. Particularly successful and effective medical service was provided to pregnant patients with H1N1 admitted to the Intensive Care Center in 2009. Out of 22 pregnant women, only 2 patients (9.1%) died. The pharmacoeconomic analysis reported a positive cost-effectiveness coefficient of -0.27 in the Intensive Care Center.

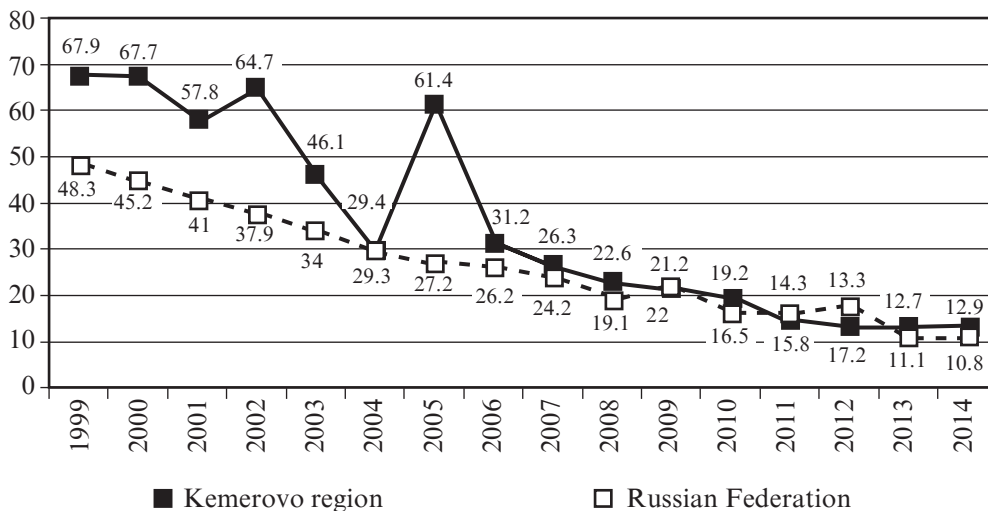


Fig. 3. Maternal mortality per 100,000 population in 1999–2014

However, the shift to the single-source financing in national health insurance in 2013 limited the opportunities of advanced specialized care. Treatment costs for sequelae of complication of pregnancy, childbirth and the puerperium (O94, ICD-10) are limited to \$600 per case. In recent years, the development of an integrated clinical and statistical group (primary diagnosis — admission to the hospital during the whole period of pregnancy or within 42 days after the delivery and the presence of 2 or more signs of organ failure or/and one organ system failure with somatic disease and any surgical manipulation) allowed to enlarge this funding up to \$350. In general, highly qualified medical service, provided in the Intensive Care Center, allowed to reduce maternal mortality to the national level, and in case of some structural nosology to obtain even lower values (Fig. 3).

Conclusion. Thus, the development of Regional Obstetric Intensive Care Center for critically ill pregnant and parturient women proved its effectiveness and efficiency, not only due to advanced treatment modalities and financial support, but also due to opportunity to receive continuous experience for all participants in this treatment process.

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