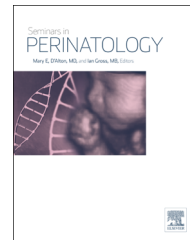


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## Multidisciplinary obstetric critical care delivery: The concept of the “virtual” intensive care unit

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## ABSTRACT

With an increasing prevalence of chronic medical conditions and the associated potential for decompensation to critical illness among modern day parturients, we present here the concept of the “virtual” intensive care unit. We challenge the traditional association of the word “unit” to extend beyond a fixed physical setting to portray an individualized, predetermined patient care team capable of managing these complex patients in a variety of settings. In this model, obstetric critical care is provided through a multidisciplinary patient care team, with emphasis on early identification of complicated pregnancies, detailed antepartum planning, anticipation of complications, and retrospective review of clinical outcomes aimed at continued quality improvement. This structured approach in the provision of care to the critically ill pregnant patient will serve as a foundation for future attempts at reduction in rates of maternal morbidity and mortality.

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### Background

In today’s world, obstetricians find themselves on a new frontier. A frontier where each day they are asked to participate in the management of intricate pregnancies complicated by an ever-growing list of coexisting medical conditions. Where in the remote past the terms “young” and “healthy” were synonymous with pregnancy, this is no longer the paradigm that characterizes the field of obstetrics.

With the advancement of modern medicine, women suffering from conditions that were previously associated with abbreviated life expectancy (i.e., cystic fibrosis, congenital heart disease, and pulmonary hypertension) now survive to

reproductive age and present unique challenges in pregnancy. Obstetricians are increasingly faced with the management of chronic medical conditions (i.e., diabetes mellitus, hypertension, chronic heart disease, and obesity) as women are becoming pregnant at increasingly older ages due to cultural changes and advancements in assisted reproductive technology.<sup>1-4</sup> A recent review of the Texas Inpatient Public Use Data File found that 9.7% of pregnancy-associated ICU admissions were notable for chronic comorbidities.<sup>5</sup> In addition, pregnancy-specific conditions such as postpartum hemorrhage and pre-eclampsia continue to present with potential for significant morbidity.<sup>5,6</sup> Pregnant women with chronic disease should be considered a new high-risk group that would benefit from heightened clinical surveillance,

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**Table 1 – Key organ system changes in pregnancy. (Adapted with permission from the American College of Obstetrics & Gynecologists.<sup>12</sup> Data from Gabbe et al.<sup>35</sup>).**

Key organ system changes in pregnancy

Cardiovascular

- Increased cardiac output
- Decreased systemic vascular resistance
- Decreased blood pressure
- Increased heart rate

Respiratory

- Decreased pulmonary vascular resistance
- Increased inspiratory capacity
- Increased tidal volume
- Decreased functional residual capacity
- Increased minute ventilation

Renal

- Increased glomerular filtration rate

Hepatobiliary

- Decreased coagulation factors: XI and XIII
- Increased coagulation factors: I, VII, VIII, IX, and X levels
- Increased alkaline phosphatase
- Increased triglyceride levels
- Increased cholesterol, low-density lipoprotein, and high-density lipoprotein levels

Pancreatic

- Increased insulin levels
- Decreased fasting blood glucose level

Adrenal

- Increased aldosterone production
- Increased serum cortisol, free cortisol, and cortisol-binding globulin
- Increased adrenocorticotropic hormone (ACTH) levels

Hematologic

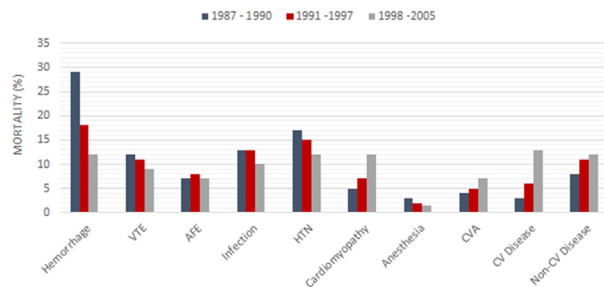
- Decreased hemoglobin and hematocrit levels
- Increased white blood cell count
- Decreased protein S levels
- Increased fibrinogen and D-dimer levels

multidisciplinary assessment, disease stabilization, and monitoring for potential deterioration.<sup>5,7</sup>

Pregnancy represents a complex physical state characterized by alterations of function in hematologic, cardiopulmonary, renal, and multiple other organ systems (Table 1). While complications may arise from further perturbation of this delicate physiologic state, exacerbation of comorbid conditions, or interaction of the two, the potential for life-threatening deterioration and onset of critical illness is ever present and has manifested in a maternal mortality rate of 14.5–16.0 deaths per 100,000 live births in the United States each year.<sup>7–9</sup>

The rate of maternal mortality remains on the rise as growth in complications secondary to both chronic and unsuspecting disease (cardiomyopathy, congenital heart disease, sepsis, etc.) has outweighed recent reductions in morbidity attributed to classic pregnancy issues such as postpartum hemorrhage and hypertensive disorders (Figure).<sup>3,7,9</sup> The Pregnancy Mortality Surveillance systems of the United States and United Kingdom are now reporting

Maternal Mortality Trends



**Fig – Cause-specific trends in maternal mortality in the United States. (Adapted with permission from Berg et al.<sup>7</sup>). (AFE, amniotic fluid embolism; CVA, cerebrovascular accident; CV, cardiovascular; HTN, hypertension; VTE, venous thromboembolism).**

thromboembolism and sepsis as the leading causes of maternal death, whereas other groups report complications of cardiovascular disease as the most common etiology.<sup>10,11</sup>

Overall, it is estimated that 1–3% of pregnancies in the United States require delivery of critical care services annually.<sup>12–14</sup> A survey of the Nationwide Inpatient Sample reported an increased utilization of critical care services from 36.5/100,000 live births in 2006 to 59.6/100,000 live births in 2012.<sup>5,15</sup> Given the multitude of maternal complications that may arise (Table 2) and the high stakes associated with management of the critically ill parturient, it should be considered futile for either general obstetricians or maternal-fetal medicine specialists to practice in isolation. While the aforementioned practice may occur, at times, out of necessity in the setting of limited resources, the more appropriate approach is the development of a multidisciplinary patient care team comprised of physicians and ancillary staff that are specialized in the management of conditions

**Table 2 – Epidemiology of pregnancy-associated ICU utilization in Texas: 2001–2010. (Adapted with permission from Oud L<sup>5</sup>).**

Epidemiology of pregnancy-associated ICU utilization in Texas: 2001–2010

Maternal complication	Incidence among ICU patients (%)	Rate of ICU admission (%)
Pre-eclampsia/eclampsia	23.3	12.0
Hemorrhage	6.9	8.9
Embolism	0.6	51.0
Cardiovascular conditions	6.1	15.2
Cardiomyopathy	1.7	63.5
Cerebrovascular accident	0.7	48.0
Sepsis	1.1	51.3
Aspiration pneumonia	0.4	40.3
Trauma	0.8	15.5
Anesthesia complications	0.1	22.6
Hyperemesis	1.3	5.0
Status asthmaticus	0.1	25.0
Status epilepticus	<0.1	65.6
Blood transfusion complication	<0.1	22.2

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