

SPECIAL FEATURE

Bed Rest in Pregnancy

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OUTLINE

EPIDEMIOLOGY OF THE

USE OF ANTEPARTUM BED REST

CLINICAL CONDITIONS FOR WHICH BED REST IS PRESCRIBED

Threatened Abortion

Multiple Gestations

Hypertensive Disease of Pregnancy:

Gestational Hypertension and

Preeclampsia

Preterm Labor

Embryo Transfer

Fetal Growth Restriction

Other Conditions

POTENTIAL COMPLICATIONS

Maternal Effects

Effects on the Family

Neonatal Effects

DISCUSSION

ABSTRACT

The use of bed rest in medicine dates back to Hippocrates, who first recommended bed rest as a restorative measure for pain. With the formalization of prenatal care in the early 1900s, maternal bed rest became a standard of care, especially toward the end of pregnancy. Antepartum bed rest is a common obstetric management tool, with up to 95% of

obstetricians utilizing maternal activity restriction in some way in their practice. Bed rest is prescribed for a variety of complications of pregnancy, from threatened abortion and multiple gestations to preeclampsia and preterm labor. Although the use of bed rest is pervasive, there is a paucity of data to support its use. Additionally, many well-documented adverse physical, psychological, familial, societal, and financial effects have been discussed in the literature. There have been no complications of pregnancy for which the literature consistently demonstrates a benefit to antepartum bed rest. Given the well-documented adverse effects of bed rest, disruption of social relationships, and financial implications of this intervention, there is a real need for scientific investigation to establish whether this is an appropriate therapeutic modality. Well-designed randomized, controlled trials of bed rest versus normal activity for various complications of pregnancy are required to lay this debate to rest once and for all. *Mt Sinai J Med* 78:291–302, 2011. © 2011 Mount Sinai School of Medicine

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Hippocrates was the first physician to recommend bed rest as a potential treatment for a medical ailment. In this case, he prescribed it for the management of pain, but noted that “should a long period of inactivity be followed by a sudden return to exercise, there will be an obvious deterioration.”¹ Before the 19th century, patients were likely to refuse bed rest due to lack of income and fear that one would never get up again. In the mid-1800s, Dr. John Hilton published his work “On Pain and Rest,” in which he advocated bed rest for postoperative recovery after orthopedic procedures,^{1,2} specifically promoting the benefit of rest on diseases of the hip joint. This work led to increased popularity of bed rest as a therapeutic intervention in medical practice. It was not until the mid-1950s that bed rest began to fall out of practice, when the National Aeronautics and Space Administration (NASA) used bed rest as a surrogate for weightlessness in space and began documenting

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physiologic side effects of activity restriction.³ Maloni⁴ summarizes NASA's research, which found that the supine position (a surrogate for bed rest) leads to several physiologic adaptive changes, including changes in hydrostatic gradients and alterations in the cardiovascular/cardiopulmonary, fluid and electrolyte, hormonal, hematologic, musculoskeletal and neurosensory/vestibular systems. These physiologic alterations ultimately lead to debilitating symptoms during bed rest and recovery, including muscle atrophy⁵ and bone demineralization.^{6,7} Maloni also highlights an organizational framework based on the aerospace research to explain some of the adverse effects of bed rest and guide future directions for research on antepartum bed rest.⁴ In addition, many studies later documented adverse behavioral and sociocultural alterations associated with bed rest during pregnancy.^{5,8-10} The decline in the use of bed rest was further fueled by studies that demonstrated worse outcomes when bed rest was used as the primary therapy for acute low back pain, uncomplicated myocardial infarction, pulmonary tuberculosis, and acute infectious hepatitis.¹¹ Early return to function and encouragement of patients to improve activity are now goals of care in many fields that previously recommended bed rest as a therapeutic measure.

Activity restriction in obstetrics, however, is surprisingly still pervasive. Bed rest in pregnancy was first recommended in midwifery texts in the mid-1800s, and became increasingly popular with the formalization of prenatal care in the early 1900s.¹ Even in the Victorian era, women were "confined" by childbirth, with the term estimated date of confinement still used in obstetric practices today. The lying-in period following childbirth was, effectively, a prolonged period of bed rest after delivery.¹ Because of this long history of bed rest prescription by obstetricians, this intervention has persisted in clinical practice, despite its being abandoned in other fields.

EPIDEMIOLOGY OF THE USE OF ANTEPARTUM BED REST

Bed rest is a very common obstetrical intervention. Up to 95% of obstetricians utilize bed rest in their practice for a variety of indications.¹²⁻¹⁵ A survey of both maternal fetal medicine (MFM) directors and practicing obstetricians not only documented widespread use of bed rest (89%–93%), but also highlighted the tremendous variability in indications, location (hospital or home), and severity of activity restriction, even when treating the same conditions.¹⁶ Almost 20% of women will be placed on bed rest at some point during their pregnancy.¹³ Although it

is clear that bed rest is used frequently, and for a variety of indications, many authors have discussed

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its apparent lack of efficacy and myriad adverse effects.^{4,11,13,15,17} A recent survey of MFM providers assessed attitudes toward the prescription of bed rest for 2 complications of pregnancy: preterm labor and premature rupture of membranes (PROM).¹⁸ More than 70% of MFM physicians recommended bed rest for preterm labor, and almost 90% recommended it for PROM. Despite these practice recommendations, the majority of these physicians reported little to no expected benefit from bed rest.

True adherence to bed rest can be quite low, and vary depending on whether bed rest is prescribed in the hospital or at home.¹⁹ Formerly, physicians prescribed sedation with bed rest, in order to improve women's compliance to restricted activity. This practice, fortunately, has fallen out of use. Women often push the limits of their activity restriction due to uncertainty about the effectiveness of the intervention²⁰ and the ambiguity surrounding their limitations while on bed rest. Although women are aware of the recommendation to stay in bed for various complications of pregnancy, many of them fail to comply with this treatment.²¹ Mothers placed on home bed rest often grapple with the temptation to perform more activity than recommended.¹⁹ Many barriers to compliance with antepartum bed rest have been identified, including need to care for other children, not feeling sick, household demands, lack of a partner or support, and having to work.²²

CLINICAL CONDITIONS FOR WHICH BED REST IS PRESCRIBED

There are a variety of clinical conditions for which bed rest is prescribed by obstetricians. Though the list of conditions is long, the list of evidence to support the use of bed rest is rather short. Some complications, such as preterm premature rupture of membranes (pPROM), have never been directly

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studied, whereas others, such as threatened abortion, multiple gestations, hypertensive diseases of pregnancy, and preterm labor, have received slightly more attention in the literature.

Threatened Abortion

Threatened abortion is defined as vaginal bleeding before viability of the fetus. The majority of threatened abortions lead to normal pregnancy outcomes, but some lead to miscarriage of the fetus. Spontaneous abortion is most commonly due to fetal or chromosomal abnormalities, though maternal risk factors such as advanced age and tobacco use also contribute.

Activity restriction for threatened abortion was first studied by Diddle *et al.* in 1953. Women from 3 sites were prospectively followed for pregnancy outcome after threatened abortion. The 3 study groups received either (1) strict bed rest with barbiturate sedation; (2) partial bed rest, sedation, and adjunctive medication (such as thyroid, stilbestrol, or progesterone); or (3) normal activity. Even though the authors found that normal activity was not more likely to lead to inevitable abortion, they still recommended bed rest to control maternal blood loss (in the event that hemorrhage occurred).¹² Despite this early suggestion that bed rest did not improve outcomes for threatened abortion, this practice has continued and was studied again in the early 1990s. Studies by Hamilton *et al.*²³ and Harrison²⁴ also did not support the recommendation of bed rest for threatened abortion, although these randomized controlled trials (RCT) had small sample sizes. The Hamilton trial reports 3 miscarriages in their study of 23 women with threatened abortion, but does

not mention which study group these patients were in. The authors closed the study in order to organize a larger, multicenter trial to better analyze the utility of bed rest, though this has not been carried out to date. These 2 studies were analyzed in a 2005 Cochrane review on bed rest for prevention of miscarriage, which again concluded that insufficient evidence exists for this recommendation.²⁵ The most recent study of bed rest for threatened abortion came out of Israel in 2003; the authors studied women with threatened abortion complicated by subchorionic hematoma (a hematoma underlying the placenta visualized sonographically). All women in the study were prescribed bed rest to prevent miscarriage. The authors retrospectively analyzed compliant ($n = 200$) versus noncompliant ($n = 30$) patients and their rates of subsequent miscarriage. Though they reported a decreased risk of miscarriage in the patients who were compliant with bed rest,²⁶ the uneven study group numbers, retrospective analysis, and comparison of noncompliant versus compliant patients make it difficult to draw meaningful conclusions from this data. Since most cases of early pregnancy loss are due to chromosomal or fetal anomalies, physical activity level or the prescription of activity restriction seems unlikely to impact the ultimate outcome of these pregnancies. Table 1 summarizes the studies performed on bed rest for threatened abortion.

Multiple Gestations

The rate of multiple gestations is exponentially increasing in the United States, mainly due to advances in assisted reproductive technology.²⁷ Multiple gestations are at increased risk for preterm

Table 1. *Bed Rest for Threatened Abortion.*

Author(s), Year	N	Study Design	Study Group	Control Group	Efficacy of Bed Rest
Diddle <i>et al.</i> , 1953 ¹²	9742	Prospective observational	Bed rest +/- sedation	Normal activity	No difference
Hamilton <i>et al.</i> , 1991 ²³	23	RCT	Bed rest	Normal activity	3 patients miscarried, does not report which study group; trial was stopped
Harrison, 1993 ²⁴	61	Double-blind RCT	Bed rest	hCG injection	hCG significantly better than bed rest to prevent abortion
Ben-Haroush <i>et al.</i> , 2003 ²⁶	230	Nonrandomized retrospective analysis	Compliant with bed rest	Noncompliant	Patients adherent to bed rest had fewer SABs ($P = 0.006$) and higher rate of term pregnancy ($P = 0.004$)

Abbreviations: hCG, human chorionic gonadotropin; RCT, randomized controlled trial; SAB, spontaneous abortion.

delivery and low-birth-weight infants and are associated with substantial increases in perinatal morbidity and mortality. Premature birth is a leading cause of such long-term complications as learning disabilities, developmental delays, or even more severe problems, such as chronic lung disease, blindness, and cerebral palsy. Approximately 14% of infant mortality is due to multiple births.²⁷ Many women pregnant with multiples and many obstetricians think that bed rest in the late second or third trimester may be useful in decreasing the incidence of preterm birth.²⁸

The recommendation of bed rest for multiple gestations has been analyzed in a Cochrane review from early 2010 by Crowther *et al.* This review included 7 studies to encompass >700 women and more than 1400 infants delivered. The authors found that routine bed rest in the hospital did not decrease the incidence of preterm birth or perinatal morbidity. They noted a possible improvement in fetal growth in the hospitalized group on bed rest (risk ratio: 0.92, 95% CI: 0.85–1.00), though this was not statistically significant.²⁸ Through this analysis, the authors concluded that insufficient evidence exists for the recommendation of routine bed rest in women with multiple gestations. Table 2 outlines the existing trials analyzing hospital bed rest for multiple gestations. Interestingly, women placed on bed rest for multiple gestations have also been shown to have significantly lower weight gain than recommended for carrying

twins or triplets.²⁹ They report more symptoms of antepartum bed rest (approximately 22 symptoms) than women carrying singleton pregnancies on bed rest (average 8 symptoms) or women with normal, healthy pregnancies that do not require bed rest. In their paper analyzing side effects of bed rest on multiple gestations, Maloni *et al.* reported appropriate infant birth weight, despite the low weight gain of the mother while on bed rest.²⁹ This may suggest that the infant continues to gain weight at the expense of the mother.

Hypertensive Disease of Pregnancy: Gestational Hypertension and Preeclampsia

Preeclampsia complicates 2%–8% of pregnancies³⁰ and is thought to result from placental vasospasm, which leads to fetal growth restriction and preterm delivery. Maternal side effects of preeclampsia include eclampsia (a progression to seizures), stroke, liver and kidney failure, and clotting disorders (such as disseminated intravascular coagulation).³⁰ Hypertensive diseases of pregnancy, such as gestational hypertension and preeclampsia, are commonly managed with some form of activity restriction.^{31,32}

Table 2. *Bed Rest for Multiple Gestations.*

Author(s), Year	N	Study Design	Study Group	Control Group	Efficacy of Bed Rest
Hartikainen-Sorri and Jouppila, 1984 ⁷¹	73	Quasi-randomized trial	Hospital bed rest	Outpatient care	No benefit
Saunders <i>et al.</i> , 1985 ⁷²	212	RCT	Hospital bed rest	Outpatient care	Increased PTD in bed rest group*
Crowther <i>et al.</i> , 1989 ⁷³	139	RCT	Hospital bed rest	Outpatient care	No benefit
Crowther <i>et al.</i> , 1990 ⁷⁴	118	RCT	Hospital bed rest	Outpatient care with activity restriction	Possible improvement in fetal growth, but otherwise no benefit
MacLennan <i>et al.</i> , 1990 ⁷⁵	141	Multicenter RCT	Hospital bed rest	Outpatient care	No benefit
Crowther <i>et al.</i> , 1991 ⁷⁶	19	RCT	Hospital bed rest	Outpatient care	Bed rest decreased incidence of PTB and LBW infants
Dodd and Crowther, 2005 ⁷⁷	7	RCT	Hospital bed rest	Outpatient care	No benefit
Maloni <i>et al.</i> , 2006 ²⁹	31	Longitudinal repeated measures study	Hospital bed rest	NA	Bed rest led to significantly lower maternal weight gain than recommended for multiples ($P = 0.04$)

Abbreviations: LBW, low birth weight; PTB, preterm birth; PTD, preterm delivery; RCT, randomized controlled trial; SAB, spontaneous abortion; NA, not applicable.

* $P < 0.05$.

Some theorize that because hypertension in pregnancy may lead to decreased placental and myometrial blood flow and, as a result, poor fetal growth and decreased amniotic-fluid volume, bed rest may reverse these effects by directing more flow to the uterus and placenta. However, it has never been proven that bed rest enhances placental blood flow—there have not been trials directly measuring changes in placental flow for pregnant women on bed rest or in animal models. Another school of thought is that, because systolic blood pressure is higher when upright, perhaps the supine position would lead to decreased pressures and improve symptoms of gestational hypertension and preeclampsia. Some authors suggest that the diuretic effect of bed rest may be useful in patients with gestational hypertension (but not preeclampsia), although this has not been well studied.^{4,33} Table 3 reviews the studies available on bed rest for hypertensive disease in pregnancy.

Initial trials by Mathews in the late 1970s and early 1980s analyzed bed rest for nonproteinuric hypertension and preeclampsia, respectively. One hundred thirty-five women were studied in a RCT in 1977 to assess maternal and neonatal outcomes after bed rest and sedation for gestational hypertension. Women who were sedated with phenobarbitone and placed on bed rest did not have improved outcomes when compared to women who were allowed normal everyday activity.³⁴ The only other RCT studying bed rest for gestational hypertension has been performed also failed to demonstrate a benefit for fetal growth

or neonatal morbidity in the bed rest group.³⁵ The recommendation for bed rest and sedation for asymptomatic, nonalbuminuric hypertension of pregnancy lacks support in the literature.

Antepartum bed rest for preeclampsia was first studied by Mathews *et al.* in 1982 in a RCT. After randomizing 40 women to complete bed rest or full ambulation, the authors followed levels of human placental lactogen (a marker of placental function and possible surrogate for fetal well-being), estriol, urate, premonitory symptoms of eclampsia (increasing headache, visual disturbances, epigastric pain, vomiting), and fetal growth. A subset of 10 high-risk patients was identified with hyperuricemia and severe fetal growth retardation. For this group, the authors found that bed rest led to fewer intrauterine deaths, but that women were more likely to experience premonitory signs of eclampsia.³⁶ This study did not, however, comment further on the benefit of bed rest for the remaining patients who were not in this “high-risk” group. The authors concluded that although there were not significant increases in serum human placental lactogen and estriol, fetal outcomes may be improved because more intrauterine deaths occurred in the ambulatory group. They also interpreted the signs of eclampsia as beneficial to the fetus by considering these “warning signs” that lead to delivery of a live fetus before intrauterine death occurs. The lack of statistical significance and the small sample size make it difficult to draw meaningful conclusions about the true benefit to fetal outcomes in women with preeclampsia who

Table 3. *Bed Rest for Hypertensive Diseases in Pregnancy.*

Author(s), Year	N	Study Design	Study Group	Control Group	Efficacy of Bed Rest
Mathews, 1977 ³⁴	135	RCT	Hospital bed rest +/- sedation	Outpatient care +/- sedation	No difference in fetal outcomes
Mathews <i>et al.</i> , 1982 ³⁶	40	RCT	Hospital bed rest	Ambulation	Bed rest showed increased premonitory signs of eclampsia but had fewer intrauterine deaths in the higher-risk group
Crowther <i>et al.</i> , 1992 ³⁵	218	RCT	Hospital bed rest	Outpatient care	No improvement in fetal growth or neonatal morbidity
Sibai <i>et al.</i> , 1992 ³¹	95	RCT	Nifedipine + bed rest	Bed rest	Nifedipine + bed rest better than bed rest alone to reduce maternal BP
Sibai <i>et al.</i> , 1994 ³²	200	RCT	Immediate delivery	Expectant management (bed rest, tocolysis, fetal testing)	Expectant management (bed rest, fetal testing, meds) reduced neonatal complications and hospital stay compared with immediate delivery

Abbreviations: BP, blood pressure; IUGR, intrauterine growth restriction; RCT, randomized controlled trial.

are placed on bed rest. Importantly, eclampsia is a severe complication of pregnancy characterized by neurological disturbances and seizures in the pregnant woman. Avoidance of eclampsia is of utmost importance, and the implication that bed rest may increase risk of progression to eclampsia in women is highly concerning. Other randomized trials of bed rest for the management of preeclampsia have used bed rest as a baseline standard of care; they have not analyzed differences in outcome for bed rest versus non-bed rest groups (see Table 3).^{31,32}

In a Cochrane review of bed rest for preeclampsia prevention from 2006, Meher *et al.* analyzed 2 studies on the prevention of preeclampsia in women with normal blood pressure. Though the studies included in this review suggested a potential reduction in relative risk for preeclampsia in singleton pregnancies before 28 weeks, the authors concluded that insufficient evidence exists to recommend bed rest for women carrying singletons due to uncertain study quality.³⁰ Institution of bed rest for all normotensive pregnant women seems an overly aggressive strategy to prevent preeclampsia, especially given the well-known adverse effects of bed rest.

Preterm Labor

Preterm labor and subsequent preterm delivery are the leading cause of perinatal morbidity and mortality.^{20,37} Bed rest for the prevention of preterm birth and as adjunctive treatment in preterm labor is a common management strategy, although few studies have objectively analyzed its usefulness (see Table 4). Many providers, when asked about effectiveness of bed rest for preterm labor, indicate that there is little evidence to support the use of bed rest and that the efficacy is fair to poor for altering pregnancy outcomes.³⁸ Yet despite these beliefs, >60% of Canadian obstetricians >50% of midwives recommend home bed rest for women at risk of preterm birth.³⁸

Most recently, a randomized multicenter trial was performed comparing bed rest with normal activity in women admitted to the hospital for preterm

labor with a negative fetal fibronectin test. Fetal fibronectin is a test used to evaluate the integrity of the fetal membranes—a negative test essentially rules out labor in the 2 weeks following the test result. In their trial, Elliott *et al.* found no difference in pregnancy outcomes or incidence of preterm birth between women who were ambulatory and those with restricted activity.³⁹ Due to the low likelihood of delivery in both groups given the negative fetal fibronectin test result, it is difficult to determine if this lack of difference was truly due to activity level. The only other RCT analyzing bed rest for singleton pregnancies compared bed rest with tocolysis. Thus, bed rest was considered a standard of care and its utility was not put into question.⁴⁰

A 2004 Cochrane review of the literature on bed rest for prevention of preterm birth found that there is no evidence to support the practice of home or hospital bed rest to prevent preterm birth.⁴¹ The costs associated with activity restriction and lack of documented benefit compared with likelihood of risk makes this an unfounded management strategy for providers.

Embryo Transfer

Bed rest has been studied in the field of reproductive endocrinology and infertility as management strategy after embryo transfer for in vitro fertilization. After transfer of fertilized embryos into the uterus via a small catheter, patients are often told to remain in the supine position for 30 minutes and minimize activity for the remainder of the day. Two prospective RCTs have assessed the benefit of bed rest after embryo transfer; no difference in uterine contents directly after transfer⁴² or clinical and ongoing pregnancy rates⁴³ were evident between the 2 study groups of bed rest and immediate ambulation. A Cochrane review in 2009 further reported insufficient evidence in the literature to support the recommendation of bed rest after embryo transfer for in vitro fertilization.⁴⁴

Table 4. *The Use of Bed Rest for Preterm Labor.*

Author(s), Year	N	Study Design	Study Group	Control Group	Efficacy of Bed Rest
Weiner <i>et al.</i> , 1988 ⁴⁰	109	RCT	Tocolysis	Bed rest	No difference in GA delivery or outcomes
Crowther <i>et al.</i> , 1989 ⁷³	139	RCT	Hospital bed rest	Outpatient care	No benefit
Elliott <i>et al.</i> , 2005 ³⁹	73	Prospective multicenter RCT	Activity restriction	Normal activity	No difference

Abbreviations: GA, gestational age; RCT, randomized controlled trial.

Fetal Growth Restriction

Fetal growth restriction (FGR) is a common complication of pregnancy seen in both developed and Third World countries. Etiologies of intrauterine growth restriction (IUGR) are variable and include fetal, maternal, and environmental influences. Some well-documented maternal causes of FGR include vascular disease (such as hypertension or diabetes), hypercoagulable states, toxins (such as tobacco or illicit drug use), and chronic hypoxia.⁴⁵ Placental insufficiency is another important cause of FGR. Growth restriction is associated with preterm delivery and the sequelae of prematurity are often more severe in these infants, including neonatal respiratory distress syndrome, necrotizing enterocolitis, and intraventricular hemorrhage.⁴⁶

The choice of therapy for FGR is shaped by the underlying etiology. Bed rest is commonly recommended in the hope that uteroplacental perfusion will improve, thereby increasing fetal growth.⁴⁷ The only RCT studying bed rest for FGR failed to demonstrate a benefit to hospital bed rest for either fetal growth or pregnancy outcome.⁴⁸

In a Cochrane review of bed rest for FGR in 2010, only the aforementioned RCT was analyzed. The review authors also concluded that there is insufficient evidence in the literature to recommend bed rest for patients with suspected IUGR.⁴⁹ This lack of studies indicates a need for a well-designed RCT studying bed rest for prevention of or improvement in FGR.

Other Conditions

Other studies of bed rest for cervical incompetence,⁵⁰ umbilical cord prolapse,²¹ and amniotic sac prolapse⁵¹ exist, but these have looked at bed rest compared with an intervention for these complications, such as cerclage placement. These studies have all used bed rest as a baseline standard of care for the conditions studied, despite insufficient evidence for this standard. In the 3 aforementioned complications, bed rest was shown to be significantly less helpful when compared with cerclage placement,^{50,51} or was recommended by providers despite their belief that bed rest would not be helpful.²¹

The efficacy of bed rest in the management of oligohydramnios has not been evaluated in the literature. However, several studies have analyzed perinatal outcomes after pPROM in which oligohydramnios was diagnosed.⁵²⁻⁵⁴ These studies used bed rest as part of their expectant management strategy for oligohydramnios, though insufficient evidence for this standard exists in the literature.

POTENTIAL COMPLICATIONS

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Maternal Effects

A variety of physical and psychological adverse effects of bed rest have been described in the literature. According to the original work on bed rest performed at NASA, using bed rest as a surrogate for weightlessness in outer space, physiologic side effects are varied and begin in a matter of hours after bed rest is initiated. Some of these side effects include diuresis, decreased intravascular volume, muscle atrophy, cardiac deconditioning, and weight loss.^{3,17,55} Though the NASA studies did not include pregnant women, this research could be instrumental for designing studies to assess the side effects of bed rest in pregnancy. One study by Maloni and Schneider in 2002 objectively analyzed the effects of inactivity on gastrocnemius muscle function in pregnant women. They found that during antepartum bed rest, the gastrocnemius muscle required significantly more time for reoxygenation after exercise (implying a decrease in muscle function). In the postpartum period, reoxygenation significantly improved, though women did not achieve complete muscle recovery to baseline at their 6-week postpartum visit.⁵

Risk of thromboembolism is higher in pregnant women due to hypercoagulability of pregnancy. Further immobilization leads to venous stasis, one of the known risk factors for thrombosis, as identified by Virchow in 1884.⁵⁶ Studies of venous thromboembolism (VTE) in patients with a variety of medical conditions have identified bed rest as a risk factor.^{56,57} This risk of thromboembolism is significantly increased in pregnant women who are prescribed activity restriction, as studied by Kovacevich *et al.* in 2000. Through a retrospective comparison of pregnant women on bed rest to a group without activity restriction, they reported an incidence of thromboembolism of 15.6/1000 women in the bed

rest group versus 0.8/1000 in women not placed on bed rest.⁵⁸ Though one study by Danilenko-Dixon in 2001 did not identify antepartum bed rest as a risk for thromboembolism,⁵⁹ another study from Japan in 2001 found that bed rest was significantly related to risk of VTE and pulmonary embolism.⁶⁰ These studies, along with the extensive literature surrounding bed rest as a risk factor for VTE from other medical fields, suggest that bed rest is an important risk factor for thrombosis in women placed on antepartum bed rest.

Bone loss and demineralization are also markedly increased in patients placed on bed rest. Normal physiology of pregnancy leads to maternal calcium shifts for fetal bone development.⁴ However, women placed on bed rest are 6× more likely to lose ≥5% of their bone density in as little as 20 weeks.⁶ The higher serum levels of bone alkaline phosphatase are measured and increases in type 1 collagen are indicative of increased bone turnover in women on bed rest. The level of serum bone alkaline phosphatase was also significantly correlated with the duration of bed rest ($r = 0.767$, $P = 0.0041$).⁷ Because of the loss of postural cues, circadian rhythm disturbances lead to altered sleep/wake cycles, fatigue, and insomnia. Increased blood flow to the brain and thorax results in early diuresis to decrease intravascular volume; the orthostatic response is also decreased due to infrequent stimulation of the carotid baroreceptors while supine.⁴⁵ Due to the plethora of physical side effects and overall deterioration that occurs with antepartum activity restriction, postpartum recovery after bed rest is often prolonged, making it difficult for the new mother to fully care for her neonate. Decreased muscle strength, fatigue, lack of coordination, and cardiac deconditioning all contribute to the mother's inability to rapidly regain her previous level of function in the home, in the family, and at work.^{4,5,9,61} Maternal weight gain is the strongest predictor of infant birth weight,¹⁰ yet women on bed rest fail to gain weight appropriately.

Psychologically, women placed on bed rest have higher levels of combined anxiety, depression, and hostility.^{8,62-65} Major stressors include separation from the family^{17,20} and concern about fetal well-being.⁶³ Many women experience profound boredom, along with depression, sensory disturbances, and fatigue.¹⁷ "Health," as described by Dunn and Shelton, is a combination of absence of disease, social support, and spirituality—women on antepartum bed rest have lower levels of spiritual well-being, which is inversely related to depression and anxiety levels.⁶⁵ Because of the psychosocial effects of activity restriction, many women "test the limits" of this prescription

in order to maintain some semblance of a normal life,²⁰ as discussed in a previous section.

Effects on the Family

Maternal activity restriction has been noted to have profound effects on the family. Children whose mothers are on bed rest have been shown to have increased negative reactions to maternal bed rest, including difficulty in school, fighting, and "acting out" behaviors.⁵⁴ They have higher incidences of depression and stress; children also have a sense of general disorientation due to the frequent shifts in childcare that occur when the mother is placed on bed rest. Effects of bed rest are equally pronounced for the woman's partner. Partners often assume the brunt of maternal responsibility as her daily activities are progressively restricted, accepting additional childcare and domestic activities in addition to their normal role in the family structure.⁶⁶⁻⁶⁸ They also report increased stress and worry about maternal and fetal well-being.^{20,66-68} Finally, financial implications of bed rest must not be overlooked. In Goldenberg's 1994 article on bed rest in pregnancy, a cost analysis was performed to evaluate the impact bed rest would have on families and on society. An estimated \$1.03 billion is lost annually by placing women on antepartum bed rest¹³—this estimate from 1994 is likely an underestimation for 2010. This activity restriction has financial effects of some degree on approximately 71% of families.⁶⁸ Current societal structure no longer places the woman in the home with the male partner as a primary breadwinner. This androcentric view of a woman's role in society may explain some of the overwhelming financial effects of maternal bed rest—a woman's income may be as much as or more than her partner's and may be crucial for the survival and stability of her family.¹⁷ Even families that are not financially disadvantaged report some degree of strain,⁶⁸ obstetricians need to keep these social stressors in mind when recommending antepartum activity restriction for their patients with complicated pregnancies.

Neonatal Effects

Many studies focus on maternal complications, but neonatal side effects of maternal bed rest also need to be considered. Neonates born to mothers who were on bed rest during their pregnancy have been shown to have lower birth weights and gestational age at delivery.^{10,17,29} Women on bed rest do not gain weight appropriately when compared with the recommendations by the Institute of Medicine.⁴ In fact,

Maloni *et al.* showed that 75% of the sample either lost weight or failed to gain weight during the first week of bed rest. Others gained no weight after that or lost weight, with more than half continuing to lose weight across hospitalization.¹⁰ This directly impacts neonatal outcome, though fetal weight gain is not as profoundly affected as the mother. This may imply that fetal weight is maintained at the expense of the mother while she on bed rest. Similar effects have been noted in women carrying multiple gestations.²⁹ Although many infant weight standards do not provide specific guidelines for the consideration of infant race, gender, and gestational age, the study by Maloni *et al.* in 2004¹⁰ matched these 3 factors between study groups. Interestingly, Bellieni *et al.* studied long-term effects on children born to mothers who had been placed on antepartum activity restriction. In their analysis, they found that offspring of mothers who had been on bed rest were significantly more likely to develop allergies, suffer from motion sickness, and require vigorous rocking to fall asleep.⁶⁹ The authors hypothesize that perhaps bed rest leads to inadequate stimulation of the vestibular system during development while the mother decreases activity and ambulation. This inappropriate development may lead to alterations in vestibular sensitivity, thereby explaining the increased incidence of motion sickness and the requirement for more rocking in order to be soothed. Thus, it seems that maternal bed rest, often perceived as being only helpful to the fetus, has possible negative neonatal considerations, and thus potential complications should be discussed with expecting parents and anticipated by obstetricians.

DISCUSSION

The use of bed rest in pregnancy, though exceedingly common, lacks supportive evidence in the literature. This review of existing studies suggests that there are no complications of pregnancy for which bed rest is consistently shown to be a beneficial intervention.

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The physical and psychological adverse effects of bed rest, along with its impact on familial and neonatal

well-being, outweigh any minimal benefit maternal activity restriction may provide.

The question must be posed: Why does bed rest still exist in obstetrical practice? Schroeder attempted to answer this question in a critical analysis from 1998, with 4 main reasons bed rest persists.⁹ The first is a question of fetal benefit from bed rest—the notion that the fetus will not be harmed during bed rest may lead to continued prescription of antepartum activity restriction, regardless of effects on maternal well-being. Yet, some studies have shown definitive adverse neonatal effects, including low birth weight,^{10,17,29} and long-term side effects in children whose mothers were on antepartum bed rest.⁶⁹ Second, Schroeder suggests a fear of malpractice may lead to increased prescription of bed rest in an attempt to “do everything possible” for a high-risk pregnancy, when, in fact, the literature does not support this intervention. Midwives have cited “protecting women” as a reason they recommend bed rest,²¹ although it seems that obstetricians make this recommendation, at least partially, to protect themselves. Third, the “idealized” and androcentric view of the family may lead to increased use of bed rest without considering the implications this strategy has on the family. Many women, however, contribute a substantial portion of income to the family, with only about 15% of families conforming to a traditional structure with a man working and a woman in the home.^{9,70} Multiple studies have examined the effects of bed rest on family structure and finances, showing that this intervention puts the majority of families under some degree of financial strain. Finally, the lack of objective research and randomized controlled trials analyzing bed rest for a variety of complications of pregnancy is a major reason this intervention still persists in daily practice. This review further highlights the need to study certain high-risk pregnancy groups for which bed rest is routinely prescribed (ie, pPROM, shortened cervix on ultrasound, threatened miscarriage, and preterm labor). These commonly encountered complications of pregnancy lack well-designed, robust trials that can provide meaningful results about the use of antepartum bed rest as part of their management.

Future directions for bed rest are 3-fold. First, well-designed RCTs are needed to continue to study the utility of bed rest in the management of women with complicated, high-risk pregnancies. Additional studies with large sample numbers are necessary for many conditions that have had conflicting results in the literature. Second, obstetricians need to thoughtfully analyze the existing literature about bed rest, both as an intervention in complicated pregnancies and as a harmful therapeutic measure with multiple

Well-designed randomized controlled trials are needed to continue to study the utility of bed rest in the management of women with complicated, high-risk pregnancies.

adverse effects. Informed clinical decision-making will be of utmost importance to altering obstetric practice to decrease the use of antepartum bed rest. Finally, involvement of women and their partners in decisions about maternal activity restriction and the risks and benefits of this intervention needs to move to the forefront of antepartum care. Through presenting the evidence, or lack thereof, for bed rest in managing high-risk pregnancy, patient autonomy can be respected and partnership can occur between mothers and physicians. Ultimately, through well-designed trials and evidence-based medicine, question of the efficacy or harm of bed rest in pregnancy will finally be answered and potentially lead to important changes in clinical practice.

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