


Antepartum Bed Rest for Pregnancy Complications: Efficacy and Safety for Preventing Preterm Birth

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Abstract

Preterm birth is the major maternal-child health issue across developed nations and the leading cause of perinatal mortality and morbidity. Of all deaths of infants <1 year of age in the United States in 2005, 68.6% occurred in infants born prior to term. Although the preterm birth rate in European countries is 5–7%, the U.S. preterm birth rate is 12.7%, representing an increase of 9% since 2000. Antepartum bed rest/activity restriction (ABR/AR) has been a mainstay of treatment to prevent preterm birth for the past 30 years prescribed for nearly 1 million women in the United States annually, despite a lack of evidence for its effectiveness. In fact, there is increasing evidence that ABR causes several adverse physiologic and psychological side effects among women and their infants. Unfortunately, these findings have had little impact on clinical practice. This integrative review of literature provides a comprehensive analysis of the evidence for the practice of prescribing ABR and its physiologic, behavioral, and experiential side effects. It also presents a model to guide continuing research about the effects of maternal bed rest as well as evidence supporting the use of home care with bed rest, a different, safe, and feasible model of prenatal care for treating women with pregnancy complications used particularly in other countries. Finally, suggestions to improve the health of high-risk pregnant and postpartum women and their infants are provided.

Keywords

pregnancy, pregnancy complications, bed rest, activity restriction, high-risk pregnancy, preterm birth, home care

Preterm birth is the major maternal-child health issue in developed countries as it is the leading cause of perinatal morbidity and mortality (Macdorman & Mathews, 2008). In 2004, the United States was ranked 29th in the world in infant mortality, tied with Poland and Slovakia. In 2005, of all deaths of infants <1 year of age in the United States, 68.6% occurred in preterm infants. The rate of preterm birth was 12.7% in the United States in 2005 and has increased steadily across at least the past two decades, compared with the current rate of 5–7% in European countries (Behrman & Butler, 2007; Goldenberg, 2002; Macdorman & Mathews, 2008).

Antepartum bed rest (ABR), or activity restriction (AR), defined as confinement to bed and restriction of activity except for toileting needs (approx. 1–2 hr/day), has been the mainstay of treatment to prevent preterm birth in the United States for the past 30+ years. The treatment is prescribed for 700,000 to 1 million women in the United States each year for periods ranging from a few days to months to treat a variety of pregnancy complications, including preterm labor, preterm premature ruptured membranes, placenta previa, multiple gestation, and hypertension (Goldenberg, 2002; Goldenberg et al., 1994; Maloni, 1998a; Maloni, Alexander, Schluchter, Shah, & Park, 2004; Maloni & Kasper, 1991; Maloni, Margevicius, & Damato, 2006; Sprague, O'Brien, Newburn-Cook, Heaman,

& Nimrod, 2008). The prescription of bed rest is based on the assumptions that it is (a) effective in preventing preterm birth and (c) safe for both the mother and fetus. Research across more than 2 decades, however, has failed to support the efficacy of bed rest for improving fetal outcomes. Randomized controlled trials (RCTs) that compared women with pregnancy complications treated with either bed rest or ambulation have consistently shown no group differences in infant outcomes commonly associated with preterm birth, including infant mortality, gestational age at birth, infant birth weight, and fetal growth restriction (Crowther, 2009; Elliott et al., 2005; Meher, Abalos, & Caroli, 2010; Say, Gulmezoglu, & Hofmeyr 2009; Sosa, Althabe, Belizán, & Bergel, 2009). In contrast, Hatch and colleagues report that evidence indicates that vigorous maternal exercise does not increase the risk of preterm birth (Hatch, Levin, Shu, & Susser, 1998). Leisure time exercise may, in

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fact, improve high-risk pregnancy outcomes and reduce the risk of preterm birth (IOM, 2007). Evenson, Siega-Riz, Savitz, Leiferman, and Thorp (2002) monitored 1,699 pregnant women and their patterns of exercise across pregnancy. They found the risk of preterm birth was somewhat decreased with vigorous leisure activity in the first trimester and further decreased in the second trimester.

The lack of effectiveness of ABR would not be as major a concern if there were no adverse effects. However, research also fails to support the assumption that bed-rest treatment is safe for either the mother or the baby. Rather, ABR has been associated with a variety of physiologic and behavioral maternal and fetal adverse effects and is a highly negative experience for women (Maloni, 1998a; Maloni & Kasper, 1991; Maloni et al., 2004; Schroeder, 1996). Given the presence of side effects, a comprehensive review of research about those effects is critical to inform practitioners and pregnant women about whether this treatment should be prescribed.

In this article, I provide a comprehensive analysis of the evidence surrounding the practice of prescribing ABR and its physiologic, behavioral, and experiential side effects. I also present a model to guide continuing research into the side effects of bed rest and evidence for a different, safe, and feasible model of high-risk prenatal care to treat women with pregnancy complications, including home care, which is used in other countries. Finally, I offer specific suggestions to improve the health of high-risk pregnant and postpartum women and their infants.

Method

To conduct this integrative literature review, I accessed MEDLINE, CINAHL, PubMed/Medline, and the Cochrane Database of Systematic Reviews and conducted a manual search of references contained within retrieved articles. I used the keywords *bed rest*, *pregnancy*, *high-risk pregnancy*, *preterm birth*, and *pregnancy complications* and combined the additional terms *side effects*, *bone loss*, *thrombosis*, *psychological effects*, *depression*, and *stress* with the original keywords for additional searches. For alternative models of antepartum care, I used the keywords *antepartum hospital care*, *antepartum home care*, *home care*, *home management*, *domiciliary antenatal care*, and *preterm labor*. I included articles reporting primary research in English of the effects of bed rest on both pregnant women and on nonpregnant persons and excluded a few relevant studies with unclear methodologies and analytic methods.

Because major research efforts related to ABR began in the 1990s, the sampling frame for review of studies to include in the integrative review was broad. I included all research designs in this review, as some of the research is still in the hypothesis-generation stage of development. I retrieved relevant quantitative and qualitative research from six disciplines: nursing, medicine, psychology, social science, and biological and aerospace sciences. Final selection of the literature was guided by the paper's overarching framework, that is the Human Response Model (HRM) and its concepts of physiologic, behavioral, and experiential adaptation (Heitkemper &

Bond, 2003). The final sample included in this review comprised 26 articles about physiologic, behavioral, and experiential side effects of ABR, 17 articles comparing antepartum hospital and home care, 5 meta-analyses of RCTs of the effectiveness of ABR, and 4 articles about physician use of bed rest. In my initial search, I actually retrieved 20 articles that compared home- and hospital-based antepartum care, but 7 did not identify whether bed rest was prescribed. My attempts to contact the authors of 4 of these studies were successful, and I determined that bed rest/activity restriction had been prescribed in the studies, resulting in the final sample listed above.

Overview of Research Framework

Aerospace Bed Rest Research

Initial research about the effects of bed rest was conducted by aerospace scientists who used bed rest in nonpregnant persons as a model to study the anticipated effects of weightlessness in space (Fortney, Schneider, & Greenleaf, 1996; Maloni & Kasper, 1991; Sandler & Vernikos, 1986). Researchers created a framework, based on aerospace science, to explain human adaptations to space flight, microgravity, and bed rest (Lujan, White, & Barber, 1994). This original aerospace framework is described in greater detail elsewhere (Fortney et al., 1996; Lujan et al., 1994; Maloni & Kasper, 1991; Sandler & Vernikos, 1986). To summarize, the aerospace framework, which is represented by the unshaded boxes in Figure 1, proposes the following: When the body is placed in the supine position, a series of physiologic events occur to help the body to adapt to the change in position. Change in body hydrostatic gradients and alteration in skeletal loading of weight-bearing tissues rapidly initiate a cascade of physiologic changes in every major organ system. There is a redistribution of body fluids toward the head. Alterations occur in the cardiovascular/cardiopulmonary, fluid and electrolyte, hormonal, hematologic, musculoskeletal, and neurosensory and vestibular systems. These physiologic alterations lead to symptoms that can become disabling across the bed rest and recovery periods. For example, reduced loading and disuse of weight-bearing muscles leads to both muscle atrophy and bone demineralization (Bloomfield, 1997; Fortney et al., 1996; LeBlanc, Schneider, Evans, Engelbretson, & Krebs, 1990; Sandler & Vernikos, 1986).

The aerospace framework was initially useful to guide new research about physiologic outcomes among pregnant women treated with bed rest, but researchers found that the framework was limited because it did not include behavioral or sociocultural alterations arising from the context of the woman's experience of bed rest. My colleagues and I as well as other researchers have empirically demonstrated these untoward outcomes of bed rest during pregnancy (Heaman, 1992; Maloni & Schneider, 2002; Maloni et al., 2004; Schroeder, 1996). It became clear, therefore, that a broader model was needed to guide investigations into the array of adverse side effects reported by pregnant women treated with bed rest (Maloni et al., 1993; Maloni, Brezinksi-Tomasi, & Johnson, 2001;

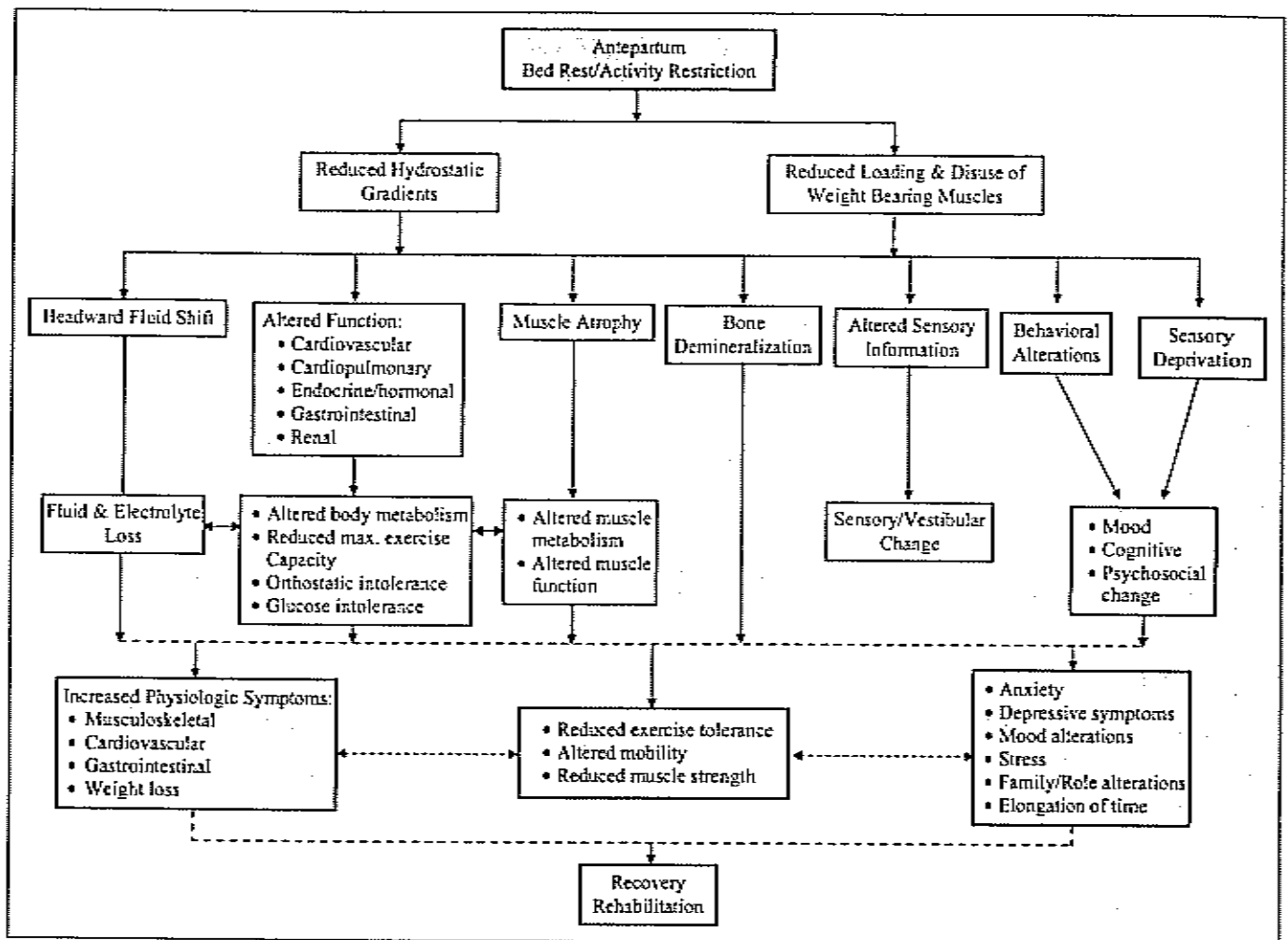


Figure 1. Maloni's Organizing Framework to Guide Study of Antepartum Bed Rest/Activity Restriction. Unshaded boxes depict items drawn from framework by Lujan et al. (1994) Shaded boxes depict items that I added to portray pregnant women's experience of bed rest. Dashed lines indicate areas in which further research is needed. Adapted from "Human Physiology in Space: A Curriculum Supplement for Secondary Schools," by B. F. Lujan, R. J. White, and H. Barber, 1994.

Maloni, Kane, Suen, & Wang, 2002; Maloni & Kutil, 2000; Maloni et al., 2006).

ABR/AR Organizing Framework

To provide a more comprehensive guide for research into the holistic effects of ABR, I created a new research framework, which combines the physiologic alterations identified in Lujan and colleagues (1994) aerospace framework with behavioral and psychosocial alterations identified in research about pregnancy bed-rest treatment. My additions to the aerospace framework are depicted in Figure 1 using shaded boxes.

The second row of the ABR/AR organizing framework presents the proposed causes of the body's adaptation to bed rest: reduced hydrostatic gradients and reduced loading and disuse of weight-bearing muscles (Fortney et al., 1996; Lujan et al., 1994; Sandler & Vemikos, 1986).

In the third row, the major physiologic adaptive responses to bed rest are depicted in a condensed format that primarily

reflects those factors most relevant to pregnant women. Thus, for example, similar to the aerospace framework, adverse physiologic effects in muscle, bone, and weight as well as symptoms of cardiovascular deconditioning have been found in pregnant women (Maloni, 1996; Maloni & Schneider, 2002; Maloni et al., 1993; Maloni et al., 2004; Promislow, Hertz-Picciotto, Schramm, Watt-Morse, & Anderson, 2004). In addition, I added two new factors, behavioral alterations and sensory deprivation, to this row of the ABR/AR framework.

Although behavioral alterations during bed rest have been documented in the aerospace literature, these were not represented by Lujan and colleagues (1994) in their framework. They include changes in cognition, mood, and socialization (Institute of Medicine, 2001; Levine, 1991; Zubek & Wilgosh, 1963). Sensory deprivation is a result of the fact that, during bed rest, movement, though physically possible, is controlled externally by others, hence the term restriction (Hammer & Kenan, 1980). This inability to move creates an "environmental sameness," a type of sensory deprivation (Hammer &

Kenan, 1980; Maloni, 1998a). Pregnant women restricted to hospital bed rest are exposed to limited, mostly noxious stimuli that exist within their immediate environment. They are estranged from that which is most familiar. Not only is kinesthetic stimulation limited, but also tactile, auditory, visual, environmental, intellectual, emotional, and social stimulation. Women report feeling imprisoned (Gupton, Heaman, & Ashcroft, 1997; Heaman & Gupton, 1998). Researchers working in other populations also report the presence of sensory deprivation during bed rest or RA and reveal that behavior and performance are altered (Downs, 1974; Institute of Medicine, 2001; Levine, 1991; Wood, 1977; Zubek & Wilgosh, 1963). Prior research has demonstrated that the physiologic and behavioral factors depicted within the third row of the ABR/AR framework interact in nonpregnant persons, but the relationships among these variables in pregnant and postpartum women after bed rest need to be more clearly explicated in future research.

The fourth row of the ABR/AR framework, again similar to the aerospace framework, depicts some of the specific physiologic changes that occur in both nonpregnant and pregnant persons. For example, among pregnant women, researchers have reported altered muscle metabolism and function (Maloni et al., 1993; Maloni & Schneider, 2002), orthostatic intolerance, and glucose intolerance with bed rest (Maloni et al., 1993; Maloni et al., 2002; Maloni & Park, 2005). Additionally, I have added behavioral and experiential outcomes that have been identified specifically among pregnant women to the framework. These are changes in mood, cognition, and psychosocial concerns.

I added the fifth row to the ABR/AR organizing framework, listing specific maternal physiologic, behavioral, and experiential responses to ABR, to more clearly depict the adverse effects of pregnancy bed rest. These responses include symptoms of various organ system alterations, including those in the cardiovascular and musculoskeletal systems leading to exercise intolerance and muscle dysfunction; difficulty with muscle strength, mobility, and exercise; and changes in behavioral status, including depressive symptoms, which appear to be a major side effect, along with anxiety and mood alterations (Maloni et al., 1993; Maloni et al., 2002; Maloni & Park, 2005; Maloni & Schneider, 2002). The box on the far right depicts the maternal experience of bed rest as involving stress, family and role alterations, and a sense of elongation of time (Gupton et al., 1997; Heaman & Gupton, 1998; Maloni et al., 2001; Schroeder, 1996; Thornburg, 2002). The box at the bottom of the framework indicates that maternal symptoms related to bed-rest treatment extend into the postpartum period and that there is a need for recovery and rehabilitation (Maloni & Park, 2005; Maloni & Schneider, 2002).

Adverse Effects of Bed Rest

The assumption that ABR/AR is safe, that is, causes no adverse effects for mother or fetus/infant, has been challenged over the past 20+ years. As depicted in the ABR/AR framework,

research about maternal–fetal side effects has revealed that women's adaptation to bed rest occurs at the physiological, behavioral, and experiential levels (Maloni et al., 1993; Maloni et al., 2002; Maloni et al., 2004; Maloni et al., 2006; Maloni & Schneider, 2002). These three adaptive levels, drawn from the HRM (Heitkemper & Bond, 2003), serve as the organizing framework for the following discussion about the adverse effects of bed rest. The studies reviewed are listed in Table 1

Physiologic Alterations

Muscle function. Researchers have identified changes in antepartum and postpartum gastrocnemius muscle metabolism, a proxy for muscle atrophy, in two longitudinal studies of women hospitalized on bed rest (Maloni et al., 1993; Maloni & Schneider, 2002). Both studies began on hospital admission, ended at 6 weeks postpartum, and assessed reoxygenation of the gastrocnemius muscle during recovery from plantar flexion exercise. The length of time needed for the gastrocnemius muscle to reoxygenate after plantar flexion exercise significantly increased (i.e., muscle metabolism deteriorated) across ABR and decreased (i.e., muscle metabolism improved) during postpartum recovery. In comparison, gastrocnemius muscle reoxygenation after exercise among normal controls did not change over time. Furthermore, women treated with bed rest at home prior to hospital admission had significantly longer lengths of muscle reoxygenation time after exercise than women whose bed rest began on hospital admission. One worrisome finding was that muscle recovery for women treated with bed rest was not complete at 6 weeks postpartum. Maternal reports of postpartum difficulty with mobility, soreness of weight-bearing muscles, and symptoms of cardiovascular deconditioning supported the presence of postpartum musculoskeletal and cardiovascular deconditioning (Maloni & Schneider, 2002).

Maternal weight. During bed rest in nonpregnant persons, weight loss often occurs due to loss of fluids, muscle, bone, and at times, appetite. Carbohydrate and fat metabolism are also altered by bed rest (Fortney et al., 1996; Krebs, Schneider, Evans, Kuo, & LeBlanc, 1990; Rice & Lane, 1997; Sandler & Vernikos, 1986). Weight gain during pregnancy, however, is critical to fetal outcome (Abrams, Altman, & Pickett, 2000; Barker, 1998; Institute of Medicine & National Research Council, 2009; Lu, Tache, Alexander, Kotelchuck, & Halfon, 2003). In three studies of maternal weight gain during ABR, researchers found that women lost or did not gain weight (Maloni et al., 1993; Maloni et al., 2004; Maloni et al., 2006). In the first study, in which the sample comprised 18 women with either a singleton or multiple gestation, the amount of weight gained during hospital bed rest was significantly lower than in healthy pregnant controls (Maloni et al., 1993). In a larger study of 141 women with singleton pregnancies researchers examined changes in body mass index (BMI) during ABR (Maloni et al., 2004). Weekly maternal weight gain was significantly lower than Institute of Medicine (IOM, 1990) recommendations that women with a normal BMI gain

Table 1. Studies on the Side Effects of Antepartum Bed Rest

Study and Country	Purpose	Design	Sample Characteristics	Admission GA (wks)	Length BR	Results
Bellieni et al., 2003, Italy	Explore long-term effects of pregnancy BR on offspring	Ret. Maternal survey	N = 43 BR, Dx = PTL, PPROM; N = 43 control	NA	M = 3.7 months	Inf in BR group had sig. more allergies, motion sickness, need to be rocked to sleep
Danilenko-Dixon et al., 2001, US	Identify risk factors for DVT and PE during pregnancy or PP	Ret. Case control cohort study	N = 90, Dx = DVT or PE; N = 85 controls	NR	NR	BR is not a significant risk factor for DVT and PE
Gupton et al., 1997, Canada	Describe the experience of prolonged BR	P. Focused ethnographic	N = 24 hosp. home or both, Dx = variety; S	M = 32.5	M = 20 days, R = 7-50	Stressors = situational, family and environmental. Physical and emotional symptoms.
Heaman, 1992, Canada	Compare stressful life events and mood disturbance in high-risk pregnant women on BR and healthy women	P. 3-group comparison.	N = 20 hosp, N = 20 home, Dx = P/H; N = 20 healthy control	M = 35.7	M = 3.6 days hosp, M = 4.3 days home	Hosp sig. higher anxiety, depression, total mood disturbance. No difference in stressful events.
Heaman & Gupton, 1998, Canada	Examine perceptions of home and hospital BR from the high-risk pregnant woman's perspective	P. Focused ethnographic study	N = 24 on BR (n = 12 hosp, n = 3 home, n = 9 both); BR for ≥ 7 days; Dx = variety; S & M NR	M = 32.7	M = 20 days, R = 7-50 days	Boredom, being a prisoner, and role reversals problematic in both settings. Home: temptation to do more. Hosp: separation from home and family, neg. emotions.
Kaji et al., 2007, Japan	Evaluate bone turnover markers, in pregnant and PP women on BR	P. Longitudinal two-group comparison	N = 15 BR before 30 wks; Dx = PTL; S & M NR	M = 30	NR	Increases in bone turnover markers with BR during pregnancy and PP
Kovacevich et al., 2000, US	Determine the prevalence of thromboembolic events among women prescribed AP BR compared to healthy controls	Ret. Chart review	N = 192 BR; Dx = PTL or PPROM; N = 6164 healthy controls; S & M NR	NR	≥ 3 days	Thromboembolic prevalence of 15.6 cases/1000 BR women was sig. higher than among women not treated with BR
Maloni et al., 1993, US	Describe the physical and psychosocial effects of AP hospital BR compared to healthy controls	P. Longitudinal repeated measures	N = 10 complete BR, N = 7 partial BR, N = 18 no BR; Dx = PTL+; S & M	M = 28.9	M = 29.2 days	Complete BR had sig. greater muscle atrophy, weight loss and dysphoria than partial or no BR. Separation was highest stressor. Sx of muscle and cardio deconditioning during PP.
Maloni et al. 2004, US	Assess maternal weight change and Inf BWt for GA, race, and gender	P. Longitudinal repeated measures	N = 141; Dx = PTL+, S	M = 29.1	M = 18.1 days	Weekly AP weight change was sig. lower than IOM recommendations. Inf BWt sig. lower than the national mean matched for GA, race, and gender
Maloni et al., 2006, US	Identify side effects of AP hosp. BR for women with twin or triplet gestation	P. Longitudinal repeated measures	N = 24 twin, N = 7 triplet mothers and their 69 live-born Inf.; Dx = PTL+; M	M = 28.0	M = 23.8 days	Wt gain less than IOM recommendations. Inf BWt appropriate for GA. Admission CESD scores high and sig. decreased across time.

(continued)

Table 1 (continued)

Study and Country	Purpose	Design	Sample Characteristics	Admission GA (wks)	Length BR	Results
Maloni et al., 2005, US	Use 3 instruments to compare AP depressive Sx among women treated with BR	P. Longitudinal repeated measures, methodological study	N = 89; Dx = PTL+; S & M.	M = 28.3	M = 29.1 days	Depressive Sx high on hosp. admission for all instruments and sig. decreased across time when measured by MAACL-R and POMS
Maloni et al., 2001, US	Identify effects of BR on the family	Ret. National survey, random selection	N = 89 hosp. or home; Dx = PTL+; S & M	NR	M = 90.5 days	Family difficulty assuming maternal responsibilities, anxiety about outcomes, financial difficulties, and adverse emotional effects on children
Maloni & Kuehl, 2000, US	Identify themes of discussion spontaneously voiced during support group	P. Descriptive	N 27; Dx = PTL+; S & M	R 24-34	NR	Themes = methods of coping, family concerns, negative emotions, psychosocial losses of BR treatment
Maloni & Park, 2005, US	Determine the type and frequency of PP Sx after AP BR	P. Longitudinal repeated measures	N = 106; Dx = PTL+; S	R = 21-33	M = 19.8 days	PP Sx sig. decreased across 6 weeks PP. Main Sx = fatigue, mood changes, tenseness, difficulty concentrating, back muscle soreness, headache.
Maloni & Schneider, 2002, US	Assess change in gastroc muscle metabolism across AP BR and PP	P. Longitudinal repeated measures	N = 65; Dx = PTL+; S & M	M = 28.4	M = 24.8 days	Gastroc muscle atrophy sig. increased during PP. Sx of PP muscle soreness, difficult mobility.
Maloni et al., 2002, US	Describe dysphoria and positive affect across AP and PP in pregnant women prescribed BR	P. Longitudinal repeated measures	N = 63; Dx = PTL+; S & M.	M = 28.7	M = 29.8 days	Depressive Sx highest on admission and sig. decreased across AP and PP. Positive affect sig. increased over same period. GA at birth sig. correlated with PP dysphoria.
Maloni & Ponder, 1997, US	Identify worries, concerns and stresses of partners of women being treated with AP BR.	Ret. Descriptive national survey, random selection	N = 59 partners of women on BR	NA	NA	Difficulty assuming multiple roles, managing emotional responses, caring for partner
May, 1994, US	Describe the impact of BR on expectant fathers	P. Descriptive interview and focus group	N = 30 fathers, after partner started BR	NA	NA	Worry and distress about partner, childcare, and household. Little support.
May, 2001, US	Examine the experience of BR among women with PTL and families	P. Naturalistic design, grounded theory	N = 58 women and 42 partners; Dx = variety	R = 20-26, continue until 36 wks	NR	Women/families balance BR and their needs. BR creates increased emotional distress and family disruption.
Mercer & Ferketich, 1988, US	Contrast stress, anxiety, depression in low-risk and high-risk preg. women	P. 2-group comparison	N = 153 BR, N = 218 control; Dx = other; S & M NR	R = 24-34	NR	Sig. higher depression, anxiety, and negative life events in high-risk grp

(continued)

Table 1 (continued)

Study and Country	Purpose	Design	Sample Characteristics	Admission GA (wks)	Length BR	Results
Promislow et al., 2004, US	Evaluate patterns of bone loss at 16 and 36 wks of pregnancy treated with BR compared to no-BR grp	P. Descriptive	N = 26 BR, N = 153 healthy controls; Dx and S & M NR.	R = 16-36	NR	Adjusted mean bone loss of 4.6% with BR compared to 1.5% not treated with BR
Schroeder, 1996, US	Explore women's experience of AP BR	P. Qualitative, naturalistic	N = 12 home or hosp; Dx NR	4-19	At least 3 wks	Physical, emotional, familial and economic hardship. Orientation toward future.
Stainton et al., 2006, Australia	Examine women's responses to two models of high-risk care: hosp. or day stay	P. Longitudinal repeated measures, AP to 6 wks PP	N = 32 day stay, N = 29 hosp; Dx = PPRM, PTL, and other; S & M NR	R = 30-39, day stay, R = 23-28, hosp	No BR	AP stress high for both grps but highest for those in hosp. Anxiety was highest for hospitalized women.
Stainton et al., 2005, Australia	Determine the experience of women with complicated pregnancies in hosp and day stay	P. Longitudinal, phenomenologic AP-PP	N = 11 hosp, N = 7 day stay; Dx = other; S & M NR	NR	No BR	"Waiting" is central to women's experience in day stay or hosp.
Thornburg, 2002, US	Understand lived experience of "waiting" among hospitalized pregnant women	P. Phenomenologic	N = 14; Dx NR	NR	NR	"Waiting is an enduring vigil of burdening toil."
White & Ritchie, 1984, Canada	Determine AP stressors of hospitalization	P. Descriptive, repeated measures	N = 61; Dx NR	R = 20-38	NR	Highest stressors were separation and emotions. Stress increased after 2 weeks.

Note. AP = antepartum; BR = bed rest; Ca = calcium; CES-D = Center for Epidemiologic Studies-Depression Scale; DVT = deep vein thrombosis; Dx = diagnosis; GA = gestational age; gastroc = gastrocnemius; grp = group; hosp = hospital; Inf = infant; Inf BWt = infant birth weight; IOM = Institute of Medicine; M = mean; MAACL-R = Multiple Adjective Affect Checklist-Revised; NA = not applicable; neg = negative; NR = not reported; other = other diagnoses; P = prospective; PE = pulmonary embolism; PH = pregnancy-induced hypertension; POMS = Profile of Mood States; PP = postpartum; PPRM = preterm premature rupture of membranes; PTL = preterm labor; PTL+ = preterm labor, plus additional diagnoses such as premature rupture of membranes, incompetent cervix, placenta previa, or placental abruption; R = range; ret. = retrospective; S = singleton; S & M = S & M = symptoms; US = United States; sig = significant; sig = significant; Sx = symptoms; wk = weeks.

approximately 1 lb per week. In fact, nearly 52% of women gained no weight at all during hospitalization. Again, in the third study, also involving women with a multiple gestation, the weekly rate of weight gain was significantly less than IOM recommendations (Maloni et al., 2006).

Infant birth weight. Birth weight is a major predictor of neonatal morbidity and mortality (Goldenberg, 2002; Lu et al., 2003; Newburn-Cook et al., 2002). In three studies, researchers looked at infant birth weight after antepartum maternal bed rest (Maloni et al., 1993; Maloni et al., 2004; Maloni et al., 2006). In the first two studies, infant birth weights were significantly lower than either the matched controls (Maloni et al., 1993) or the national mean for each infants' gender, gestational age at birth, and race (Maloni et al., 2004). However, in the third study of multiple gestation infants, despite maternal weight loss, birth weights were appropriate for gestational age using a current standard for twins and triplets by gestational age and gender.

Bone loss. In nonpregnant individuals, changes in bone begin within days of the initiation of bed rest and continue without leveling off (Fortney et al., 1996). These changes are due to bone demineralization and altered calcium metabolism and calcitropic hormones. Bone loss varies among anatomical sites and is greatest in weight-bearing trabecular bones of the spine and hip (Fortney et al., 1996; LeBlanc et al., 1990). Among pregnant women, measurement of changes in bone mass attributable to bed rest is difficult as there is a natural maternal calcium transfer to the fetus (Oliveri, Parisi, Zeni, & Mautalen, 2004). Further, X-ray assessment unnecessarily exposes the fetus to radiation, which could affect development. Therefore, research about bone loss during pregnancy bed rest was nonexistent until recently. One prospective study assessed maternal bone loss in the radius and ulna between 16 and 36 weeks gestation using dual energy X-ray absorptiometry (DEXA; Promislow et al., 2004). Women treated with bed rest had a significant adjusted mean loss of 4%–6% compared to 1.5% for those not treated with bed rest ($p = .001$). In another study, pregnancy bed rest was associated with increased bone turnover markers from 10 to 36 weeks gestation and from 4 days to 1 month postpartum (Kaji et al., 2007).

Thrombosis. Deep vein thrombosis (DVT) and other emboli are 5 times more likely to occur during pregnancy (James, Tapson, & Goldhaber, 2005). Kovacevich and colleagues (2000) studied the prevalence of thromboembolic events among women treated with bed rest using a retrospective chart review. The prevalence was 15.6 per 1,000 women compared to 0.8 among those not treated with bed rest. In contrast, in another retrospective chart review across 25 years, Danilenko-Dixon et al. (2001) did not identify ABR as a risk factor for thrombosis or emboli. Furthermore, in two prospective assessments of symptoms of hospital bed rest among women who were healthy prior to pregnancy, DVT was not identified by women as an

antepartum or postpartum symptom (Maloni et al., 1993; Maloni et al., 2006).

Antepartum symptoms. Researchers conducted two studies of antepartum physical and psychosocial symptoms during hospital bed rest among women with either a singleton or multiple pregnancy (Maloni et al., 1993; Maloni et al., 2006). The number of weekly symptoms reported by women treated with bed rest during hospitalization was significantly higher ($M = 9$ per week) compared to a healthy control group and did not change throughout the treatment. The most common symptoms were fatigue, back muscle soreness, sleep cycle changes, round ligament pain, dry lips, nasal congestion, reflux, indigestion, mood changes, tenseness, and boredom.

Postpartum symptoms. Researchers have also examined the incidence of maternal physical and psychosocial symptoms after bed rest (Maloni et al., 1993; Maloni et al., 2006; Maloni & Park, 2005). Women reported a mean number of 13 symptoms after bed rest, which significantly decreased over time to 6 symptoms at 6 weeks postpartum. Women treated with bed rest reported significantly more shortness of breath and soreness of weight-bearing muscles (Maloni et al., 1993). Symptoms for women with a singleton gestation treated with bed rest were similar to those of women with a multiple gestation in number and type. Common postpartum symptoms included fatigue, dry skin, back muscle soreness, headache, mood changes, tenseness, and difficulty concentrating.

Behavioral Alterations

Depressive symptoms. Depressive symptoms during and after ABR treatment are common. The five studies of depressive symptoms among women treated with hospital bed rest for pregnancy complications (Heaman, 1992; Maloni et al., 1993; Maloni et al., 2002; Mercer & Ferketich, 1988; Maloni, Park, Anthony, & Musil, 2005) all used different but reliable standardized instruments, including the Center for Epidemiologic Studies–Depression Scale (CES-D), Profile of Mood States (POMS), and the Multiple Affect Adjective Checklist–Revised (MAACL-R). Two of the studies compared antepartum depressive symptoms among high-risk pregnant women and healthy pregnant women at one time point using either the POMS or the CES-D. In both, researchers found that depressive symptoms were significantly higher for those treated with hospital bed rest than for controls (Heaman, 1992; Mercer & Ferketich, 1988). The mean antepartum CES-D score for 153 high-risk women was 17.1, indicating mild depression and a need for further screening (Mercer & Ferketich, 1988).

The remaining three studies were longitudinal studies in which investigators assessed both antepartum and postpartum depressive symptoms (dysphoria) using the MAACL-R among mothers with either a singleton or multiple gestation. Dysphoria, a combination of anxiety, hostility, and depression, was highest on antepartum hospital admission and decreased across the postpartum but remained slightly elevated at 6 weeks

(Maloni et al., 1993; Maloni et al., 2002; Maloni et al., 2006). Women with greater severity of complications had significantly higher scores at all times. In an attempt to replicate the results of Heaman (1992), Maloni et al. (1993), and Mercer & Ferketich (1988), Maloni et al. (2005) used all three instruments to assess antepartum depression in women treated with bed rest. Depression as assessed by each instrument was high on hospital admission and gradually declined until birth. Test-retest reliability and convergent validity were high among the three instruments, suggesting that results can be generalized across studies.

Infant behavior. Bellieni and colleagues (2003) conducted the one published study of infants' behavioral outcomes after maternal bed rest. In it, they studied children of 43 mothers who had been confined to bed for at least 15 days during their pregnancy. Maternal reports revealed that infants had a significantly higher incidence of allergies, motion sickness, and need to be rocked to fall asleep than the control group.

The Experience of Bed Rest

A high-risk pregnancy treated with antepartum hospital bed rest is characterized not only by depressive symptoms but also by maternal anxiety and fear for her own outcome and that of her fetus's (Gupton et al., 1997; Heaman, 1992; Schroeder, 1996; Thornburg, 2002). A major theme that emerges from women's descriptions of bed rest is altered temporality (Schroeder, 1996). Women, apparently out of concern for their infant's outcome and their experiences of boredom and isolation, are profoundly oriented toward the future. The present is an agonizing burden to be endured to meet future goals, that is, birthing a viable, healthy infant. Thus, the experience of time is slowed, with minutes experienced as interminable hours (Schroeder, 1996; Thornburg, 2002). Schroeder (1996) described this experience as "always waiting." The waiting is accompanied by uncertainty, mood lability, anxiety, and feelings of being out of control of their bodies (Gupton et al., 1997; Heaman & Gupton, 1998; Maloni, 1998a; Schroeder, 1996). It is difficult to know, however, whether "waiting" is associated with bed rest, having a high-risk pregnancy, or both, as these factors are confounded.

Maternal antepartum stress and the effect of hospital bed rest on the family have been investigated in several studies. Maternal stress is high during hospitalization, with the primary sources of stress being separation from and concerns for the family at home, negative emotions, self-image, and health status (Maloni et al., 1993; Maloni & Kutil, 2000; Maloni et al., 2006; White & Ritchie, 1984). Women worry about their children and partner whether they are being treated with home or hospital bed rest. Maternal reports of family stress identify family disruption and difficulty with assuming maternal responsibilities, anxiety about maternal-fetal outcome, financial difficulties, and adverse emotional and child care issues related to children at home (Maloni et al., 2001; May, 2001). Reports from women's partners confirm that assuming multiple

new roles is a major issue for them, including caring for their partner on bed rest, responsibility for child care, and household management (Maloni & Ponder, 1997; May, 1994; May, 2001).

Summary and Limitations

In summary, there is a body of research that has identified numerous adverse physiological and behavioral effects of ABR upon pregnant and postpartum women. The experience of bed rest for mothers is harrowing and characterized by fear for self and fetus, the presence of a variety of negative emotions including depression and anxiety, and altered temporality that makes enduring the present a major task. Additionally, some research suggests that the fetus/infant may also be affected, particularly in the critical area of infant birth weight. However, as there are few and conflicting reports, further research is needed on the effects of ABR on fetal and infant health and well-being.

A strength of the research about the side effects of ABR is that there is also a compendium of research that documents similar side effects of bed rest among other samples (Fortney et al., 1996; LeBlanc et al., 1990; Sandler & Vernikos, 1986). Study of the effects of bed rest is, however, more complex in pregnant than in nonpregnant persons as several confounding variables that are not easily controlled coalesce during a high-risk pregnancy. These include the presence of concomitant symptoms associated with childbearing that are unrelated to bed-rest treatment and the physiologic and psychological effects of having a high-risk pregnancy. Researchers have incorporated a healthy control group in only two studies to differentiate symptoms of bed rest and childbearing (Heaman, 1992; Maloni et al., 1993). Being identified as having a high-risk pregnancy and being treated in the hospital for an emergent condition are likely to affect assessment of outcomes associated with bed-rest treatment, particularly psychosocial outcomes. Enrollment of a control group of high-risk pregnant women who are not yet experiencing complications would provide the opportunity to determine whether there are unique symptoms associated with high-risk pregnancy prior to bed-rest treatment and determine whether being labeled as having a high-risk pregnancy induces psychological changes. However, identifying such women ahead of time is extremely difficult. Despite attempts across decades, perinatal medicine has been unable to predict which women will have high-risk pregnancies or be hospitalized.

The site of treatment—hospital or home—also confounds results. Although some studies have compared the effects of hospital and home bed-rest treatment (Gupton et al., 1997; Heaman, 1992; Maloni et al., 1993), more research, including RCTs, is needed. Future studies, however, may have even greater difficulty controlling for setting as more women are now being treated with a variety of combinations of home and hospital bed rest.

Many of the studies of the side effects of bed rest included women with a variety of diagnoses, used a convenience sample, and enrolled small samples. Based on our research experience,

it is, indeed, the case that women hospitalized for ABR frequently have more than one obstetric diagnosis. RCTs that control for types of diagnoses and explicate exclusion criteria are needed. Approximately 8–10% of women have pregnancy complications treated with hospitalization (Gazmararian et al., 2002); thus, multisite studies may be needed to increase sample size and ensure sufficient power.

Finally, a major limitation of the extant body of literature on the effects of ABR is that the authors often do not provide a definition of bed rest/AR or explicate the length of bed rest (hours and days), type of activity restriction, or the daily amount of weight-bearing activity performed, with the majority simply stating that bed rest was used. Precise definitions of bed rest and descriptions of length of time activity is restricted in future studies will allow comparisons to be made across studies and could assist in defining the optimal length of bed rest for preventing both preterm birth and maternal side effects, should the effectiveness of bed rest be demonstrated. Similarly, studies need to be specific about the gestational timing of bed rest as the psychosocial effects of bed rest may vary with the gestational age of the pregnancy and fetal chance for survival.

Alternative Models for Antepartum High-Risk Care

Antepartum hospital bed-rest treatment is the current U.S. standard of care for high-risk pregnancy, despite the fact that perinatal morbidity and mortality has not been reduced since this treatment became widespread (Fox, Gelber, Kalish, & Chasen, 2009; Goldenberg, 2002; Goldenberg et al., 1994; IOM, 2007; Maloni et al., 2004). In the 1990s, approximately 89–92% of obstetricians and maternal–fetal medicine specialists prescribed ABR (Maloni et al., 1998a). Recent research reveals only a slight decline in use, with 71–89% of maternal–fetal-medicine specialists in the United States currently prescribing bed rest (Fox et al., 2009). Canadian physicians also prescribe activity restriction but primarily in the home (Sprague et al., 2008), with less than one half prescribing hospital bed rest. Use of ABR varies within and among U.S. obstetricians for the same pregnancy complications (Maloni et al., 1998a; Ramsey et al., 2004). Reasons for the use of bed rest and hospital treatment are unclear, though one appears to be the assumption that high-risk antepartum care cannot be safely and economically implemented in an outpatient setting (Stainton, Lohan, & Woodhart, 2005; Turnbull et al., 2004). Table 2 lists studies that compare antepartum hospital care with home care programs, with or without bed rest.

Comparison of Hospital and Home Care, With Bed Rest

Overview. Women with emergent pregnancy complications are initially admitted to the hospital to stabilize their status but care varies after stabilization. Some women remain in hospital care whereas others are discharged to home care. If subsequent complications arise among women at home, transfer to a

hospital is expedited, but once stabilized, women return to the home. Home care programs are called by a variety of names depending on the country, including antenatal day care, domiciliary care, and antenatal day stay, that is, a stay of a few hours in a facility associated with a medical center followed by an immediate return to home (Goulet, Gevry, Lemay, et al., 2001; Helewa, Heaman, & Dewar, 2000; Moninx, Birnie, Zondervan, Bleker, & Bonsel, 2001; Stainton et al., 2005). Home care consists of components similar to hospital care, that is, monitoring of maternal and fetal status, but may also contain additional components. In the United States, home care most often consists of instructions on hospital discharge to return to their physician's office for weekly reassessment. Some U. S. home care programs provide home uterine monitoring of contractions and fetal heart rate or continuous infusion therapy of terbutaline, a drug thought to reduce uterine contractions. In other countries, however, other needed services are also provided such as health care provider visitation, housekeeping and child care services, nutritional counseling or assistance, home visits and/or phone consultation, teaching, and counseling (Harrison et al., 2001; Helewa et al., 2000; Moninx et al., 2001).

Physiologic outcomes. A number of studies conducted in Canada, the Netherlands, and the United States have compared physiologic maternal/fetal outcomes among high-risk pregnant women treated with bed rest in either hospital or home care (Table 2). Of these, six were RCTs, seven were either prospective or retrospective cohort studies, and two used an ethnographic design. Outcomes investigated varied among studies but primarily focused on the infant.

In several studies, researchers found no significant group differences in infant gestational age between home and hospital bed-rest groups (Carlan, O'Brien, Parsons, & Lense, 1993; Goulet, Gevry, Gauthier, et al., 2001; Goulet, Gevry, Lemay, et al., 2001; Moninx, Zondervan, Birnie, Ris, & Bossuyt, 1997; Mouer, 1994; Salvador et al., 2003; Yost, Bloom, McIntire, & Leveno, 2005); however, in three studies researchers found a significant improvement in gestational age at birth in the home care group (Ambrose, Rhea, Istwan, Collins, & Stanziano, 2004; Harrison et al., 2001; Helewa et al., 2000). Researchers also found no significant group differences in infant birth weight in six studies (Carlan et al., 1993; Goulet, Gevry, Gauthier, et al., 2001; Goulet, Gevry, Lemay, et al., 2001; Mouer, 1994; Salvador et al., 2003; Yost et al., 2005) but, in three studies, infant birth weight was significantly increased in the home care group (Ambrose et al., 2004; Harrison et al., 2001; Helewa et al., 2000). Ambrose and colleagues (2004), in particular, found that the rate of preterm birth and incidence of preterm delivery at <34 weeks was significantly lower ($p = .001$) and birth weight was significantly greater by almost 1 pound ($p = .001$) in the home care group. Furthermore, researchers found no significant differences in Apgar scores in four studies (Harrison et al., 2001; Helewa et al., 2000; Salvador et al., 2003; Yost et al., 2005), but Goulet and colleagues (Goulet, Gevry, Gauthier, et al., 2001; Goulet, Gevry, Lemay, et al., 2001) found a significant increase in the hospital group.

Table 2. Comparison of Outcomes for Women With High-Risk Pregnancies Treated in Hospital or Home Care, With and Without Bed-Rest Treatment

Author, Year, Country	Design	Group Size, Dx	Length BR	Hospital LOS	GA Birth	BWt	Apgar	NICU Admission or Length Stay	Inf Mortal	Cost	Other Results
Ambrose et al., 2004, US	R, Cohort	N = 90 home, N = 90 hosp; PTL	NR	Sig less home	Sig inc home	Sig inc home	NR	Sig fewer home	NS	Sig inc hosp	
Carlén et al., 1993, US	RCT	N = 28 home, N = 27 hosp; PPRoM	NR	Sig less home	NS	NS	NR	NS	NS	Sig higher hosp	
Goulet, Gevry, Gauthier, et al., 2001, Can	RCT	N = 125 home, N = 125 hosp; PTL	NR	Sig less home	NS	NS	Sig inc hosp	NS	NR	NA	Stress lowered across time both grps
Goulet, Gevry, Lemay, et al., 2001, Can	RCT	N = 125 home, N = 125 hosp; PTL	NR	Sig less home	NS	NS	Sig inc hosp	NS	NR	NA	
Gupton et al., 1997, Can	Ethno	N = 24 in home, hosp, or both; PTL+	M = 20 days; R = 7-50	NA	NA	NA	NA	NA	NA	NA	Inc stress in either setting
Harrison et al., 2001, Can	R, Cohort	N = 228 home, N = 209 hosp; PTL, HTN	NR ^a	NR	Sig inc home	Sig inc home	NS PTL grp; NS HTN grp	NS	NS	NS	
Hearman, 1992, Can	P, Cohort	N = 20 home PIH, N = 20 hosp PIH, N = 20 healthy contrl	NR ^b	NA	NA	NA	NA	NA	NA	NA	Sig inc dep & anx hosp compared to both home and contrl
Hearman & Gupta, 1998, Can	Ethno	N = 24 home or hosp; PTL+	M = 20 days	NA	NA	NA	NA	NA	NA	NA	Sig emot & soc impact
Helawa et al., 1993, Can	R	N = 321; Preclampsia	NR	NR	NR	NR	NR	NR	NR	Home care less cost ^c	Home care safe
Helawa et al., 2000, Can	R, Cohort	N = 59 home, N = 54 hosp; PPRoM	NR	NR	Sig inc home	Sig inc home	Sig inc home	Sig fewer home	NS	NA	Sig less chorioamnionitis home care grp
Monieux et al., 2001, Neth	RCT	N = 69 home, N = 61 hosp, PTL+; N = 55 healthy contrl	NR	NR	NA	NA	NA	NA	NA	NA	Mental health better in contrl
Monieux et al., 1997, Neth	RCT	N = 76 home, N = 74 hosp; HTN, IUGR, PPRoM & other	NR	NR	NR	NR	NR	NR	NR	NA	NS Inf Prechtl scores
Mouyer, 1994, US	R, Cohort	N = 49 home, N = 55 hosp; PP	M = 30.2 days home, M = 26.7 days hosp	NR	NS	NS	NR	NR	NR	NA	NS pregnancy outcomes
Salvador et al., 2003, Can	R, Cohort	N = 48 home, N = 23 hosp; PTL+	NR	NR	NS	NS	NS	NR	NR	Home cost less	NS pregnancy outcomes
Scalton et al., 2006, Aus	P, Longit	N = 32 home, N = 29 hosp; PTL+	No BR	NR	NR	NR	NR	NR	NR	NA	AP stress high for both. Anx sig higher for hosp.
Scalton et al., 2005, Aus	Phenom	N = 7 home, N = 11 hosp; PTL+	No BR	NR	NA	NA	NA	NA	NA	NA	*Waiting, anxiety both grps
Yost et al., 2005, US	RCT	N = 50 home, N = 51 hosp; PTL	NR ^a	NR	NS	NS	NS	NS	NR	NA	

Note. Anx = anxiety; AP = antepartum; Aus = Australia; BR = bed rest; BR NR = statistics for bed rest status not reported; BR NR BWt = birth weight; Can = Canada; cohort = cohort study; contrl = control; dep = depression; Dx = diagnosis; emot = emotional; ethno = ethnographic study; GA = gestational age; grp = group; hosp = hospital; HTN = hypertension; inc = increased; inf = infant; IUGR = intrauterine growth retardation; Longit = longitudinal; LOS = length of stay; M = mean; mortal = mortality; NA = not applicable; Neth = Netherlands; NICU = neonatal intensive care unit; NR = not reported; NS = nonsignificant group difference; other = one or more of a possible variety of pregnancy-related diagnoses; P = prospective; PIH = pregnancy-induced hypertension; phenom = phenomenologic design; PP = placenta previa; PPRoM = preterm premature rupture of membranes; PTL = preterm labor; PTL+ = preterm labor plus other diagnoses; Prechtl = neonatal neurologic test; RCT = randomized controlled trial; R = retrospective; sig = significant group difference; soc = social; US = United States of America.

^a Bed rest status not reported but personal communication with the author indicated bed rest was not strictly enforced.

^b Bed rest status not reported but personal communication with the author indicated bed rest was used.

^c Test of significance not reported.

Researchers assessed the number of NICU admissions or length of NICU stay, finding no significant group differences in five studies (Carlan et al., 1993; Goulet, Gevry, Gauthier, et al., 2001; Goulet, Gevry, Lemay, et al., 2001; Harrison et al., 2001; Yost et al., 2005) and fewer NICU admission or shorter stays in the home care group in two (Ambrose et al., 2004; Helewa et al., 2000). The percentage of infants admitted to the NICU in the home group of one study was nearly half of that of the inpatient group (Ambrose et al., 2004). Findings revealed no significant differences in infant mortality between home and hospital groups in four studies (Ambrose et al., 2004; Carlan et al., 1993; Harrison et al., 2001; Helewa et al., 2000) and no significant difference in a variety of reported infant complications and emergency cesarean sections in several (Carlan et al., 1993; Goulet, Gevry, Gauthier, et al., 2001; Goulet, Gevry, Lemay, et al., 2001; Harrison et al., 2001; Helewa et al., 2000; Moninckx et al., 1997; Yost et al., 2005). Furthermore, researchers found that, for the home care group, length of maternal hospital stay was significantly less (Ambrose et al., 2004; Carlan et al., 1993; Goulet, Gevry, Gauthier, et al., 2001; Goulet, Gevry, Lemay, et al., 2001) and cost of care was less (Ambrose et al., 2004; Carlan et al., 1993; Helewa, Heaman, Robinson, & Thompson, 1993; Salvador et al., 2003), though only Ambrose and colleagues and Carlan and colleagues determined statistical significance for cost of care. In another study, in which the home care program provided extensive services, researchers found no significance difference between hospital and home care cost (Harrison et al., 2001). All researchers concluded that the home care of high-risk pregnant women with bed rest is as effective, safe, and feasible as hospital care.

Behavioral outcomes. In comparisons of home and hospital care with bed-rest treatment that examined behavioral outcomes, depression was a primary outcome. Heaman (1992), using the POMS, found that depression was significantly greater among high-risk hospitalized women compared to high-risk women on bed rest at home or a control group of healthy pregnant women. In a later ethnographic study, Heaman and Gupton (1998) confirmed that feelings of depression were predominant among women in their hospital group. In a large RCT, Moninckx and colleagues (2001) used the RAND 36 to assess mental health across antepartum enrollment through 8 weeks postpartum. They found significantly less optimal mental health scores for both the home and hospital bed-rest groups compared to a healthy control group.

Maternal experience. Bed rest and the site of antepartum care have a significant emotional and social impact on women and their families. In a Canadian ethnographic study of 24 women treated with bed rest in the hospital, home, or both, women reported experiencing excruciating boredom and a sense of timelessness in both settings (Gupton et al., 1997; Heaman & Gupton, 1998). Women in both groups also experienced feelings of lack of control, uncertainty, confinement and imprisonment, and loneliness; concerns about fetal well-being, their

children, and a negative impact on relationships with their partners; and a sense of missing out on life. Other descriptive and qualitative studies have also provided insight into the experience of women with high-risk pregnancies treated with bed rest (Maloni et al., 2001). In each setting, life and family relationships are altered. Furthermore, a profound sense of elongation of time dominates the experience of having a high-risk pregnancy treated with bed rest (Heaman & Gupton, 1998).

Goulet, Gevry, Gauthier, et al. (2001) found that stress was high among women treated with bed rest both at home and in the hospital and that it significantly decreased across time for all women. In another study, Gupton and colleagues (1997) concluded that stress categories were situational, environmental, and family related. Women at home identified stress related to the temptation to be more active, feeling like a prisoner, and partner role reversal. Hospitalization and bed rest increased the number of stressors, adding the stress of separation from the home and family, lack of privacy, hospital discomforts, and incompatible roommates (Gupton et al., 1997; Heaman & Gupton, 1998). Manifestations of stress were evidenced in physical symptoms, emotional reactions, and altered social relationships. Coping strategies included keeping a positive attitude, taking it one day at a time, setting goals, keeping busy, doing it for the baby, and getting used to it (Gupton et al., 1997). Women also noted some benefits for each of the two settings: Women at home appreciated support from nurses and having comfortable, familiar surroundings, whereas women in the hospital cited proximity of medical attention as a benefit.

Comparison of Hospital and Home Care, Without Bed Rest

There are currently no studies comparing infant and maternal physiologic outcomes for women with high-risk pregnancies treated without bed rest in day stay (home) versus hospital care. Researchers in two studies conducted in Australia, however, investigated emotional and experiential outcomes of care provided in the two settings. Both studies assessed outcomes for women who had a variety of pregnancy complications but were not treated with bed rest (Stainton et al., 2005; Stainton, Lohan, Fethney, Woodhart, & Islam, 2006). Women in both settings had high levels of anxiety that decreased over time, but anxiety was significantly higher among hospitalized women (Stainton et al., 2006). Stress was also increased in both groups but, again, was higher in the hospital group, though researchers could not run tests of statistical significance due to small sample size. Women reported stress from a variety of sources, including negative emotions and separation from the family. There was a trend toward better family functioning in the day-stay group but scores were variable. Women in both groups also experienced a profound sense of elongation of time (Stainton et al., 2005). Stainton and colleagues (2006) concluded that neither the site of antenatal care nor the presence or absence of RA changes the level of maternal stress, anxiety, or uncertainty about her neonate's health in high-risk pregnancies.

Summary and Limitations

In summary, comparisons of maternal and infant physiologic and behavioral outcomes for women with pregnancy complications revealed that hospital care and bed rest did not improve infant or maternal physiologic outcomes, but, in some instances, outcomes were improved in the home care groups. In studies of behavioral outcomes with bed-rest treatment, depression and mental health scores appear to be less optimal among hospitalized women. Maternal anxiety was lower among those treated at home.

In contrast, there is a lack of research about physiologic outcomes when women with pregnancy complication are not treated with bed rest. Two studies, however, reported that even when bed-rest treatment was not used, anxiety and stress was high in both the hospital and home settings. Furthermore, the experience of women treated either with or without bed rest appears to be extremely negative, with women embedded in depression, anxiety, alterations in family relationships, and elongation of time.

A strength of studies comparing home and hospital care for pregnancy complications is that designs have controlled for the important variables of setting and, often, diagnosis. However, most studies appeared to pay little or no attention to the variable of bed rest/activity restriction. Several studies did not clearly report whether bed rest was a part of the home and hospital antepartum treatment; rather, I obtained this information by personal contact with the authors (Harrison et al., 2001; Heaman, 1992; Helewa et al., 1993). Bed rest induces major physiologic change that could affect maternal-fetal outcomes. For example, bed rest induces diuresis, which may complicate the condition of a pregnant woman with decreased plasma volume or premature rupture of membranes but conversely may improve the condition of a woman with gestational hypertension without preeclampsia (Society of Obstetricians and Gynaecologists of Canada, 2008). Studies were also limited by a lack of definition of bed rest/activity restriction, including descriptions of the type of activity allowed and restricted and of the daily and total length of restriction. Thus, although there have been several RCTs that compared outcomes of home and hospital care for women treated with bed rest, additional research is needed. Future research also needs to compare the impact of bed rest versus unrestricted activity on perinatal outcomes in both the home and hospital settings, as other countries, such as Australia and Canada, have begun to eliminate ABR treatment (Society of Obstetricians and Gynaecologists of Canada, 2008; Stainton et al., 2006) or have never used it at all.

Discussion

The side effects of bed rest have significant implications for short- and long-term maternal and infant health. A number of the more serious antepartum side effects of bed rest persist into the postpartum period, including muscle atrophy and cardiovascular deconditioning, possible bone loss, the influence of inadequate

maternal weight gain on infant birth weight, depressive symptoms, and physiologic and psychosocial symptoms.

Physiologic Effects

Muscle. Evidence of maternal muscle atrophy during bed rest and maternal symptoms of musculoskeletal and cardiovascular deconditioning is consistent with the results of aerospace bed rest research (de Boer et al., 2008; Maloni et al., 1993; Maloni & Park, 2005; Maloni & Schneider, 2002). Fortney and colleagues (1996) describe a composite of symptoms that occurs among nonpregnant persons during physiologic recovery after bed rest including generalized weakness; poor exercise tolerance; disturbance of coordination, posture, and gait; heel and foot pain; difficulty with standing and walking; and muscle pain. Maternal symptoms, however, are unrecognized by health care providers (Maloni et al., 1998). Women are discharged from the hospital in a deconditioned state without knowing that they need to recover from both childbearing and bed rest and without advice about how to recover (Maloni & Schneider, 2002).

Recovery from muscle atrophy in nonpregnant persons is slow, requiring at least twice the duration of disuse, and it is unclear whether muscle loss is fully reversible (Fortney et al., 1996; LeBlanc et al., 1990). Postpartum women would benefit from a physical therapy assessment prior to hospital discharge and a planned program of rehabilitation to rebuild muscle strength and stamina. They also need guidance to prevent overuse of muscles, which induces further damage, prevent falls due to decreased strength, and prevent long-term injury (Maloni & Schneider, 2002). Instrumental support, such as help with cooking, cleaning, and childcare, would also allow women time to recover and to address their own health needs as well as those of their infants.

Bone. We urgently need a body of research about the impact of ABR on bone loss, as this effect could have lifelong implications. As with muscle deconditioning, among nonpregnant persons recovery from bone loss requires at least twice the length of bed rest, and loss may not be fully reversible (Fortney et al., 1996; Giangregorio & Blimkie, 2002; LeBlanc et al., 1990). Pregnancy bed rest occurs at an age when peak bone mass is normally accrued or, if the woman is older, as natural bone loss with aging begins. Concomitantly, there is also a temporary pregnancy-related maternal calcium shift from bone toward the fetus (Black, Topping, Durham, Farquharson, & Fraser, 2000; Kaur, Godber, et al., 2003; Kaur, Pearson, et al., 2003; Sowers, Crutchfield, Jannausch, Updike, & Corton, 1991; Sowers, Scholl, Harris, & Jannausch, 2000). In women who have not reached peak bone mass, bone loss associated with bed rest may interfere with achieving their optimal bone mass. Those who do not reach optimal peak bone mass are at risk of developing osteoporosis (National Institutes of Health Consensus Development Panel, 2001). In those who have already accrued peak bone mass, age-related bone loss may be temporarily accelerated during bed rest resulting in a greater

decline in mass and an earlier arrival of fracture threshold (Krasnoff & Painter, 1999). Because the greatest trabecular bone loss occurs in the spine and hip, failure to fully recover loss may compromise lifelong maternal skeletal integrity (Fortney et al., 1996; Giangregorio & Blimkie, 2002; Leblanc et al., 1990).

Pregnancy weight gain and infant birth weight. There is a direct relationship between pregnancy weight gain and infant birth weight (Abrams et al., 2000; Barker, 1998; Institute of Medicine, 2009; Newburn-Cook et al., 2002). Low birth weight is associated with fetal growth restriction and increased infant mortality. In a comprehensive review of animal and human studies, Barker (1998) concluded that prolonged inadequate fetal nutrition during pregnancy leads to an adaptive slowing of cell division and alteration in fetal and placental hormones controlling growth that may reprogram intrauterine development. Barker (1995, 1998) and others also propose that antenatal undernutrition may place newborn infants at higher risk for later adult diseases such as coronary heart disease, hypertension, stroke, and diabetes mellitus (Eriksson, Forsén, Tuomi-lehto, Osmond, & Barker, 2001; Fattal-Valevski et al., 2001). Longitudinal investigations into the effect of ABR on infant birth weight and subsequent health are urgently needed. Additionally, we need to develop a more sensitive birth weight standard for infants from a multiple gestation. Currently, comparisons can only be made for gestational age and gender or gestational age and race but not for all three of these variables.

Antepartum and postpartum symptoms. Some health care providers might perceive that maternal reports of multiple minor physiologic and psychosocial antepartum and postpartum symptoms of ABR are of little concern. The persistent presence of multiple minor symptoms, however, such as fatigue, headache, and backache, that continue into the postpartum reveal an underlying morbidity that does not appear to be resolved at 6 weeks (Albers, 2000; Maloni & Park, 2005). Typically such symptoms are not recognized or treated by obstetric health care providers. Research among healthy postpartum women indicates that postpartum symptoms persist over time rather than resolve. In investigations of symptoms from 6 months to 1 year after delivery, only a small percentage of healthy postpartum women (not treated with bed rest) reported no health problems (Glazener et al., 1995; Thompson, Roberts, Currie, & Ellwood, 2002). The number of symptoms experienced among pregnant women treated with bed rest may be increased compared to healthy postpartum women, as researchers measured only those symptoms associated with bed rest and not those related to childbearing (Maloni & Park, 2005). Furthermore, when experienced together, symptoms often have a multiplicative effect, resulting in an increase in overall discomfort and a decrease in function fitness, role performance, cognitive functioning, and quality of life (Lenz, Pugh, Milligan, Gift, & Suppe, 1997; Maloni & Park, 2005).

Behavioral Effects

Researchers have found negative affect and stress during pregnancy to be related to adverse obstetric and neonatal outcomes (Hobel & Culhane, 2003; Hoffman & Hatch, 2000; Kurki, Hiilesmaa, Raitasalo, Matila, & Ylikorkala, 2000; Orr & Miller, 1995; Wadhwa et al., 2001). Antepartum depressive symptoms decrease over time during bed rest, but postpartum scores remain somewhat elevated at 6 weeks, particularly among women who had a preterm infant (Maloni et al., 2002). Postpartum depressive symptoms are associated with the diagnosis of postpartum depression and disturbance in mother-infant interaction and subsequent child development (Beck, 1995, 1996; Field, 1995; O'Hara & Swain, 1996). Beck (2002) reported that the first 12 weeks of postpartum are the most vulnerable period for the development of clinical depression among mothers of multiples. However, there is a paucity of longitudinal research beyond 6 weeks about depression and depressive symptoms in women with perinatal complications. In the immediate postpartum, health care providers need to take aggressive steps to screen and monitor women who had pregnancy complications to ensure that both the mother and infant are healthy and safe (Beck, 1995, 1996; Field, 1995).

In the presence of pregnancy complications, perinatal stress emanates, not only from having a high-risk pregnancy, but also from the increased threat to health, hospitalization, and obstetric treatments that are frequently physically and psychologically invasive and demanding and serve as a reminder of the precarious nature of the pregnancy. With ABR, physiologic sources of stress may occur from the body's rapid adaptation to bed rest, similar to what is reported by aerospace researchers (Fortney et al., 1996; Sandler & Vernikos, 1986). Exposure to chronic environmental stressors as well as anxiety, separation, and concerns for self and family contribute to behavioral stress responses (Behrman & Butler, 2007; Gupton et al., 1997; Heaman & Gupton, 1998; Maloni et al., 2001; Stainton et al., 2006). The experiences of vigilant waiting for an important future maternal or infant health outcome over which women have no control and of isolation likely compound maternal stress. Isolation has been identified as one of the major contributors to increased allostatic load (McEwen, 1998a, 1998b). Furthermore, there is increasing evidence that physiologic and psychosocial stress leads to disease processes and increased risk for preterm birth (Institute of Medicine, 2006; McEwen, 1998a). Research is needed to compare the complex nature of antepartum stress in the hospital and home settings, as most research has been conducted solely in the antepartum hospital setting. Multidimensional interventions can then be designed to reduce the number, variety, and intensity of antepartum stressors that occur.

Experience of Bed Rest

The impact of a negative pregnancy experience among women with pregnancy complications treated with bed rest has been ignored. When new mothers begin to talk about their negative

experiences, a common response is to negate the experience with comments such as "at least you got a (healthy) baby" or "wasn't it worth it?" My clinical observations suggest that new mothers quickly retreat from talking further, as their expressions are often perceived as being inappropriate for a new mother.

Mothers in a bed-rest support group that I facilitated for over 5 years and in subsequent postpartum interviews often talked about "flashbacks" to their time on bed rest and with their infant in the NICU (Maloni, 1998b; Maloni & Kutil, 2000). Postpartum posttraumatic stress disorder (PTSD) has been associated with increased obstetric interventions and with having a preterm infant (Ayers, 2004; Bailham & Joseph, 2003; Olde, van der Hart, Kleber, & van Son, 2006). Future investigations should consider postpartum maternal assessment for PTSD, as a high-risk pregnancy and the postpartum period often encompass criteria associated with the development of PTSD, including a threat to life and a loss of sense of control over the maternal or infant outcome (DeMier et al., 2000; DeMier, Hynan, Harris, & Manniello, 1996; Quinnell & Hynan, 1999).

Physicians' Use of Bed Rest

Bed rest and clinical practice. Neither research about the effectiveness and safety of bed rest nor the paradigm shift toward evidence-based practice has had much impact on obstetric clinical practice or patterns over time (Fox et al., 2009; Maloni et al., 1998; Sprague et al., 2008). Health care provider reliance on the use of bed rest may have originated in early methodologically flawed research that showed bed rest was effective for improving infant outcomes (Maloni & Kasper, 1991). Common reasons physicians cite for continued use of ABR include the lack of reliable knowledge about the pathogenesis of preterm birth, the fact that many alternative treatments to prevent preterm birth are also known to be ineffective, physicians' or regional practice preferences, and the continued belief that bed rest is a harmless intervention (Fox et al., 2009; Goldenberg, 2002; Kramer, 1987; Maloni et al., 1998; Ramsey et al., 2004). That final belief indicates either a lack of knowledge about the type, number, and severity of ABR side effects or a discounting of current evidence (Maloni et al., 1998; Sprague et al., 2008).

Decisional conflict. Even with an understanding of some of the side effects of ABR, decisional conflict may contribute to continued use of bed rest. Sprague and colleagues (2008) report that a sample of 516 Canadian physicians and nurse midwives experienced a moderate degree of decisional conflict about prescribing activity restriction. Decisional conflict occurs in health care when there is a state of uncertainty about the course of action to be taken (O'Connor, 1995). Conflict arises when the level of risk in patient outcome is unclear, and the provider has a lack of clarity about his or her values, skill deficits, time constraints, emotional distress, and/or peer pressure. The need to make tradeoffs in selecting a course of action also contributes

to decisional conflict (Di Caccavo & Reid, 1995; O'Connor, 1995; Westert & Groenewegen, 1999). The decision maker often takes what she or he perceives to be the less objectionable course of action. Despite the fact that the health status of the fetus and mother are interrelated, perinatal care has traditionally had a single-minded focus on the fetus/neonate. It is only when there is substantive risk to maternal health that providers also focus on the well-being of the mother (Moninex et al., 2001). The continued use of bed rest indicates a neglect to consider the full range of evidence about both the efficacy and safety of bed-rest treatment for both the mother and the infant.

Conclusions

It is possible that ABR might decrease preterm birth but evidence has not yet been found to support that conclusion. Such evidence may be masked by the complex multicausal and interrelated factors that contribute to preterm birth. Until that evidence is produced, however, the health care profession should, at least, do no harm. Experts agree that bed rest should not be a standard component of treatment for prevention of preterm birth and, furthermore, that the practice should be eliminated (Crowther, 2009; Goldenberg, 2002; Lu et al., 2003; Meher et al., 2010; Sosa et al., 2009). For example, in Canada, new clinical practice guidelines published by the Society of Obstetricians and Gynaecologists states that strict bed rest is not recommended for treatment of preeclampsia and that there is insufficient evidence to make recommendations about the use of bed rest for women with hypertensive disorders of pregnancy (Society of Obstetricians and Gynaecologists of Canada, 2008). Nurses can challenge bed-rest treatment by functioning as advocates for women and educating them about the evidence for bed-rest treatment as well as the risks and benefits, if any, of this practice (Sprague, 2004). If research does eventually uncover convincing evidence of the efficacy of bed rest, investigators and care providers must pay strict attention to the prevention and treatment of adverse maternal and infant side effects.

Hospitalization may also need to be discontinued after emergent treatment (Goldenberg, 2005). Studies have clearly indicated that home care for women with pregnancy complications is safe and effective, and there is emerging evidence that infant outcomes may be improved with home care. RCTs are needed to address the effects of both bed rest and hospitalization, as these two factors are often confounding.

Although neonatal mortality has been reduced across the last 20 years, this change has been largely due to improved neonatal intensive care and better access to this care. The incidence of preterm birth has not been affected. There is a growing consensus that the current model of prenatal care cannot prevent preterm birth (Goldenberg, 2002; Heaman, Sprague, & Stewart, 2001; Lu et al., 2003). Numerous studies have failed to support, not only standard components of treatments to reduce preterm birth such as bed rest, but also other treatments such as hydration, cerclage, tocolytic drugs without concomitant use of corticosteroids, sedation, psychosocial support, and

nutritional intervention (Goldenberg, 2002; Hodnett & Fredericks, 2009; Lu et al., 2003). New, effective interventions have not been developed. Risk assessment, early detection, and maternal education about signs and symptoms have also not been effective (Goldenberg, 2002). Success in the effort to reduce preterm birth may only come about when we, as researchers and providers, reconceptualize prenatal care as only one part of a lifelong effort to optimize women's health, beginning at birth.

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