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# Cardiomyopathy in Pregnancy

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**Course Description:**

- In all of the United States' public health, pregnancy-related mortality has the widest and most persistent racial and ethnic disparity (inequality). Alarming is the fact that African-American women have a 3 to 4-fold greater risk of maternal mortality than women of other ethnic or racial groups. The disparities stem from social, medical, clinical care and health system factors. Provider and institutional biases are factors impacting these health disparities as well.
- Cardiomyopathy has both intrigued and terrified obstetricians for more than 150 years. It is the leading cause of maternal mortality with cardiovascular disease accounting for one-third of all pregnancy-related deaths! Terrorizing is the fact that only a small fraction of these women had a known diagnosis of heart disease prior to death. However, the majority of women who died *had* presented with symptoms either during pregnancy or postpartum.

**Approximate Time to Complete:** 60 minutes

***Click here to download a print version of this course.***


**Introduction**

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Hi! My name is Chantel. I will be guiding you through an introduction to cardiomyopathy in pregnancy as well as a case study.

My name is Sachi and I will guide you through peripartum cardiomyopathy in more depth.

Meet the Presenters

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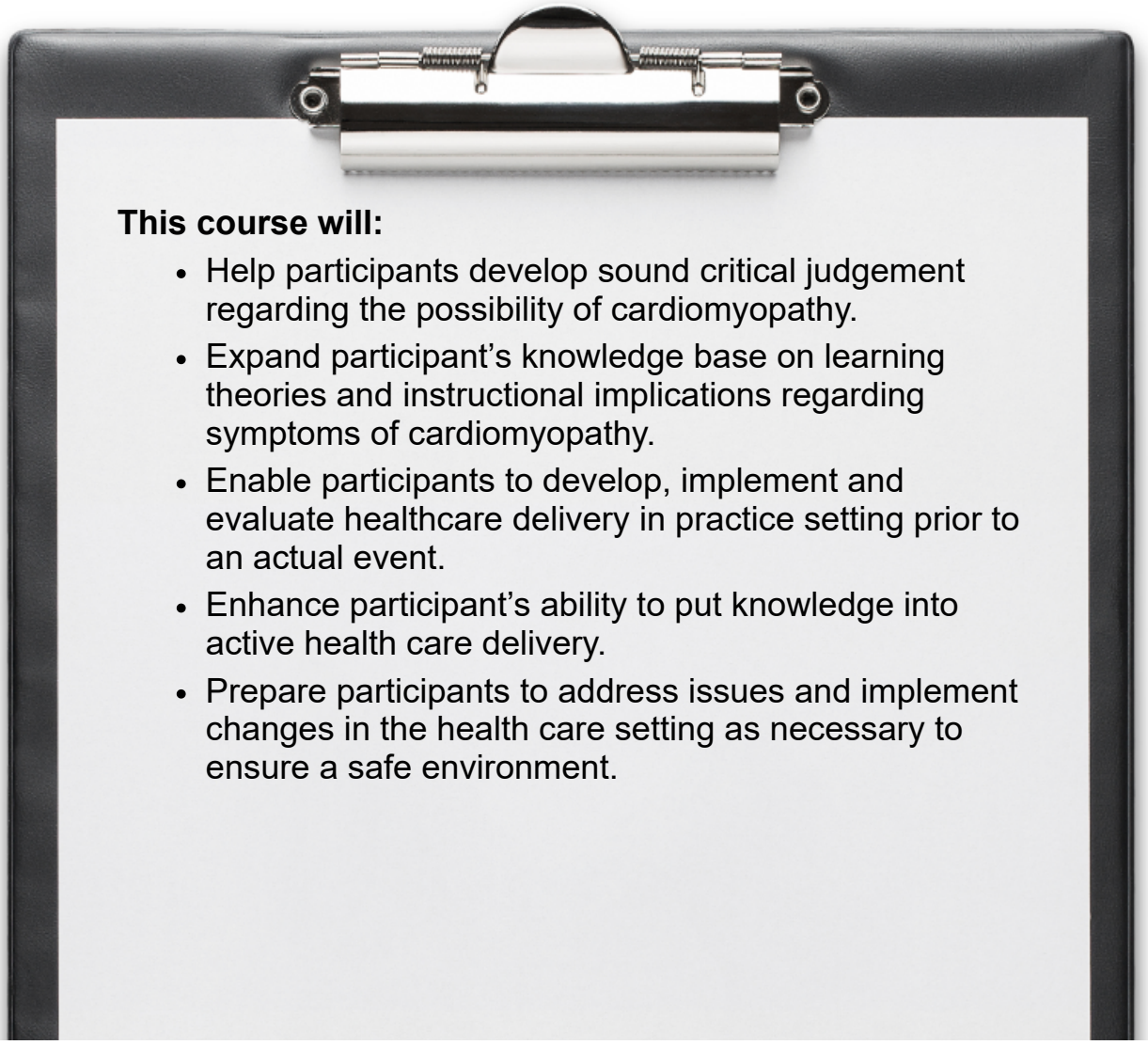
Here's how to use this module: The buttons above from left to right - Table of Contents, Home, Help, References and the X to close.



**This course will:**

- Help participants develop sound critical judgement regarding the possibility of cardiomyopathy.
- Expand participant's knowledge base on learning theories and instructional implications regarding symptoms of cardiomyopathy.
- Enable participants to develop, implement and evaluate healthcare delivery in practice setting prior to an actual event.
- Enhance participant's ability to put knowledge into active health care delivery.
- Prepare participants to address issues and implement changes in the health care setting as necessary to ensure a safe environment.

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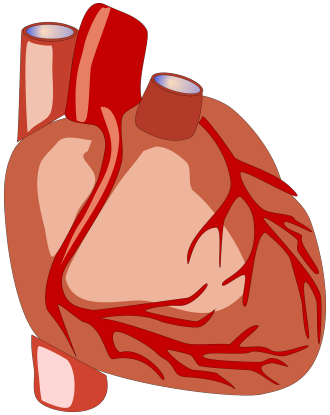
**Table of Contents**

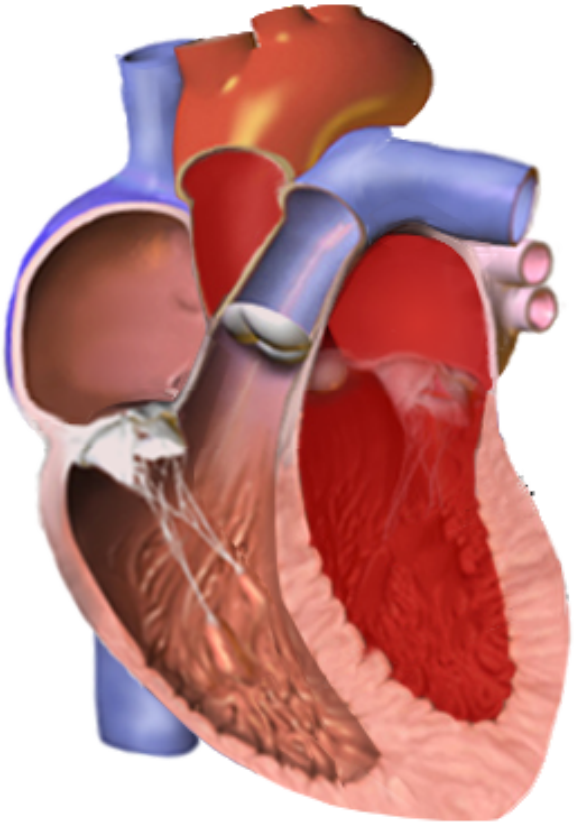
**Peripartum heart failure has both intrigued and terrified obstetricians for more than 150 years.**



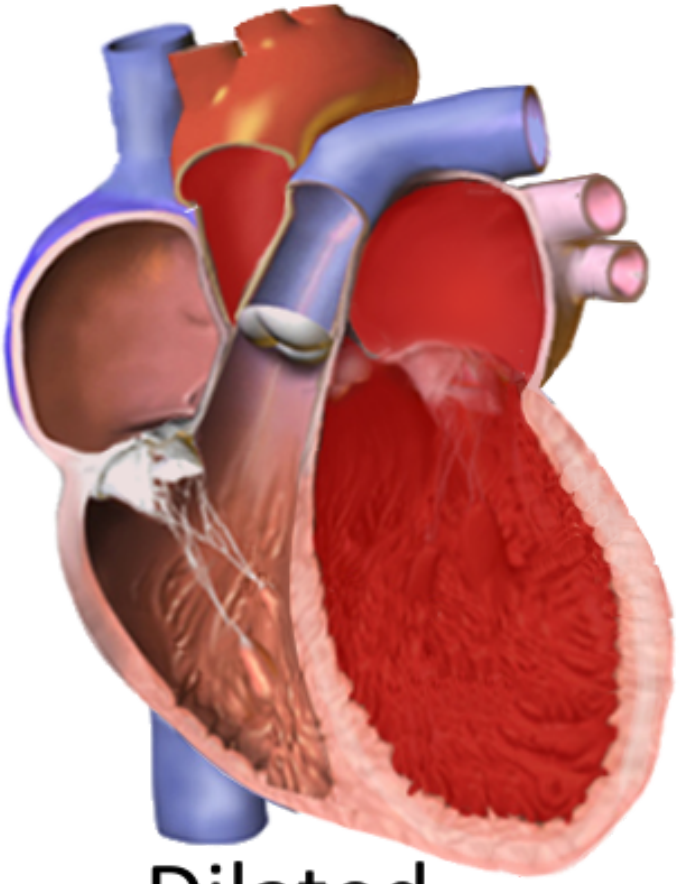
**Click the heart for some pictures of common cardiomyopathies.**

# Introduction [1,2]

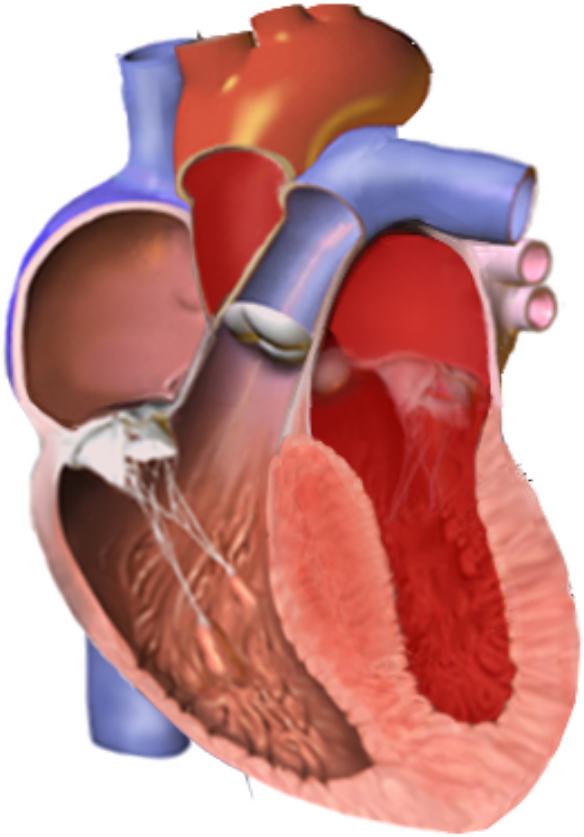
- Cardiomyopathy is a chronic disease of the heart muscle.
- The group of disorders where the heart muscle is structurally and functionally abnormal in the absence of other disease is cardiomyopathy.
- The most common cardiomyopathies are:
  - Hypertrophic
  - Dilated
- Rare types are:
  - Arrhythmogenic right ventricular
  - Restrictive
  - Takotsubo and left ventricular non-compaction cardiomyopathies.



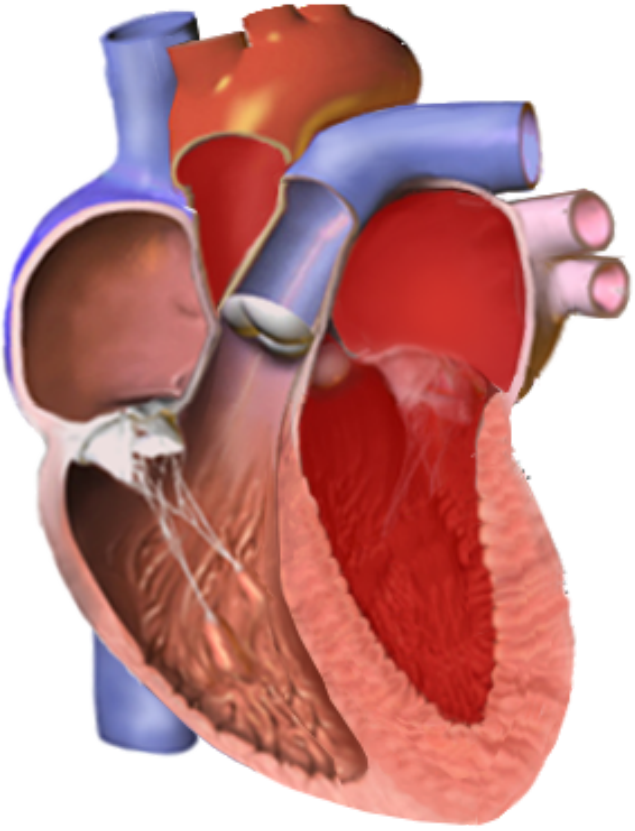
Normal



Dilated



Hypertrophic



Restrictive

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# Cardiovascular Disease (CVD) [3]

Cardiovascular Disease (CVD)

**The leading cause of maternal mortality lies in cardiovascular disease in the United States (U.S.) and accounts for one-third of all pregnancy-related deaths!**

1 of 3

Click the next arrows to see what Chantel has to say about cardiovascular disease

# Cardiovascular Disease (CVD) [3]

Cardiovascular Disease (CVD)

**Terrorizing is the fact that only a small fraction of these women had a known diagnosis of heart disease prior to death. However, the majority of women who died presented with symptoms either during pregnancy or postpartum.**

2 of 3

Click the next arrows to see what Chantel has to say about cardiovascular disease

# Cardiovascular Disease (CVD) [3]

Cardiovascular Disease (CVD)

**Despite numerous attempts to uncover the etiology of peripartum cardiomyopathy (PPCM), the cause remains unknown and may be multifactorial.**



Click the next arrow to continue

Let's start learning more by taking a look at a case example.

Case Example

"Sample Case Presentation A 25-year-old obese (Body Mass Index (BMI) 38) African-American G2P2 underwent an uncomplicated vaginal delivery 10 days ago. She presents to the urgent care clinic with complaints of fatigue and persistent cough since delivery. She is afebrile with blood pressure of 110/80 mmHg, heart rate 110 bpm and respiratory rate of 28 per minute. Chest X-ray reveals bilateral infiltrates. Oxygen saturation is 94% on room air."

1 of 3

**Click the next arrows to read the case study**

Case Example

"The patient is diagnosed with a respiratory infection. Fatigue is attributed to the lack of sleep due to care of the newborn. She is prescribed an antibiotic and sent home. One week later, she presents again with continued symptoms. Antibiotics are switched at this time, and beta agonists are added due to presumptive diagnosis of “new-onset asthma” as evidenced by physical examination findings. Two days later, the patient experiences cardiac arrest at home. Resuscitation attempts are unsuccessful. Autopsy findings were indicative of cardiomyopathy."

2 of 3

**Click the next arrows to read the case study**

Case Example

"This case is representative of similar deaths attributed to cardiovascular disease reviewed by California Pregnancy-Associated Mortality Review (CA-PAMR). Maternal mortality due to cardiac disease primarily revolved around the lack of awareness of CVD at both patient and provider levels, coupled with delays in diagnosis. In most cases, diagnosis was made in the perimortem period or at the time of autopsy." [4]



Click the next arrow to continue

# Racial Disparities [4]

- Clinical implications for African-American women with cardiovascular disease.
  - Retaining a high index of suspicion when CVD risk factors are present is needed to help impact the known racial disparities.

# Racial Disparities - Maternal and Pregnancy-Related Mortality

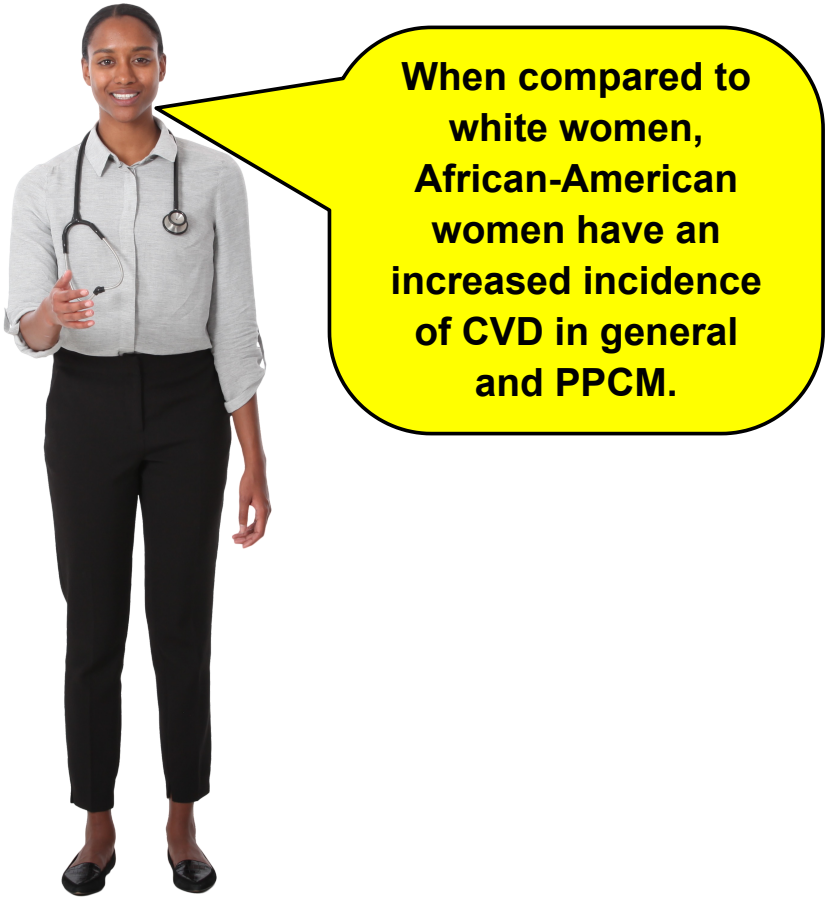
**Pregnancy-related mortality has the widest and most persistent racial and ethnic disparity (inequality) in all of U.S. public health [5].**

- The fact that African-American women have a 3-4 fold greater risk of maternal mortality than women of other ethnic or racial groups is alarming. [5].
- In California, pregnancy-related CVD is more than 8 times higher than that for white women [6].

# Racial Disparities - CVD Incidence and Comorbidities [5,6]

- Higher rates of pre-existing CVD occurs among African-American women [5].
- Comorbid conditions, such as hypertensive disorders of pregnancy, are more pervasive among African-American women.
  - Hypertensive disorders correlate to all types of CVD.
- It has been reported that African-American women have a lower number of visits for prenatal care and seek care later in pregnancy when compared to women of other racial and ethnic groups [7].

# Racial Disparities - Peripartum Cardiomyopathy (PPCM) Prevalence [8-11]




Racial Disparities - Peripartum Cardiomyopathy (PPCM) Prevalence

- All forms of hypertensive disease in pregnancy highly correlate to PPCM
  - Women with gestational hypertension, chronic hypertension, and mild preeclampsia had 2- to 5-fold increases in odds of PPCM.
  - Women with severe preeclampsia had a 17-fold increase in odds of PPCM and eclampsia had a 25-fold increase.
- Reviewing the population with PPCM, African-American women were typically younger, more frequently presented with severe symptoms, and were more likely to be diagnosed postpartum than white women.

# Racial Disparities

Factors Affecting Racial Disparities in CVD-Related Diagnoses [12-19]:

Maternal mortality and morbidity are impacted by racial and ethnic disparities that stem from social, medical, clinical care, and health system factors.



Click the next arrows to read more information.

# Racial Disparities

Factors Affecting Racial Disparities in CVD-Related Diagnoses [12-19]:

The incidence of hypertension and preeclampsia is higher with African-American women, yet these women are less likely to be hospitalized for treatment.



Click the next arrows to read more information.

# Racial Disparities

Factors Affecting Racial Disparities in CVD-Related Diagnoses [12-19]:

Maternal health outcomes are likely impacted by the chronic stress and experiences of racism over the course of life contributing to the higher rates of low birth weight infants and infant mortality.



Click the next arrows to read more information.

# Racial Disparities

Factors Affecting Racial Disparities in CVD-Related Diagnoses [12-19]:

Birth outcomes have known factors where high stress levels (the allostatic load) both before and after pregnancy impact the outcomes. African-American women are subject to higher loads which is multi-factorial with ‘embodied inequality’ arising from environmental, social, and genetic factors.



**Click the next arrows to read more information.**

# Racial Disparities

Factors Affecting Racial Disparities in CVD-Related Diagnoses [12-19]:

These are some of the socially patterned factors impacting maternal health, such as: malnutrition, toxic substance exposure, intimate partner violence, smoking, infections, racial discrimination, inadequate medical, and dental care.

- These factors highly correlate to low socioeconomic status.
- African-American women living in underserved areas often lack resources to maintain a healthy lifestyle, further impacting the negative cycle of poor reproductive and maternal health.
- What is even more frightening is the fact that African-American women with higher socioeconomic status and education does not necessarily resolve nor provide a protective effect against poor maternal outcomes.

# Racial Disparities - Provider and Institutional Bias [19-23]

**The doctor-patient interaction is influenced by racial bias (conscious or not), gender bias (conscious or not), social ideas about race and class. These issues can shape and influence treatment disparities.**

**Click the picture to learn more about provider and institutional bias.**

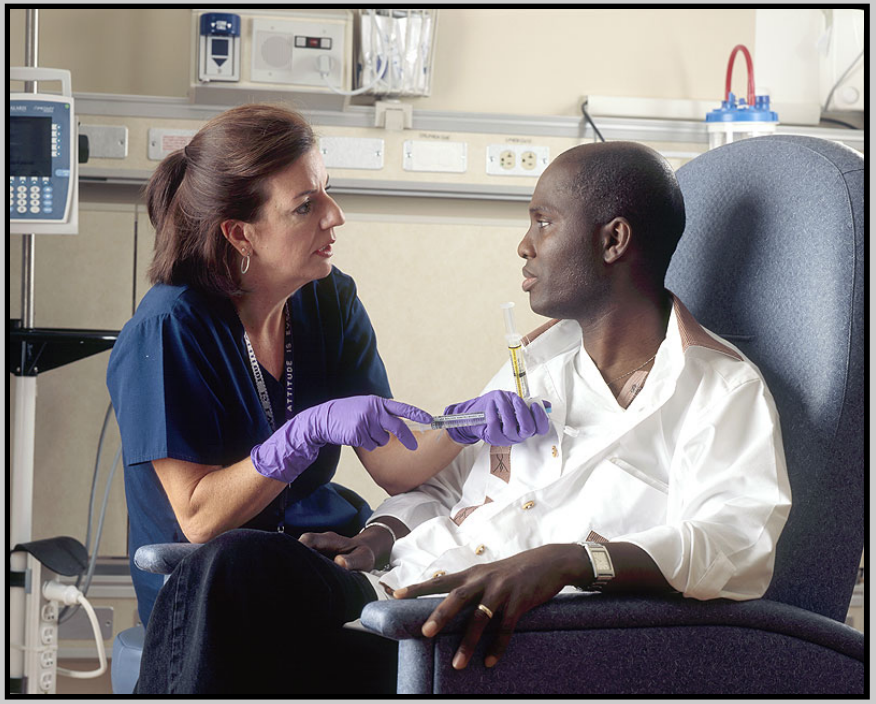
Research has examined physicians' implicit racial attitudes and found:

- African-American Physicians
- Woman Physicians
- White Male Physicians

**Click the links to see implicit racial attitudes of each physician type.**

African-American patients are less likely to have cardiovascular therapy of proven benefit and worse outcomes after the procedures. This has been shown in multiple studies.

- Unfortunately, multiple studies show, surgical and medical care often occurs at lower quality health care facilities and experience higher mortality regarding African-American patients.



African-American doctors show no preference toward care for White or African-American patients.

picture credit: www.audio-luci-store.it

Women physicians showed less implicit bias than their male counterparts.


White male physicians demonstrated significant implicit preference for White compared to non-White patients.

## Racial Disparities - Clinical Implications [24-26]

Complaints from patients need to be taken seriously, and clinicians need to maintain a high suspicion for CVD, especially when seeing African-American women who are pregnant or postpartum.

Click the next arrows to read more information.

1 of 3

## Racial Disparities - Clinical Implications [24-26]

- Careful, thorough evaluations need to occur when African-American women having chronic or gestational hypertension with high pre-pregnancy BMI (≥35) presenting with:
  - Extreme shortness of breath, especially when lying down
  - Persistent cough unrelieved with treatment
  - Significant fatigue
  - Palpitations
  - Swelling
  - Chest pain
  - Abnormal vital signs

**Click the next arrows to read more information.**

2 of 3

## Racial Disparities - Clinical Implications [24-26]

- We each have an opportunity to reduce disparities when diagnosing and treating CVD by implementing standardized protocols:
  - Assessment algorithms (an option follows)
  - Patient-level interventions with signs and symptoms
  - Examining the *process*
  - Content of educational interventions

Click the next arrow to continue



# Algorithm 1 – Red Flags Not Present, Move on to Next Algorithm [4]


**Red Flags**

- Shortness of breath at rest
- Severe orthopnea ≥ 4 pillows
- Resting HR ≥120 bpm
- Resting systolic BP ≥160 mm Hg
- Resting RR ≥30
- Oxygen saturations ≤94% with or without personal history of CVD

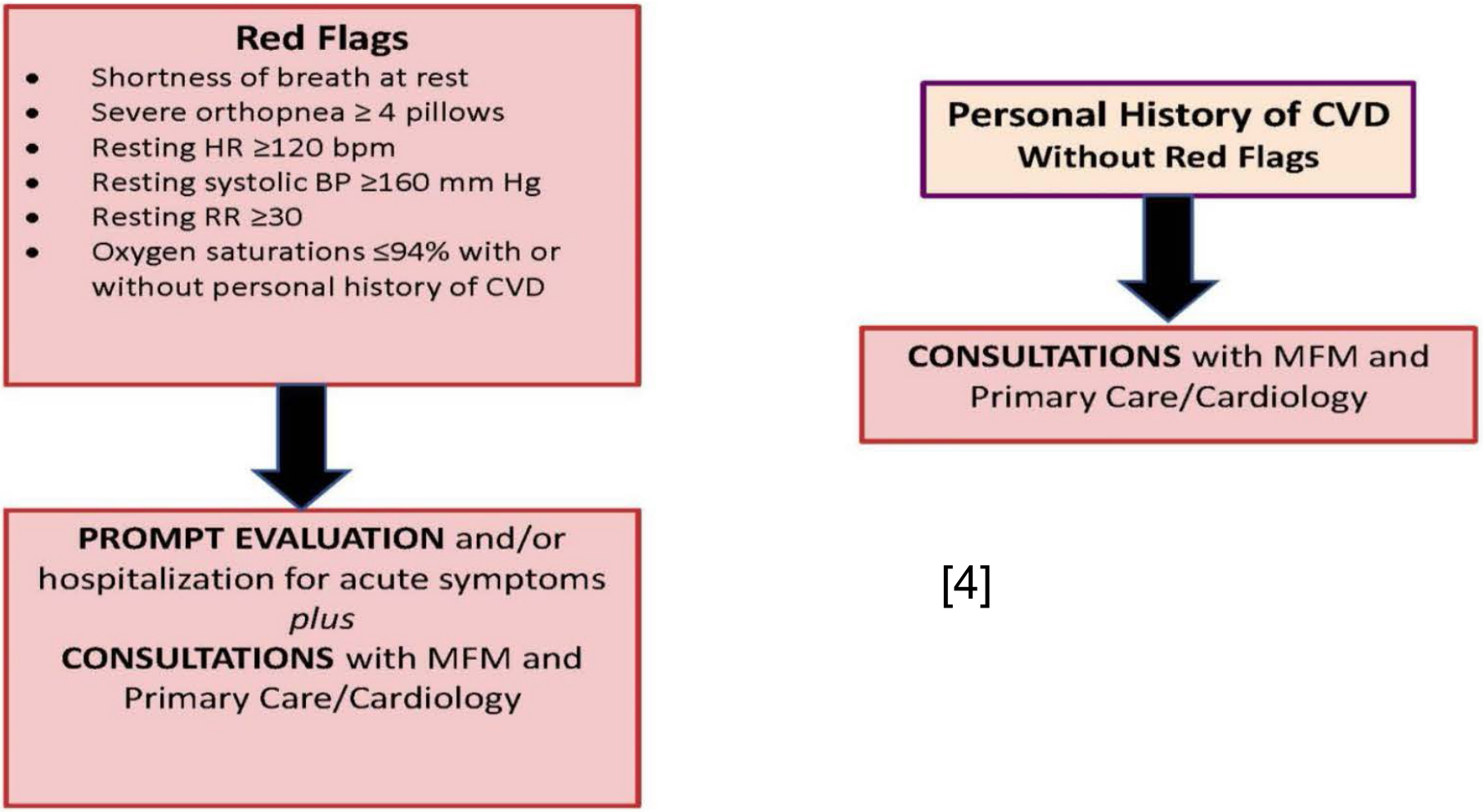
**PROMPT EVALUATION** and/or hospitalization for acute symptoms
*plus*
**CONSULTATIONS** with MFM and Primary Care/Cardiology

**Personal History of CVD Without Red Flags**

**CONSULTATIONS** with MFM and Primary Care/Cardiology

Click the picture for a larger view

Algorithm 1 – Red Flags Not Present, Move on to Next Algorithm


Red Flags
Shortness of breath at rest
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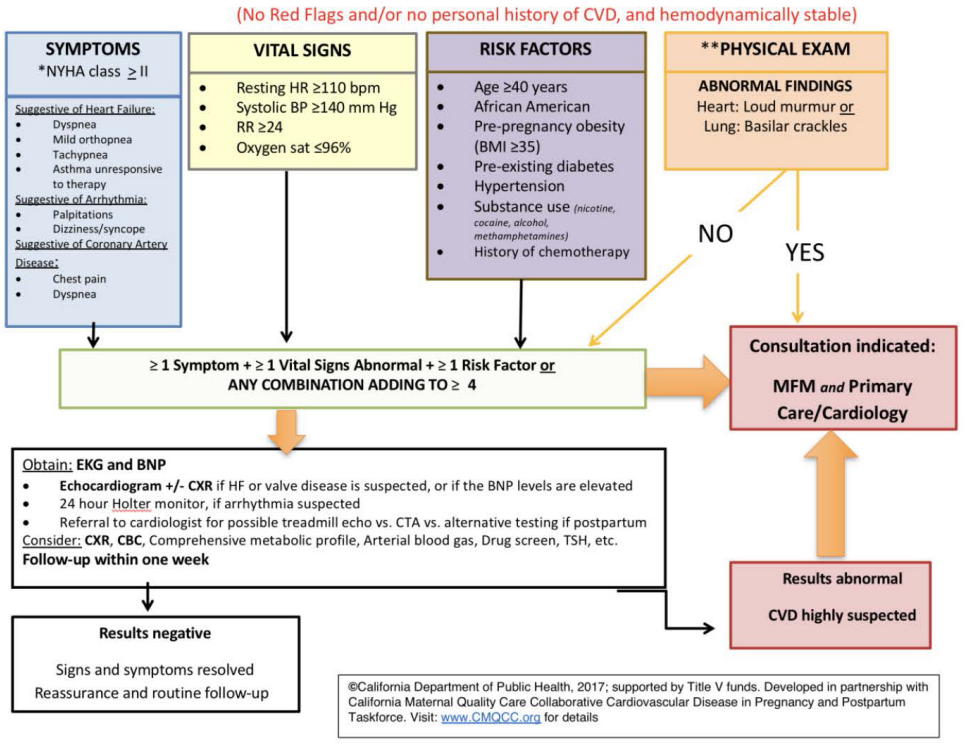
Oxygen saturations ≤94% with or without personal history of CVD
PROMPT EVALUATION and/or hospitalization for acute symptoms
plus
CONSULTATIONS with MFM and Primary Care/Cardiology
Personal History of CVD
Without Red Flags
CONSULTATIONS with MFM and Primary Care/Cardiology

[4]

# Algorithm 2 Assessment

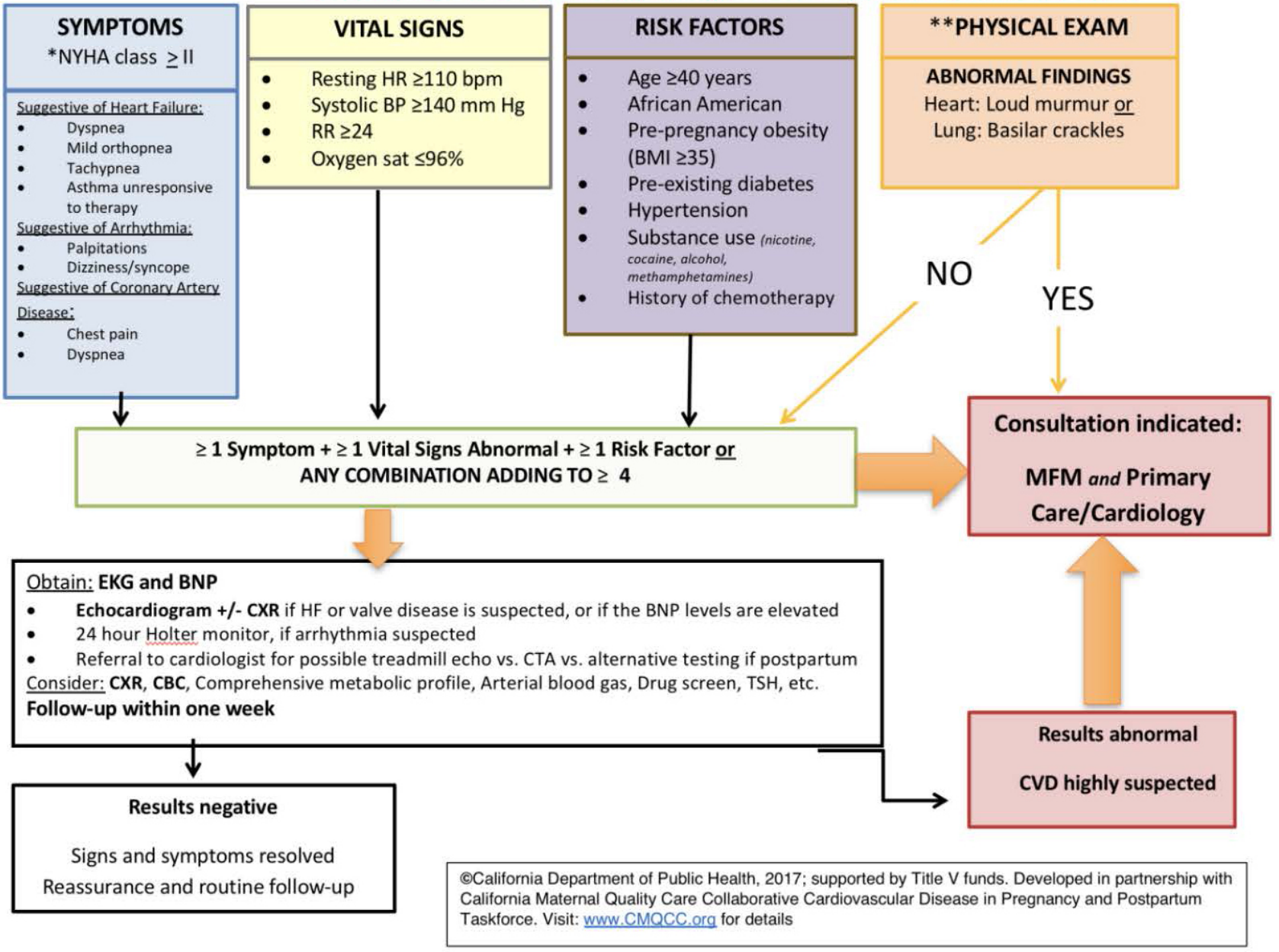
**When there are no Red Flags nor personal history of CVD and the patient is hemodynamically stable this algorithm can be utilized:**




**Click the picture for a larger view**

Algorithm 2 Assessment

(No Red Flags and/or no personal history of CVD, and hemodynamically stable)



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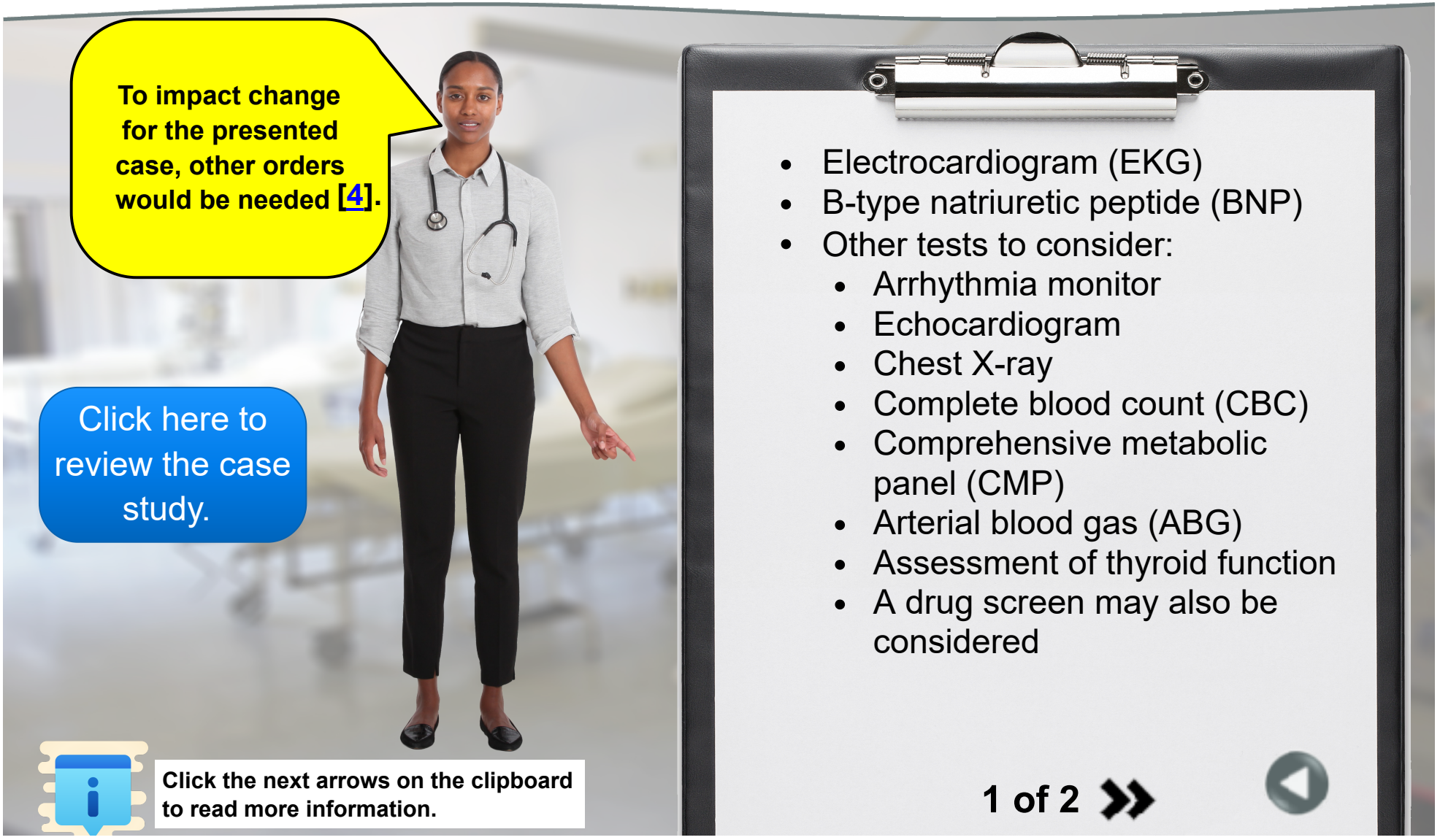


- Electrocardiogram (EKG)
- B-type natriuretic peptide (BNP)
- Other tests to consider:
  - Arrhythmia monitor
  - Echocardiogram
  - Chest X-ray
  - Complete blood count (CBC)
  - Comprehensive metabolic panel (CMP)
  - Arterial blood gas (ABG)
  - Assessment of thyroid function
  - A drug screen may also be considered

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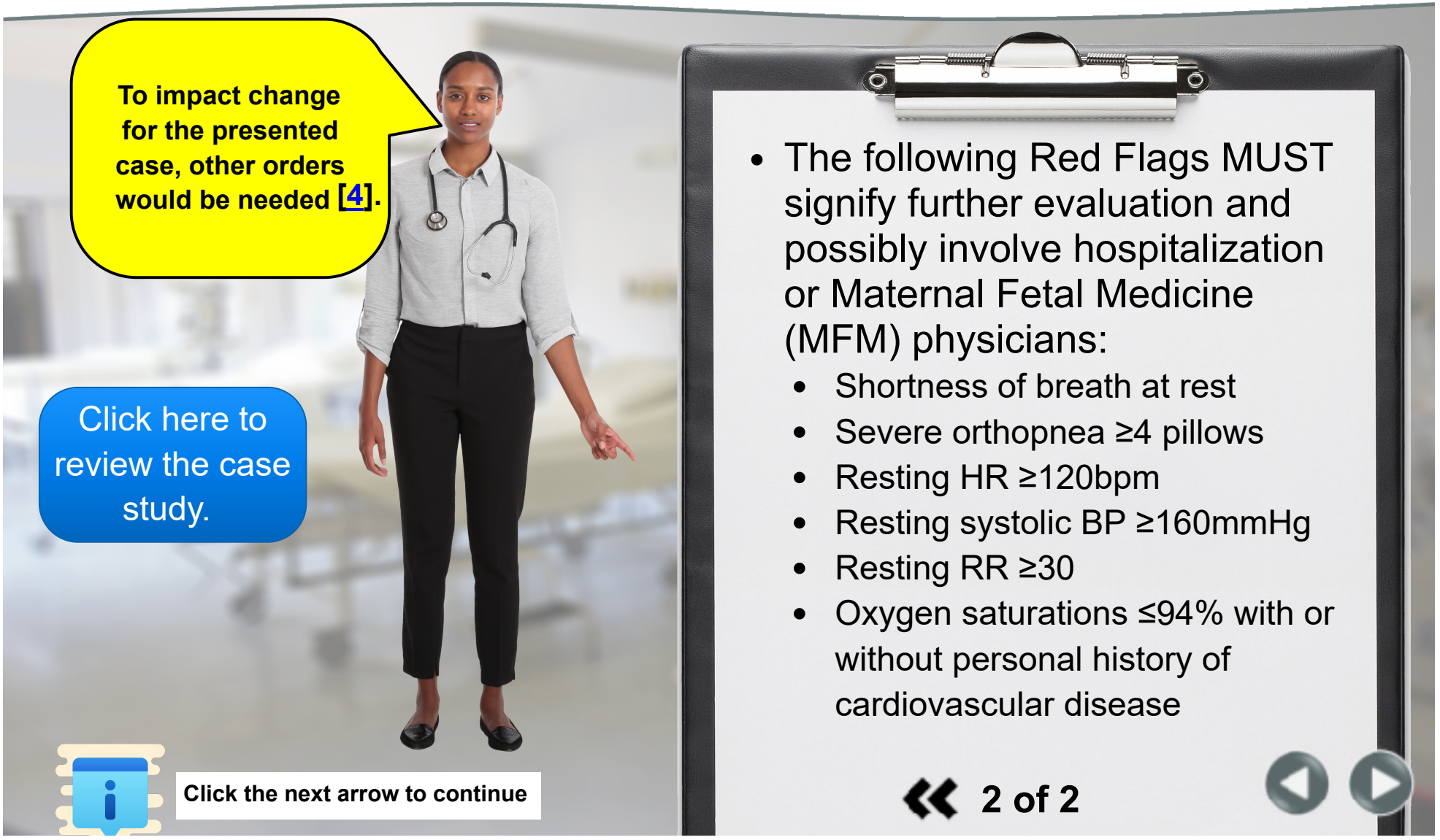


- The following Red Flags MUST signify further evaluation and possibly involve hospitalization or Maternal Fetal Medicine (MFM) physicians:
  - Shortness of breath at rest
  - Severe orthopnea ≥4 pillows
  - Resting HR ≥120bpm
  - Resting systolic BP ≥160mmHg
  - Resting RR ≥30
  - Oxygen saturations ≤94% with or without personal history of cardiovascular disease

“Sample Case Presentation A 25-year-old obese (Body Mass Index (BMI) 38) African-American G2P2 underwent an uncomplicated vaginal delivery 10 days ago. She presents to the urgent care clinic with complaints of fatigue and persistent cough since delivery. She is afebrile with blood pressure of 110/80 mmHg, heart rate 110 bpm and respiratory rate of 28 per minute. Chest X-ray reveals bilateral infiltrates. Oxygen saturation is 94% on room air. The patient is diagnosed with a respiratory infection. Fatigue is attributed to the lack of sleep due to care of the newborn. She is prescribed an antibiotic and sent home. One week later, she presents again with continued symptoms. Antibiotics are switched at this time, and beta agonists are added due to presumptive diagnosis of “new-onset asthma” as evidenced by physical examination findings. Two days later, the patient experiences cardiac arrest at home. Resuscitation attempts are unsuccessful. Autopsy findings were indicative of cardiomyopathy.

This case is representative of similar deaths attributed to cardiovascular disease reviewed by California Pregnancy-Associated Mortality Review (CA-PAMR). Maternal mortality due to cardiac disease primarily revolved around the lack of awareness of CVD at both patient and provider levels, coupled with delays in diagnosis. In most cases, diagnosis was made in the perimortem period or at the time of autopsy. [4]”

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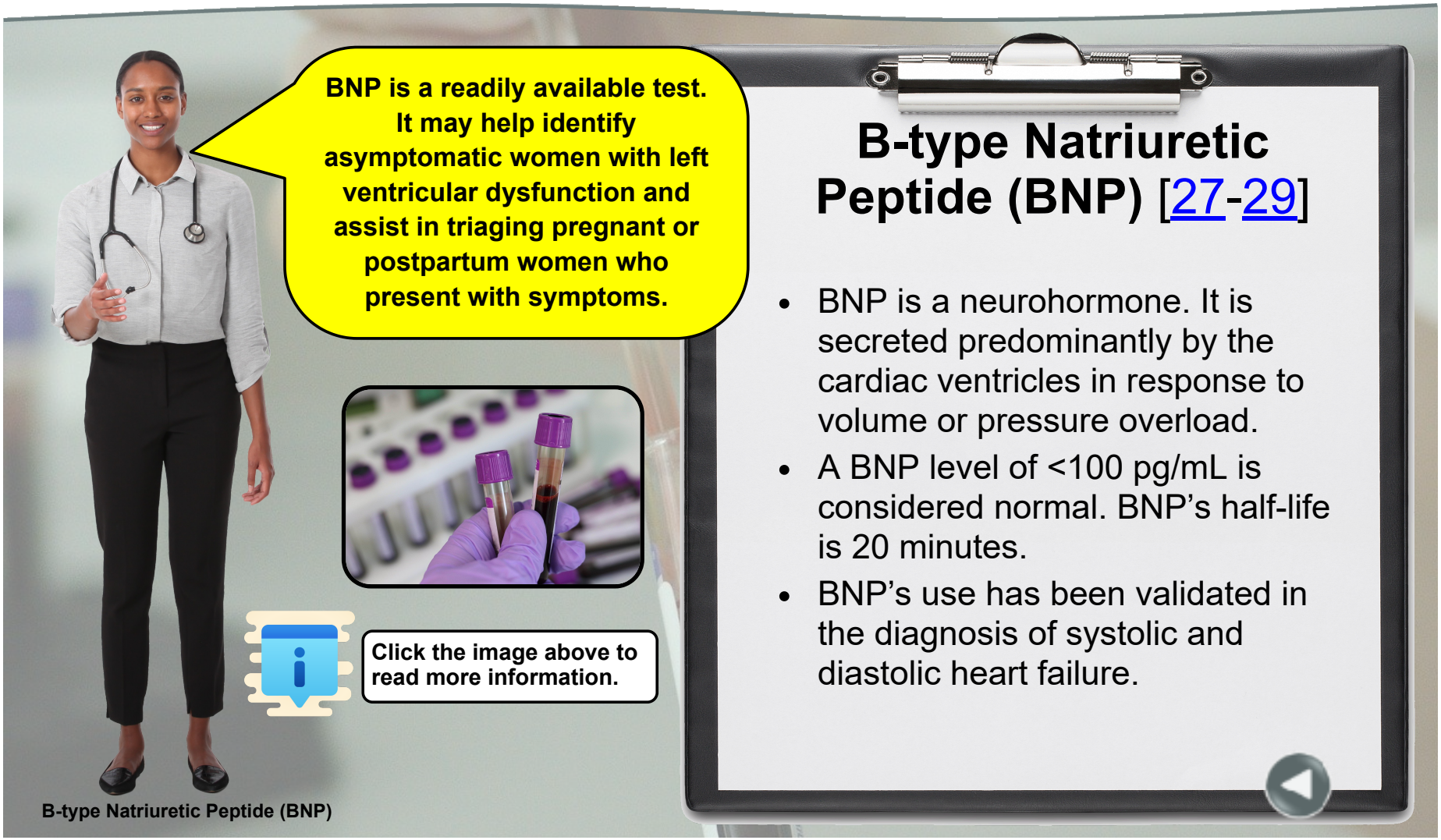


BNP is a readily available test. It may help identify asymptomatic women with left ventricular dysfunction and assist in triaging pregnant or postpartum women who present with symptoms.



Click the image above to read more information.

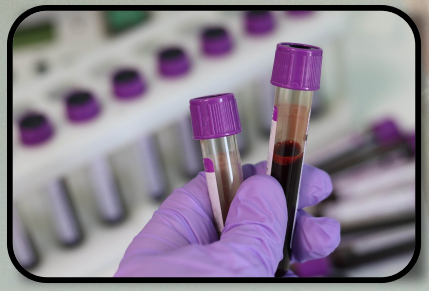
B-type Natriuretic Peptide (BNP)

# B-type Natriuretic Peptide (BNP) [27-29]

- BNP is a neurohormone. It is secreted predominantly by the cardiac ventricles in response to volume or pressure overload.
- A BNP level of <100 pg/mL is considered normal. BNP's half-life is 20 minutes.
- BNP's use has been validated in the diagnosis of systolic and diastolic heart failure.

B-type Natriuretic Peptide (BNP)

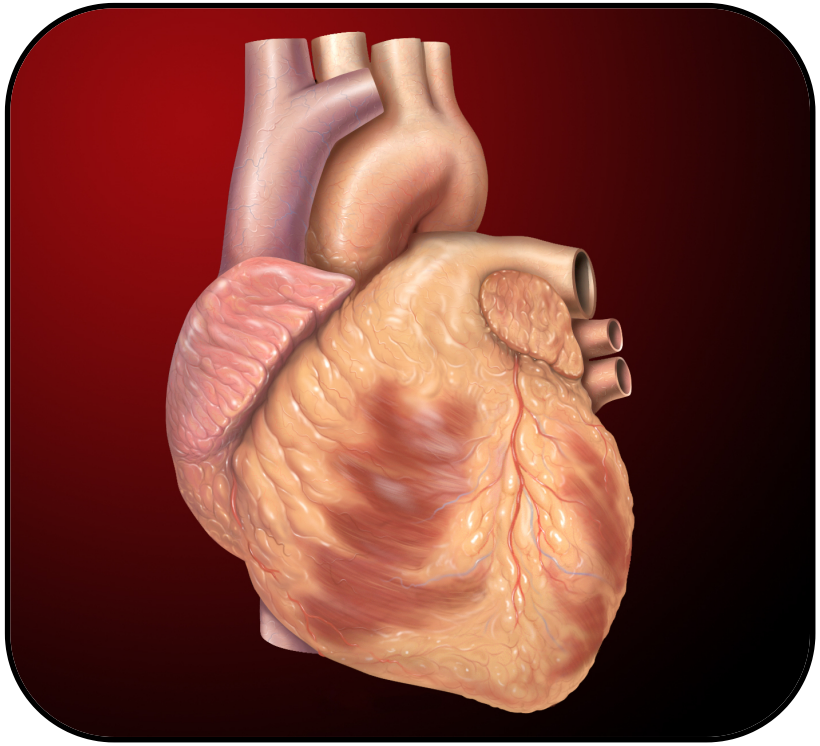
**BNP is a readily available test. It may help identify asymptomatic women with left ventricular dysfunction and assist in triaging pregnant or postpartum women who present with symptoms.**



**Click the image above to read more information.**

# B-type Natriuretic Peptide (BNP) [27-29]

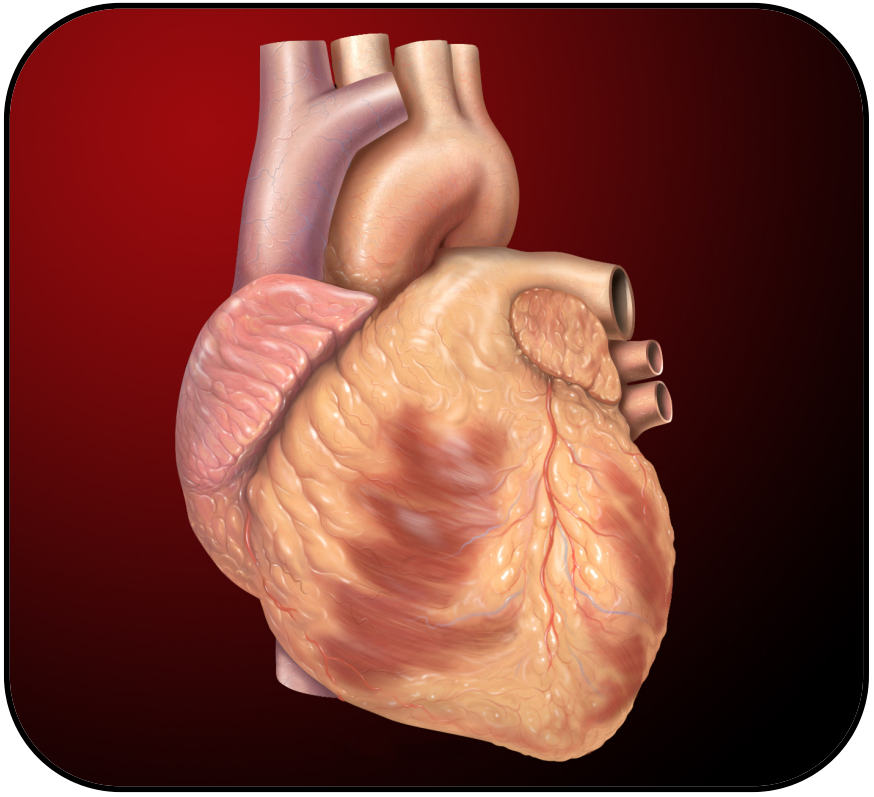
- BNP levels in pregnancy remain within normal range despite significant volume overload in pregnancy, and the levels are higher in pathologic conditions.
- An elevated BNP level should trigger an echocardiogram to evaluate cardiac function.
- Serial measurements of BNP in pregnant women with dilated cardiomyopathy are shown to be predictive of adverse cardiovascular outcomes.



Click the heart graphic above to read more information.

## Presentation of Women with CVD:

- In the California Collaborative study, only 2 women entered pregnancy with known CVD [6].
- However, the prevalence of CVD symptoms (SOB, wheezing, palpitations, edema, chest pain, dizziness, or extreme fatigue) follow:
  - Prenatal period 43%
  - Labor and delivery 51%
  - Postpartum 80%



Click the heart graphic above to read more information.

## Presentation of Women with CVD:

- It can be tricky to determine pathology from normal pregnancy variance since many young healthy pregnant women without cardiac disease have signs and symptoms of CVD such as shortness of breath, fatigue, limitation of exercise capacity, and swelling [4].
- The people providing care to a pregnant population must become familiar with risk factors, warning signs and certain physical exam findings that suggest underlying cardiac conditions [4].
- Global cardiovascular risk assessment should be obtained in all pregnant women at their first encounter with an obstetric provider [4].

## How to differentiate common signs and symptoms of normal pregnancy versus those that are abnormal and indicative of underlying cardiac disease*

| | ROUTINE CARE<br>Reassurance | CAUTION<br>Nonemergent Evaluation | STOP<br>Prompt Evaluation Pregnancy Heart Team |
|---|---|---|---|
| **HISTORY OF CVD** | None | None | Yes |
| **SELF-REPORTED SYMPTOMS** | None or mild | Yes | Yes |
| Shortness of Breath | No interference with activities of daily living; with heavy exertion only | With moderate exertion, new-onset asthma, persistent cough, or moderate or severe OSA | At rest; paroxysmal nocturnal dyspnea or orthopnea; bilateral chest infiltrates on CXR or refractory pneumonia |
| Fatigue | Mild | Mild or moderate | Extreme |
| **VITAL SIGNS** | | | |
| Heart Rate | <90 | 90-119 | ≥120 |
| **PHYSICAL EXAMINATION** | Normal | | |
| Edema | Mild | Moderate | Marked |

*This is an abbreviated list—see Practice Bulletin *Pregnancy and Heart Disease* for complete table of symptoms.

ACOG

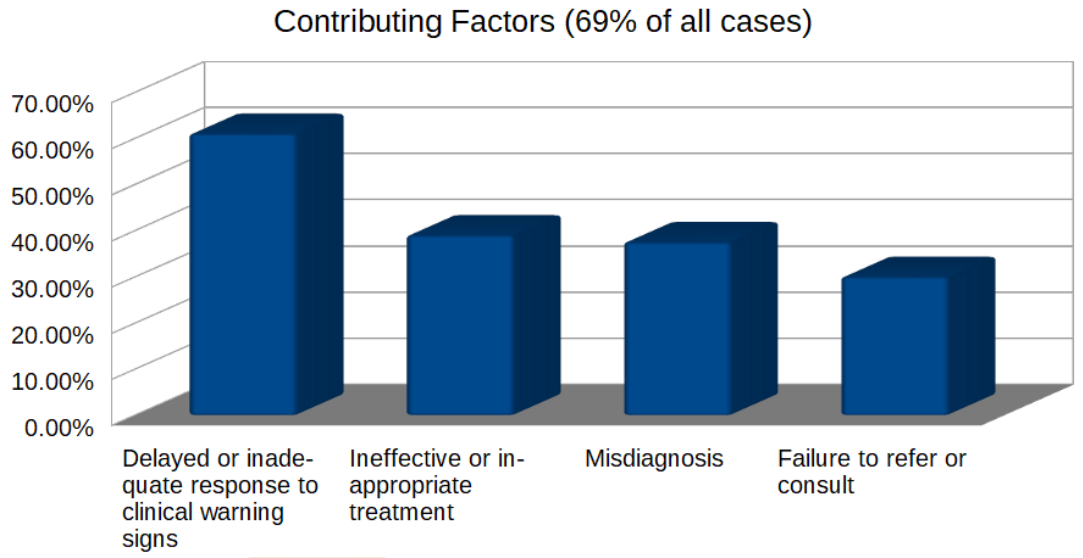
Eliminate preventable maternal mortality
**#EveryMomEveryTime**

[33]

ACOG table

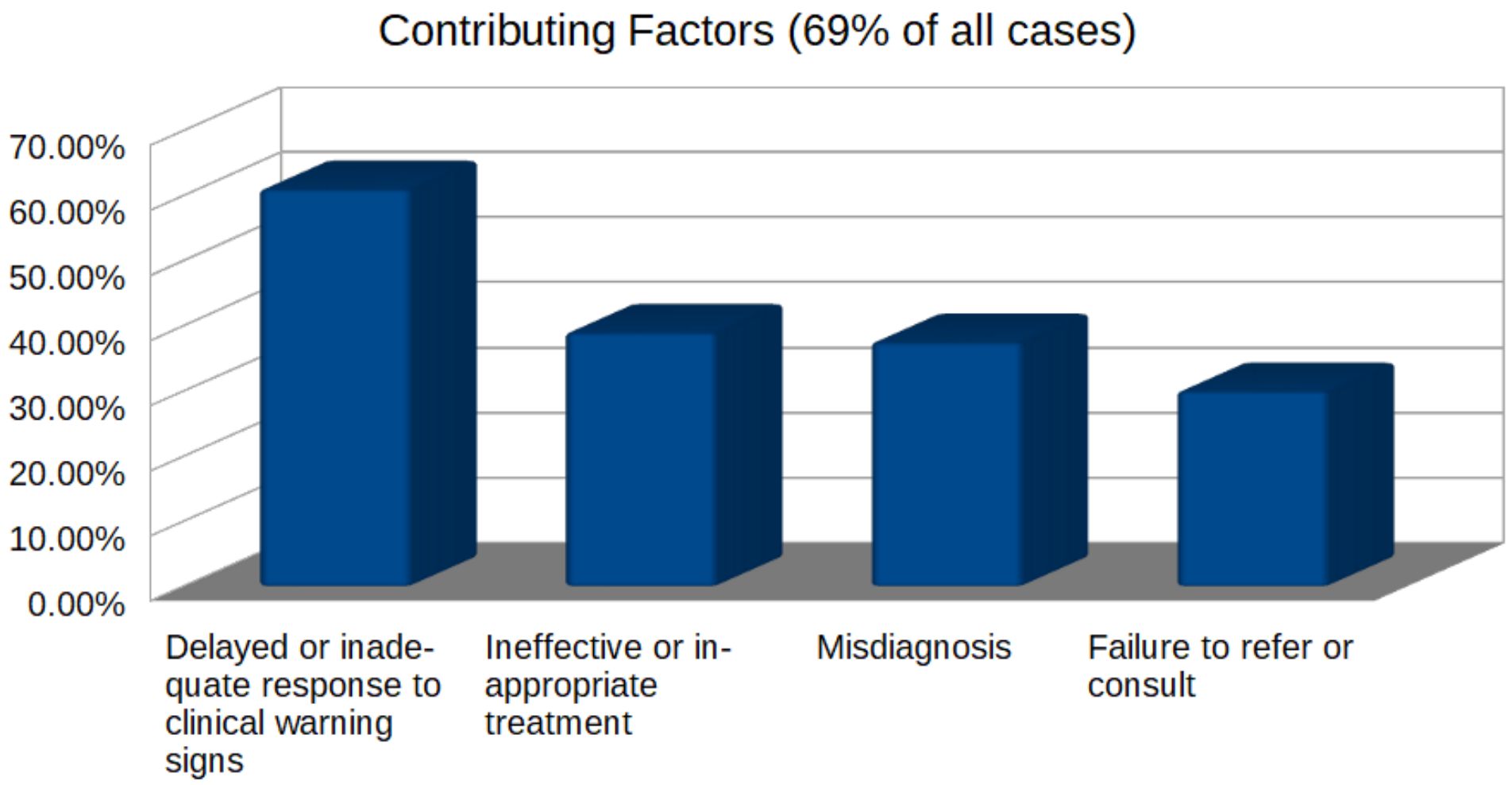
**Another contributing factor to maternal morbidity and mortality with CVD from the health care provider perspective: Insufficient use of hypertensive medications and misdiagnosis of "new onset asthma" or other respiratory illness [4].**

Click here for a list of improvement opportunities.




**Click the graph above for a larger**

**Contributing Factors to Maternal Morbidity and Mortality with CVD – Health Care Providers**


Contributing Factors (69% of all cases)
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Delayed or inade-quate response to clinical warning signs
Ineffective or in-appropriate treatment
Misdiagnosis
Failure to refer or consult

Improvement opportunities [4]:

- Better recognition of signs and symptoms of CVD in pregnancy:
  - Shortness of breath, fatigue
  - Tachycardia, BP change, and low oxygen saturation
  - Improved hypertensive management

Incidence of Peripartum Cardiomyopathy

**Incidence is important for careful exclusion of alternative etiologies of heart failure and paramount in both defining prevalence in the population and in caring for individual patients [31].**

# Incidence of Peripartum Cardiomyopathy [30]:

- Incidence varies widely owing to numerous factors [32]:
  - Geographic difficult area
  - Differing definitions
  - Evolving diagnostic criteria
  - Lacking of accurate data

Africa and Haiti

United States

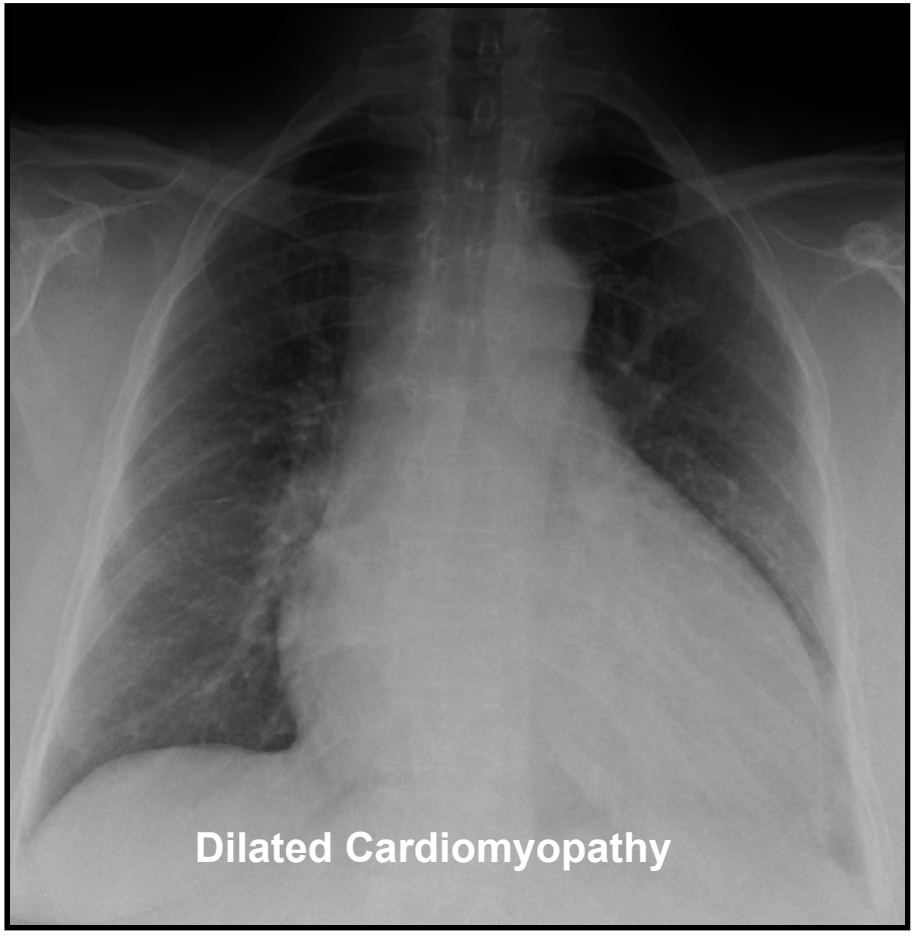
**Mouse over each map above for more on cardiomyopathy incidence in each location**

The incidence of peripartum cardiomyopathy in the U.S. has increased from 1 in 4,350 births in the early 1990s to 1 in 2,230 births in the mid-2000's [31].

Worldwide, peripartum cardiomyopathy affects approximately 1 per 1,000 pregnancies with geographic hot spots found in Africa--up to 1 per 100 pregnancies-- and Haiti--1 in 300 births [30]. Genetic predisposition may contribute to geographical variation.

Peripartum cardiomyopathy is defined by left ventricular dysfunction and development of cardiac failure without a known cause and occurring in the final month of pregnancy and up to 5 months postpartum [1].

Mouse over the xray for more information




Defining Peripartum Cardiomyopathy

Absence of another identifiable cause for the heart failure [55]:

- Left ventricular (LV) systolic dysfunction with an LV ejection fraction (LVEF) of less than 45% [55].
  - The LV may or may not be dilated [55].


- Multiparity
- Advanced maternal age
- Multifetal pregnancy
- Preeclampsia
- Gestational HTN
- African-American race
  - African-American's may also have more severe disease
- History of preeclampsia, eclampsia, or postpartum hypertension
- Maternal cocaine abuse
- >4 weeks of oral tocolytic therapy with beta adrenergic agonists such as terbutaline


## Review of Cardiac Physiology Related to Pregnancy

A 30-50% increase of cardiac output occurs to meet the needs of a colossal uterine blood flow and fetal perfusion while allowing the mother to function without impairment [1,35].

- Hormones secreted by the corpus luteum likely orchestrate these early cardiovascular changes [1,35].
- These hormones induce profound changes in systemic vascular resistance and result in significantly decreased systolic and diastolic blood pressures as early as 5 weeks [1,36].

**Click the next arrow to review information on cardiac physiology in pregnancy.**


## Review of Cardiac Physiology Related to Pregnancy

At least half of the total rise in cardiac output during pregnancy has manifested as early as 8 weeks gestation [37,38].

On the other had, mean BP nadirs at 16-29 weeks gestation [37,38].

- These changes persist until the 3rd trimester [37,38].
- “From early pregnancy until about 16 weeks of gestation a reduction in peripheral vascular resistance occurs causing stroke volume to be augmented and increase after this time in gestation, typically stroke volume plateaus along with cardiac output [1]."

**Click the next arrow to review information on cardiac physiology in pregnancy.**


## Review of Cardiac Physiology Related to Pregnancy

Intrinsic left ventricular contractility does not appear to change appreciably, even with all the dramatic hemodynamic alterations that occur while pregnant.

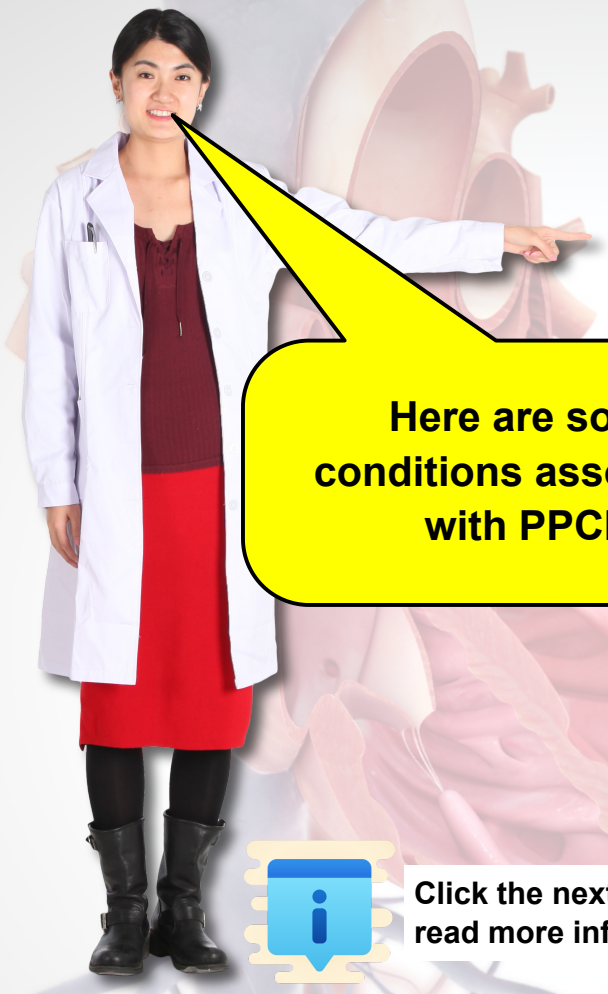
It is uncharacteristic in a high output cardiac state with hyperdynamic function to maintain normal left ventricular function as it is in pregnancy [35].

The pregnancy induced hypervolumia involves an increase in end-systolic and end-diastolic dimensions is accommodated by cardiac atria and ventricles.

- Due to these facts, the left ventricular mass is increased proportional to maternal size.
- The cardiac atria have a similar increase in mass.

Most, but not all, agree the cardiac remodeling is a normal physiologic response resolving by 3 months postpartum.

After reviewing normal physiologic cardiac changes, we will now discuss peripartum cardiomyopathy (PPCM) in more depth.



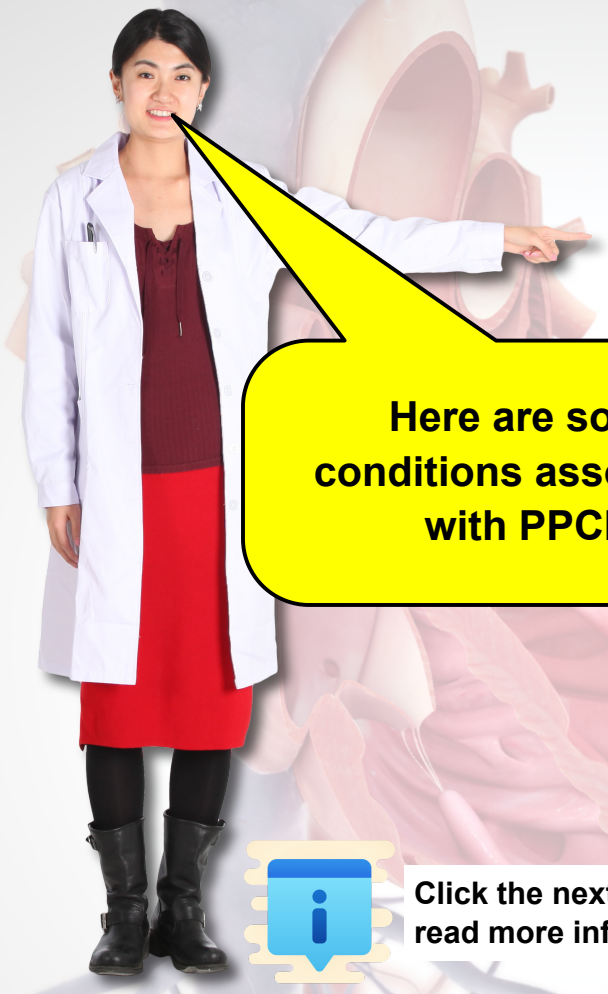
Here are some conditions associated with PPCM [1].

Click the next arrows to read more information.

Conditions Associated with PPCM

**Advanced maternal age** [39]:

- More than half of PPCM occurs in women >30 years old.
- Interestingly, the incidence of PPCM is 10-fold higher in women >40 years old compared with those <20 years old.



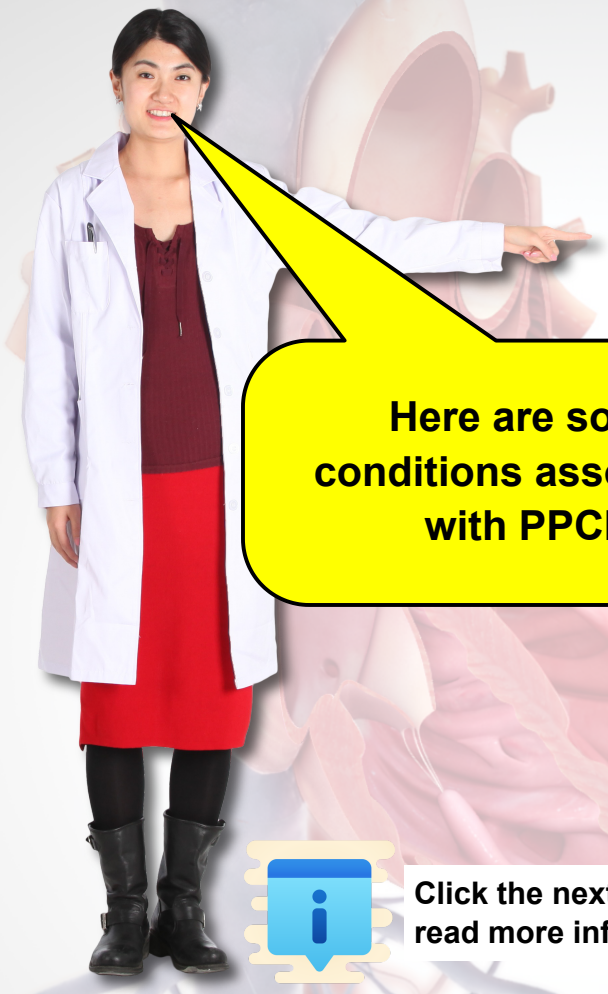
Here are some conditions associated with PPCM [1].

Click the next arrows to read more information.

Conditions Associated with PPCM

**Black race is strongly associated risk factor for PPCM** [10]:

- This translates to the geographic propensity with incidences as high at 1% in some populations.
- In the U.S. a 5- to 15-fold increased risk for black women compared with other races has been reported.



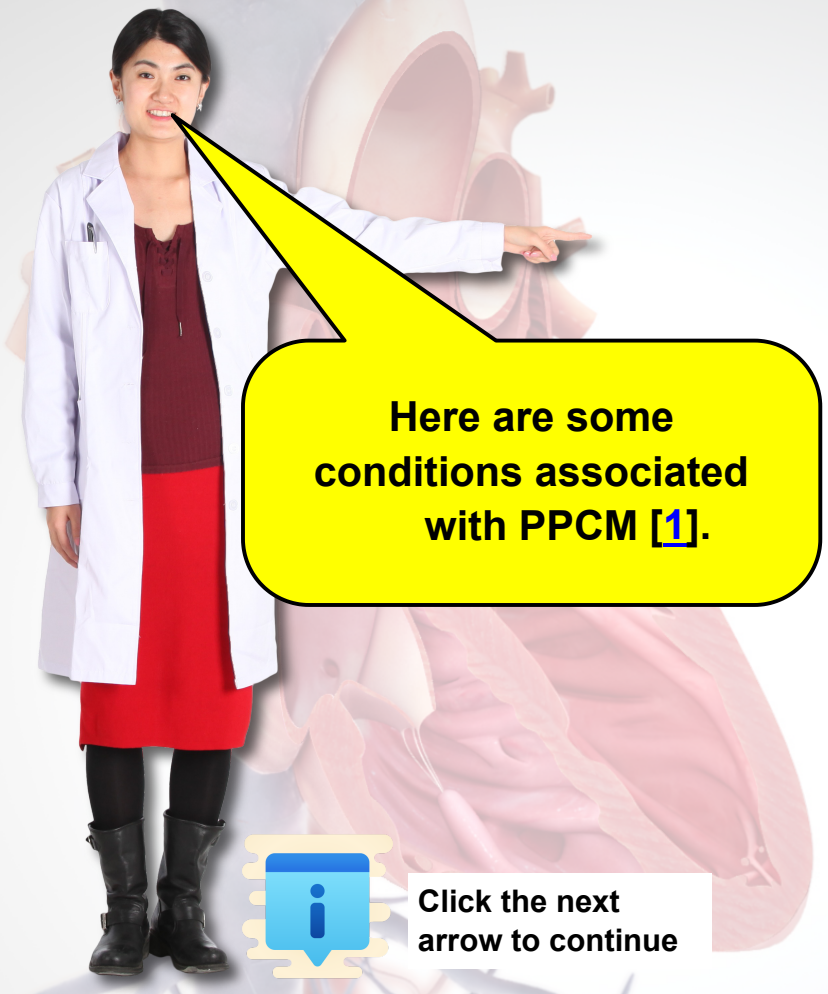
Here are some conditions associated with PPCM [1].

Click the next arrows to read more information.

Conditions Associated with PPCM

**Pregnancy induced hypertension (PIH)**

- Particularly preeclampsia, strongly disposes patients to the development of peripartum cardiomyopathy.
- The incidence associated with hypertensive disorders increases from 5- to 30-fold.
  - Permeability pulmonary edema caused by preeclampsia can mimic cardiogenic edema caused by heart failure from peripartum cardiomyopathy.
  - Distinguishing the 2 is imperative to her outcome.




Conditions Associated with PPCM

**Multifetal pregnancy increases her risk:**

- 9% of cases of peripartum cardiomyopathy were in women with a multifetal pregnancy.

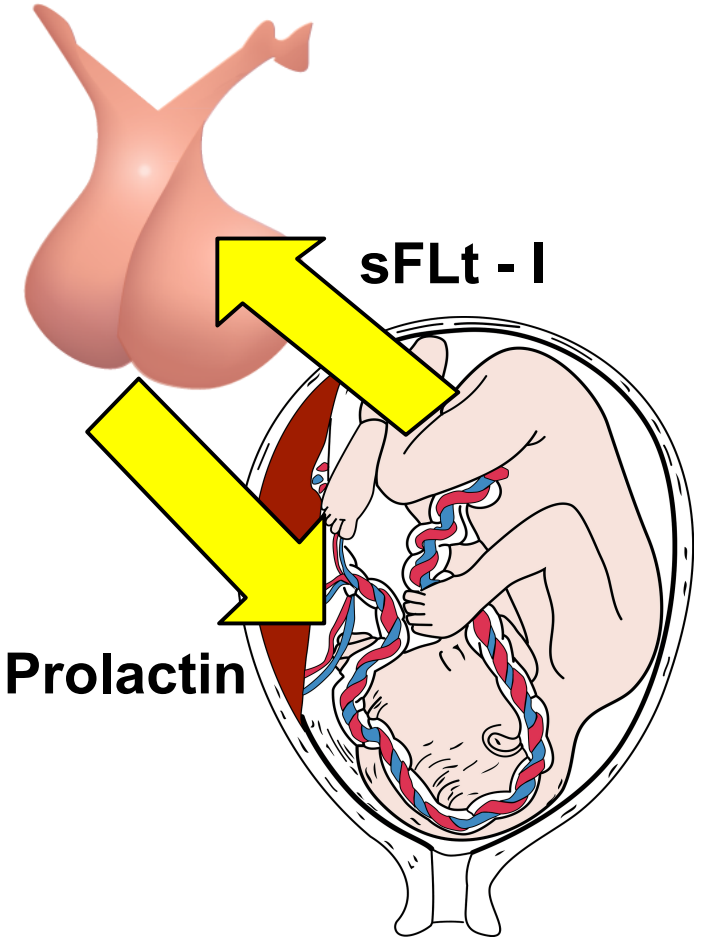
**Common with peripartum cardiomyopathy are common obstetric comorbidities:**

- Obesity
- Anemia
- Infection

**“Two hit Hypothesis”**
**Peripartum cardiomyopathy affects genetically susceptible women who carry one of the following gene mutations [1]:**

- **TTNC1**
- **TTN**
- **STAT3**

**Click the picture to read more information.**



**"Two hit Hypothesis" Peripartum cardiomyopathy affects genetically susceptible women who carry one of the following gene mutations [1]:**

- **TTNC1**
- **TTN**
- **STAT3**

**Click the picture to read more information.**

Term pregnancy is also characterized by prodigious secretions of prolactin by the maternal pituitary and at the same time the placenta secretes high levels of the antiangiogenic molecule, sFLt-I:

- There is a fragment of the prolactin molecule that is hypothesized to trigger events of vasoinhibin-acts which is thought to cause myocardial damage with ventricular dysfunction.
- This is made worse by secretions of high levels of vascular endothelial growth factor inhibitory molecule, sFLt-1 which is superabundant in women with preeclampsia, multifetal pregnancy, or both.
- So altered prolactin processing is believed to be involved in the pathogenesis of PPCM.

**Angiogenic Imbalance** [56]:

- PPCM may be caused by systemic angiogenic imbalance which may explain why preeclampsia and multiple gestations are risk factors for PPCM.
- Angiogenic imbalances damage the vasculature leading to PPCM issues.

**Prolactin** [57]:

- Altered prolactin processing is believed to be involved in the pathogenesis of PPCM.
- Alterations in prolactin processing may contribute to angiogenic imbalances.

« 2 of 6 »



Click the next arrows to read more information.

**Myocarditis** [58]:

- Viral genomes have been noted in research where the endomyocardium was biopsied.
- However, myocarditis is not always present with PPCM.

**Abnormal Immune Response** [59]:

- The maternal immunologic response to a fetal antigen has been suggested as an etiology leading to PPCM.
- If these cells lodge in the cardiac tissue, they can trigger an autoimmune response.

« 4 of 6 »



Click the next arrows to read more information.

**Genetic Predisposition:**

- Several studies support the hypothesis that PPCM may develop as a result of interaction between pregnancy-related factors, such as late pregnancy oxidative stress, and a susceptible genetic background.
- African genomic ancestry may be a rick factor for the development of PPCM and explain the high prevalence of PPCM in Haitian, African, and black women in the U.S.

**Hemodynamic Factors:**

- As discussed, in pregnancy there is a 40 to 50% increase in blood volume and cardiac output resulting in left ventricular remodeling and hypertrophy. It is possible this remodeling is an exaggerated response with a decrease in left ventricular systolic function in women who develop PPCM.
- The hemodynamic stress of gestational hypertension may contribute to the development of heart failure with gestational hypertension being more common in women with PPCM.

**Next I will share with you some pearls of knowledge for providers on cardiomyopathy in pregnancy.**

# Pearls for Providers

The highest risk period for a preexisting cardiac condition to manifest is generally in the late 2nd trimester — 24-28 weeks — or in the postpartum period [4].



Click the next arrows to read more information.

# Pearls for Providers

The first presentation of cardiovascular disease may occur during pregnancy or in the early postpartum time frame [4].



Click the next arrows to read more information.

# Pearls for Providers

Cardiovascular risk assessment needs to occur in all pregnant women, with or without symptoms [4].



Click the next arrows to read more information.

# Pearls for Providers

Pregnant or postpartum women presenting with symptoms of shortness of breath, cough, or excessive fatigue should be evaluated in the context of risk factors, vital sign abnormalities, and abnormal physical examination findings [4].



Click the next arrows to read more information.

# Pearls for Providers

A symptom of heart failure may present as persistent respiratory symptoms and ‘new-onset’ asthma [4].



Click the next arrows to read more information.

# Pearls for Providers

When an chest x-ray shows bilateral infiltrates, this may be due to heart failure rather than pneumonia, correlate these findings clinically [4].



Click the next arrows to read more information.

# Pearls for Providers

Counsel women currently pregnant or postpartum with significant cardiovascular risk factors regarding their future cardiovascular risk [4].

Involving the woman's primary care provider (PCP) early is crucial to ensure a smooth transition postpartum [4].



Click the next arrows to read more information.

# Pearls for Providers

Emphasizing awareness of risk factors, sign and symptoms of cardiac disease, and compliance with follow-up are key patient education points [4].



Click the next arrows to read more information.

# Pearls for Providers

Optimally, when a woman has known CVD, she should receive preconception and interconception care by perinatology and cardiology with a high risk pregnancy in a center with access to cardiovascular care [4].



Click the next arrows to read more information.

# Pearls for Providers

Education for the patient and the provider is essential [4].



Click the next arrows to read more information.

# Pearls for Providers

Tailoring contraception choices is a must for the type of CVD present [4].



Click the next arrows to read more information.

# Pearls for Providers

Key elements to a successful outcome includes [4]:

- High index of suspicion
- Early diagnosis
- Appropriate referrals
- Follow up



Click the next arrows to read more information.

# Pearls for Providers

When Red Flags are present then immediate evaluation and/or hospitalization [4]:

- Shortness of breath at rest
- Severe orthopnea ≥4 pillows
- Resting HR ≥120bpm
- Resting systolic BP ≥160mmHg
- Resting respiratory rate ≥30
- Oxygen saturation ≤94% with or without personal history of CVD

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# Algorithm 1 – Red Flags Not Present, Move on to Next Algorithm


**Red Flags**

- Shortness of breath at rest
- Severe orthopnea ≥ 4 pillows
- Resting HR ≥120 bpm
- Resting systolic BP ≥160 mm Hg
- Resting RR ≥30
- Oxygen saturations ≤94% with or without personal history of CVD

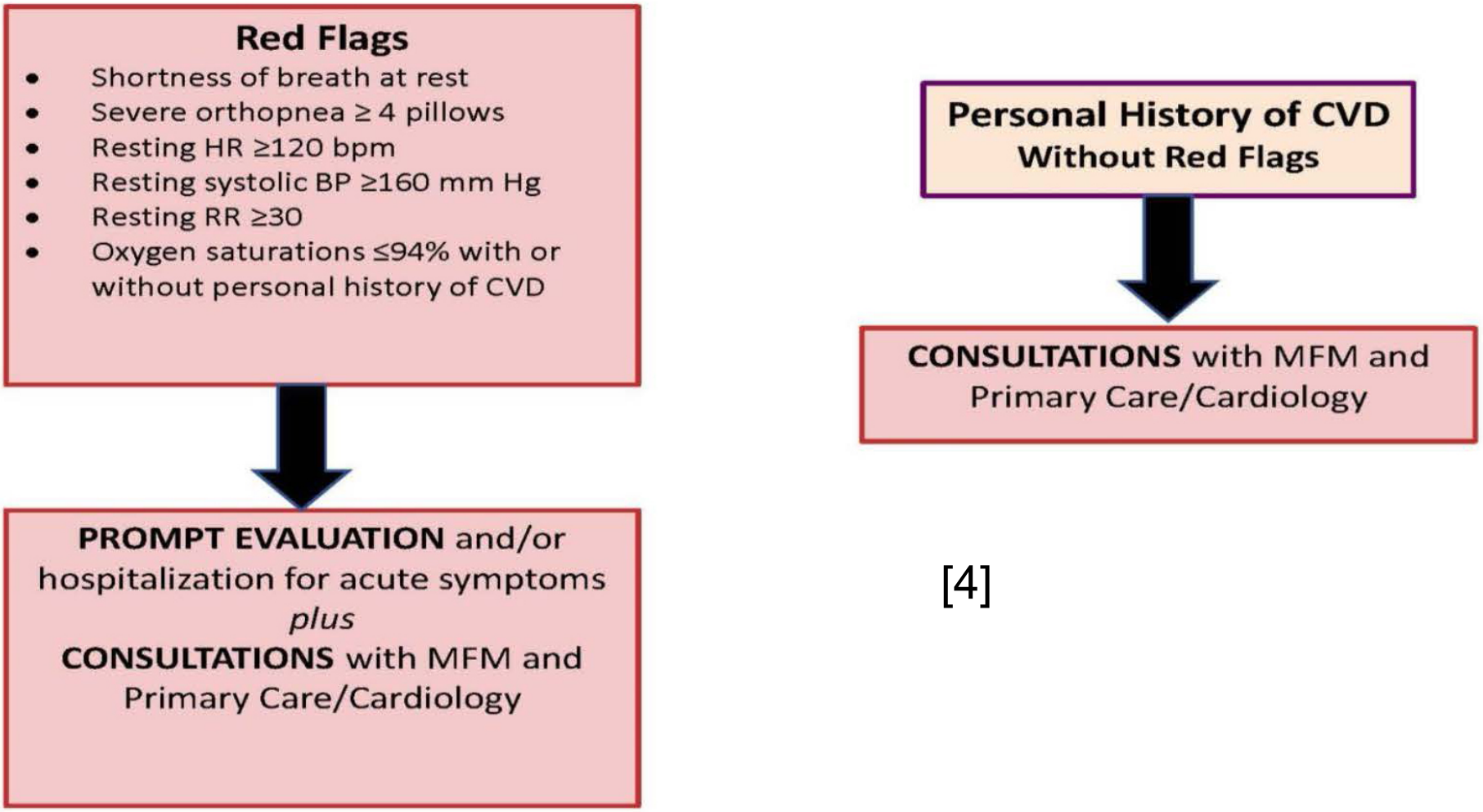
**PROMPT EVALUATION** and/or hospitalization for acute symptoms
*plus*
**CONSULTATIONS** with MFM and Primary Care/Cardiology

**Personal History of CVD Without Red Flags**

**CONSULTATIONS** with MFM and Primary Care/Cardiology

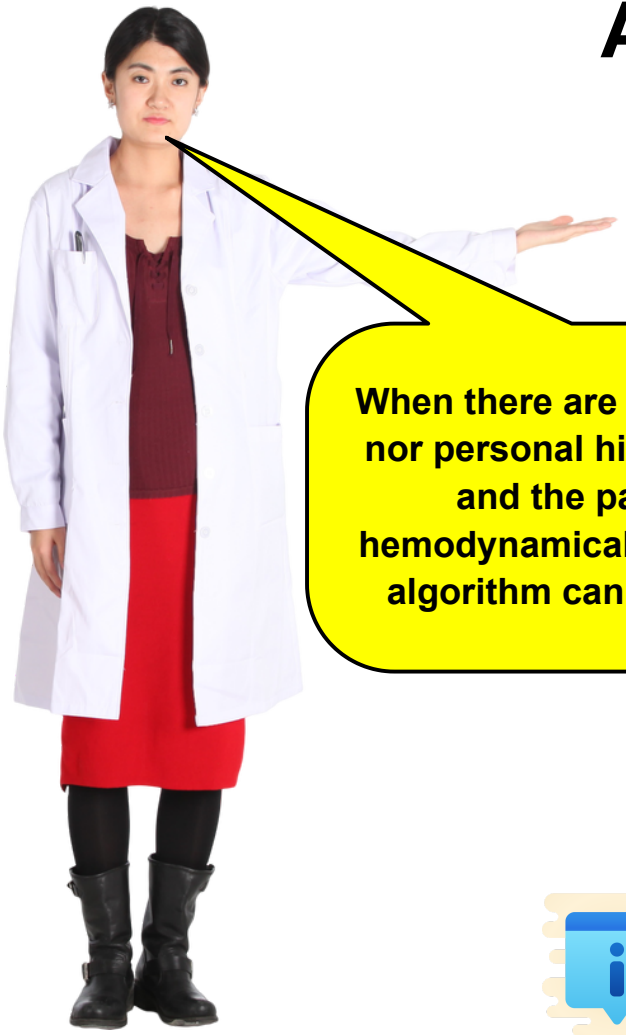
Click the picture for a larger view

**Algorithm 1 – Red flags not present, move on to next algorithm.**

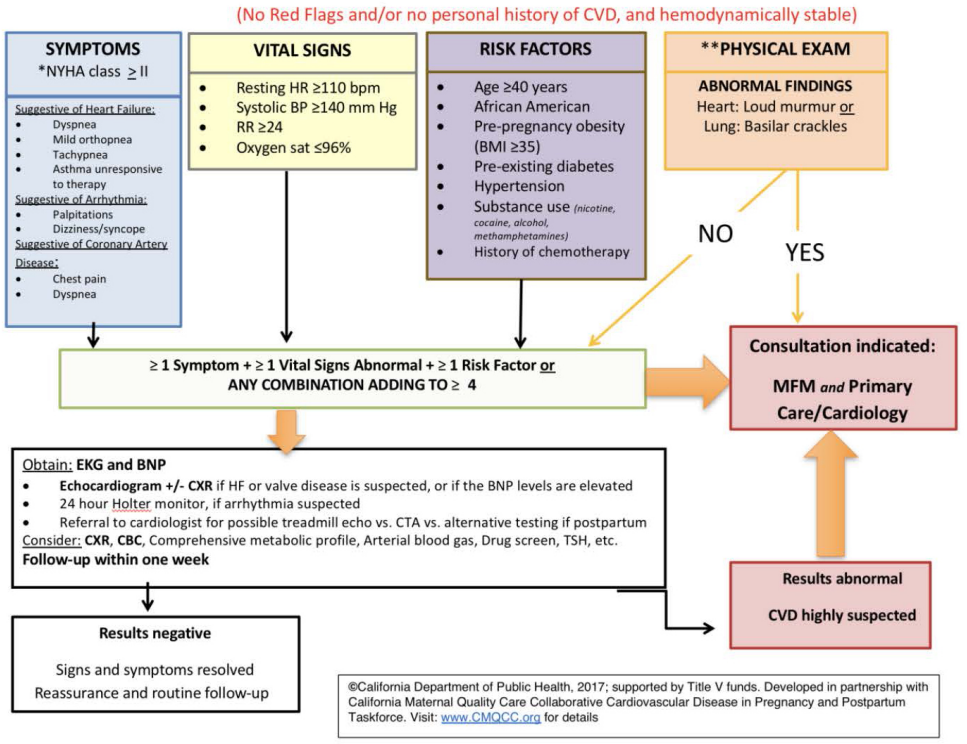

Red Flags
Shortness of breath at rest
Severe orthopnea ≥ 4 pillows
Resting HR ≥120 bpm
Resting systolic BP ≥160 mm Hg
Resting RR ≥30
Oxygen saturations ≤94% with or without personal history of CVD
PROMPT EVALUATION and/or hospitalization for acute symptoms
plus
CONSULTATIONS with MFM and Primary Care/Cardiology
Personal History of CVD
Without Red Flags
CONSULTATIONS with MFM and Primary Care/Cardiology

[4]

# Algorithm 2 Assessment



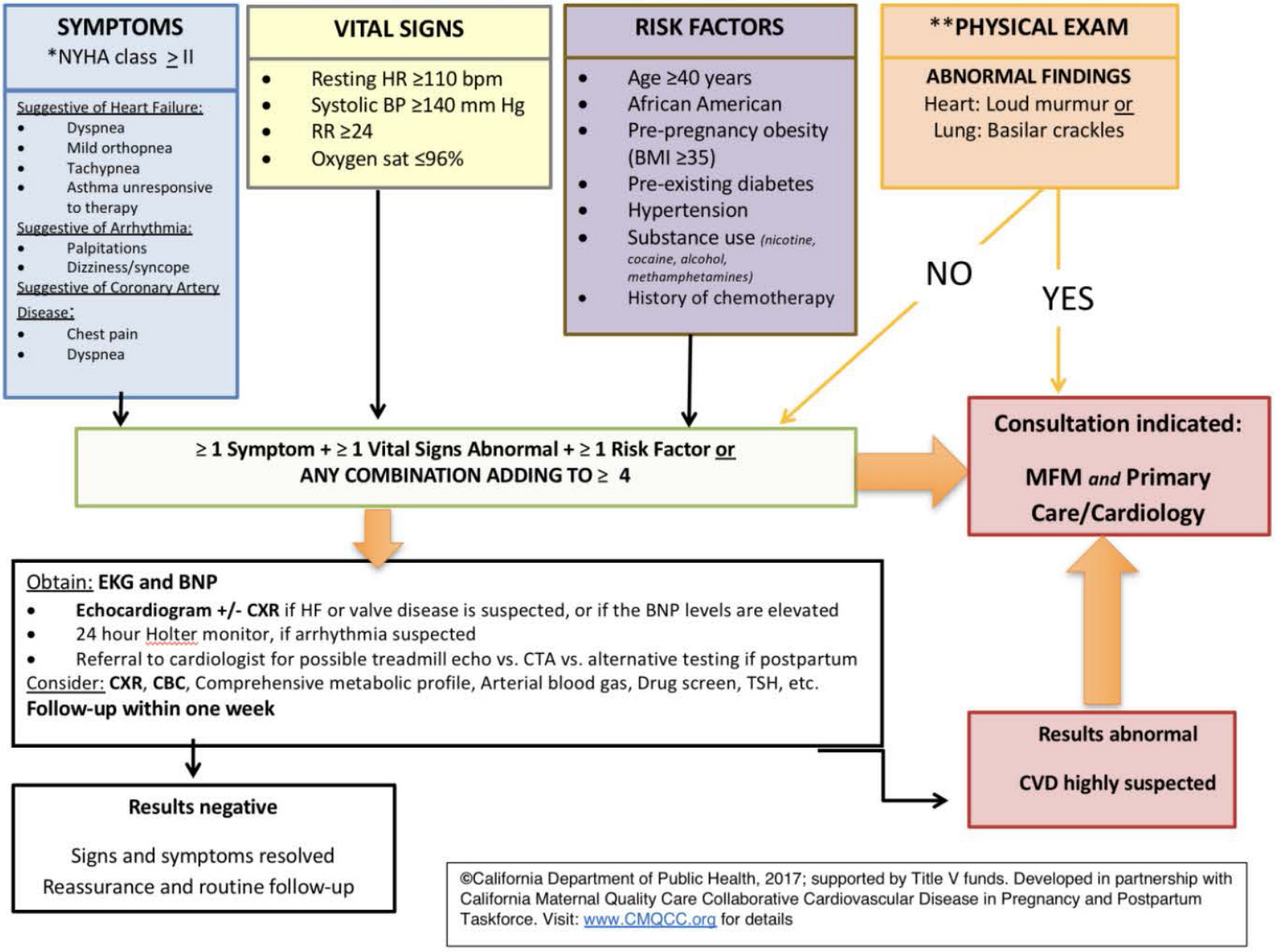
When there are no Red Flags nor personal history of CVD and the patient is hemodynamically stable this algorithm can be utilized:




Click the picture for a larger view

Algorithm 2 Assessment

(No Red Flags and/or no personal history of CVD, and hemodynamically stable)



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**B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].**

1 of 9

**Click the next arrows to read more information.**

BNP is a B-type Natriuretic Peptide:

- BNP can also be utilized to triage patients presenting with symptoms in need of further diagnostic test [4].

B-type Natriuretic Peptide (BNP) a tool

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**B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].**

2 of 9

Click the next arrows to read more information.

- BNP is a neurohormone secreted predominantly by the cardiac ventricles in response to volume expansion or pressure overload.
- BNP acts as the body's defense against volume overload by virtue of its vasodilatory and renin-angiotensin-aldosterone system inhibitory properties that lead to natriuresis and diuresis.

B-type Natriuretic Peptide (BNP) a tool

**B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].**

« 3 of 9 »

Click the next arrows to read more information.

**BNP Facts** [4,48]:

- Half-life is 20 minutes
- BNP level <100pg/mL is considered normal
- Women tend to have higher levels than men
- Known to be elevated in patients with renal insufficiency or renal failure
- Obesity is associated with lower plasma BNP compared to non-obese
- BNP level under 50pg/mL has a negative predictive value of 96% in excluding heart failure

B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].

« 4 of 9 »

Click the next arrows to read more information.

## Asymptomatic Left Ventricular Dysfunction [4, 49]:

- When a BNP level of 50pg/mL is used as a cutoff, it has been shown to detect asymptomatic left ventricular dysfunction with sensitivity of 88% and specificity of 67%.
- In this situation, BNP may be used as an initial low-cost modality to identify asymptomatic high risk individuals who would need further testing.

B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].

« 5 of 9 »

Click the next arrows to read more information.

**Predictor of Adverse Cardiovascular Outcomes in an Older Population** [50,51]:

- The strongest predictor of serious *adverse* cardiovascular outcomes is a BNP level >50 pg/mL in the elderly.
- BNP level correlates directly with left ventricular hypertrophy and is increased in diastolic left ventricular dysfunction.

B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].

## BNP and Pregnancy:

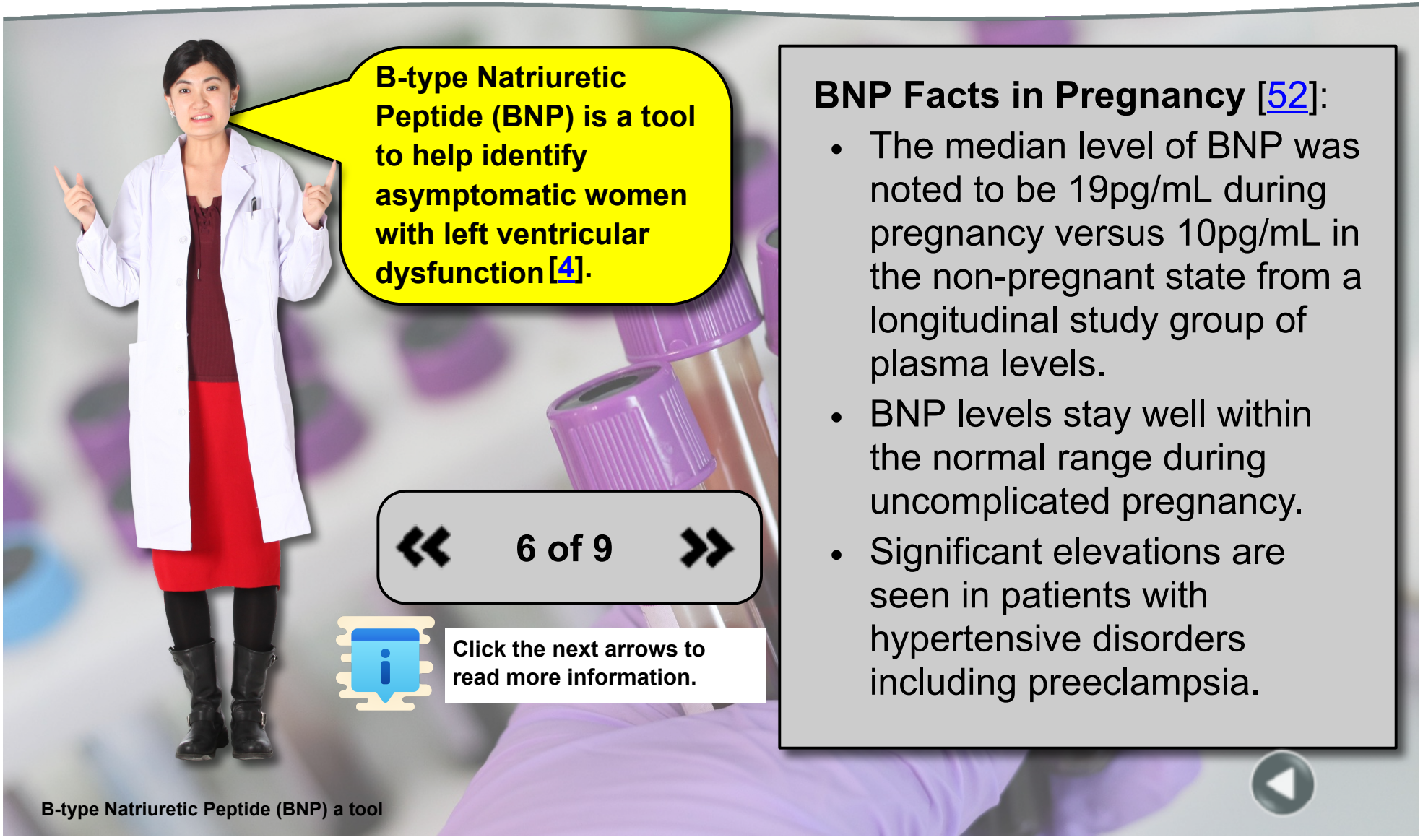
- BNP levels remain stable throughout the pregnancy and postpartum period, despite an increase in left ventricular wall mass and end-diastolic dimensions during normal pregnancy [52].

Click here for more information on BNP and pregnancy.

6 of 9

Click the next arrows to read more information.

B-type Natriuretic Peptide (BNP) a tool




**BNP Facts in Pregnancy** [52]:

- The median level of BNP was noted to be 19pg/mL during pregnancy versus 10pg/mL in the non-pregnant state from a longitudinal study group of plasma levels.
- BNP levels stay well within the normal range during uncomplicated pregnancy.
- Significant elevations are seen in patients with hypertensive disorders including preeclampsia.

**B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].**

## Preexisting Heart Disease:

- Serial measurements of N-terminal pro-BNP (NT-proBNP) are shown to be predictive of adverse cardiovascular outcomes in women with *preexisting* dilated cardiomyopathy [29].
- Another study, with 66 women having cardiac symptoms, all remained event-free during pregnancy and had BNP < 100 pg/mL [53].



Click the next arrows to read more information.

B-type Natriuretic Peptide (BNP) a tool

B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].

« 8 of 9 »

Click the next arrows to read more information.

**Pregnant Women with Symptoms** [54]:

- BNP plays an important role for pregnant women presenting with cardiac symptoms such as shortness of breath:
  - BNP levels correlate with elevated left ventricular filling pressures in symptomatic pregnant women.
  - Helping to determine both systolic and diastolic left ventricular dysfunction.

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B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].

9 of 9

**In Summary** [4]:

- BNP may assist clinicians in triaging patients who present with symptoms for further diagnostic testing:
  - Simple test
  - Relatively inexpensive
  - Readily available

Click here for more information

Click the next arrow to continue

B-type Natriuretic Peptide (BNP) a tool

B-type Natriuretic Peptide (BNP) is a tool to help identify asymptomatic women with left ventricular dysfunction [4].

9 of 9

## Summary Continued

- Many pregnant women have some degree of fatigue, shortness of breath, palpitations, and/or edema during pregnancy. BNP added to routine evaluation in cases with symptoms out of proportion to pregnancy will be a useful tool in triaging.
- Certainly, the women presenting with symptoms suggestive of cardiac disease, evaluating the BNP may reduce potential morbidity.

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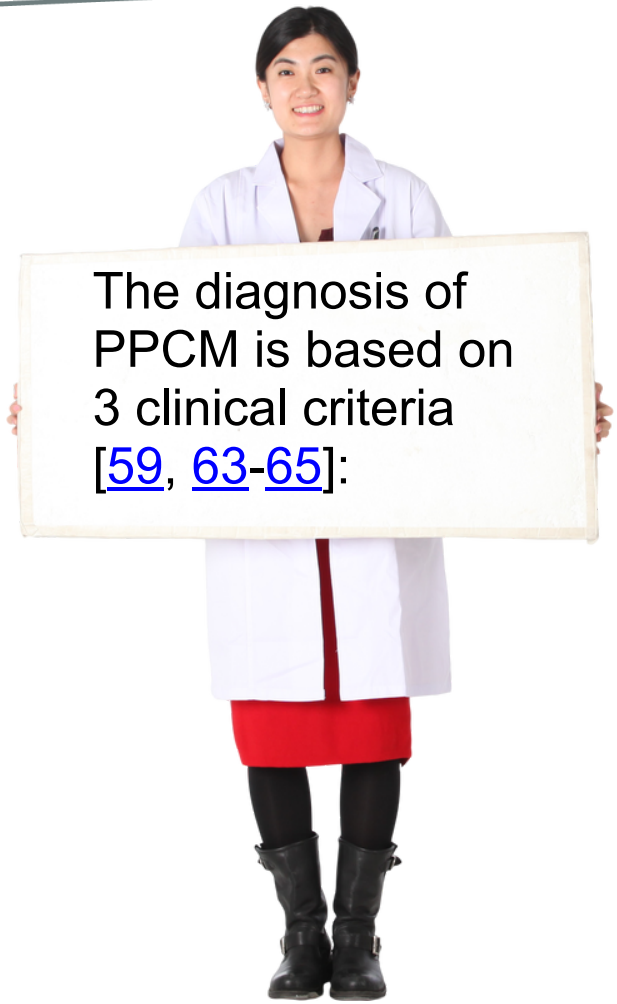
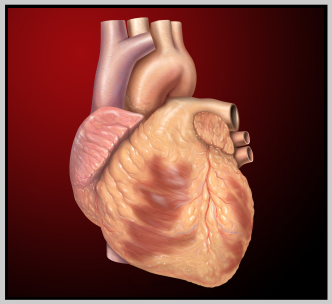



1. Development of heart failure toward the end of pregnancy or in the months following delivery.
2. Absence of another identifiable cause of heart failure.
3. Left ventricular systolic dysfunction with a left ventricular ejection fraction generally <45%.

Directing investigations to a timely diagnosis and treatment is necessary.

# Studies

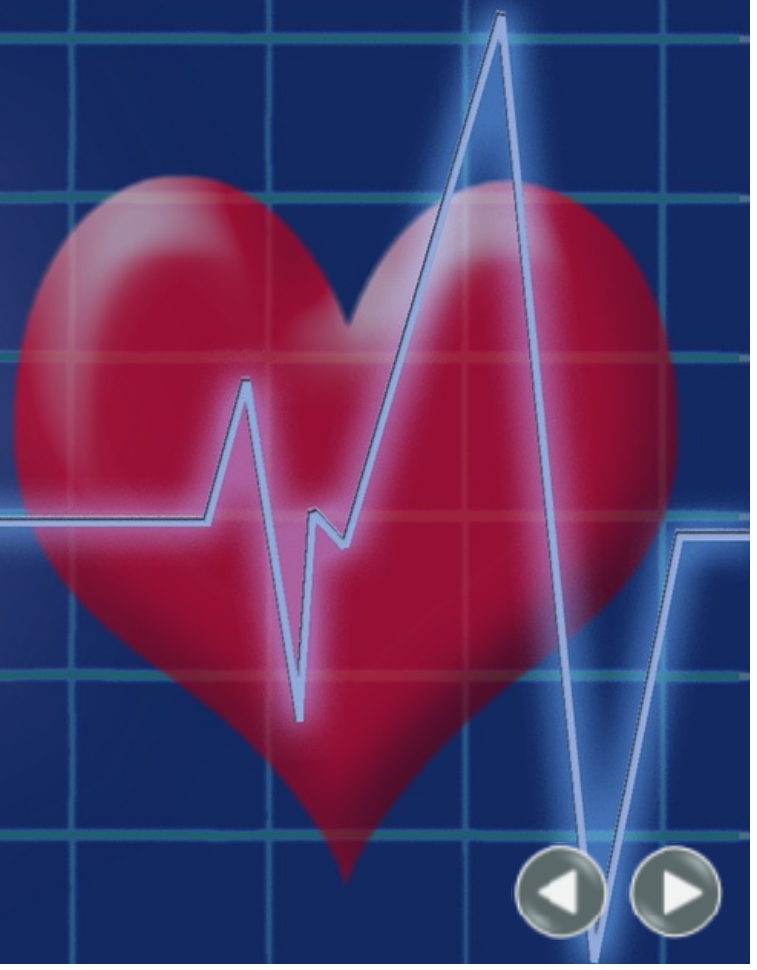
- There are no pathognomonic findings in PPCM and is a diagnosis of exclusion.
- A variable portion of patients have evidence of myocarditis.
- Ordering an electrocardiogram (ECG) and echocardiogram are prudent actions in those suspected of having PPCM.
  - A normal ECG does not rule out PPCM [66].
  - An ECG may be helpful in differentiating between other diagnosis such as a myocardial infarction (MI) or pulmonary embolism (PE).
  - An echocardiogram generally reveals global reduction in left ventricular function with LVEF nearly always <45%; the left ventricle is frequently dilated, but not always.

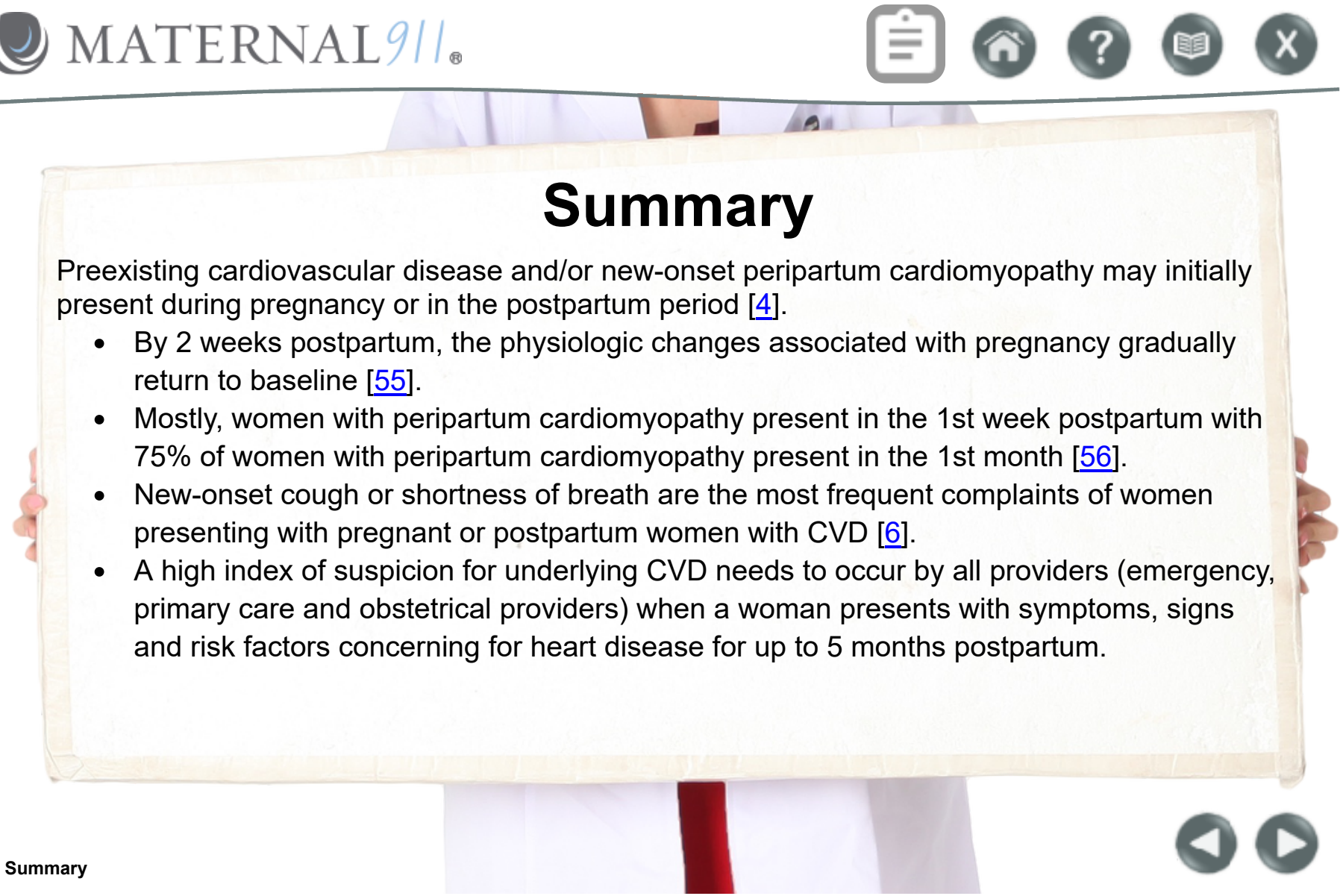


Click the heart for more information.

# Studies

- BNP, chest X-ray (with fetal shielding when pregnant), cardiac magnetic resonance (CMR), cardiac catheterization and even endomyocardial biopsy (EMB) may be helpful in certain cases.
  - BNP can help evaluate patients suspected of having heart failure when the diagnosis is uncertain with higher levels noted then their healthy female counterparts [67].





# Summary

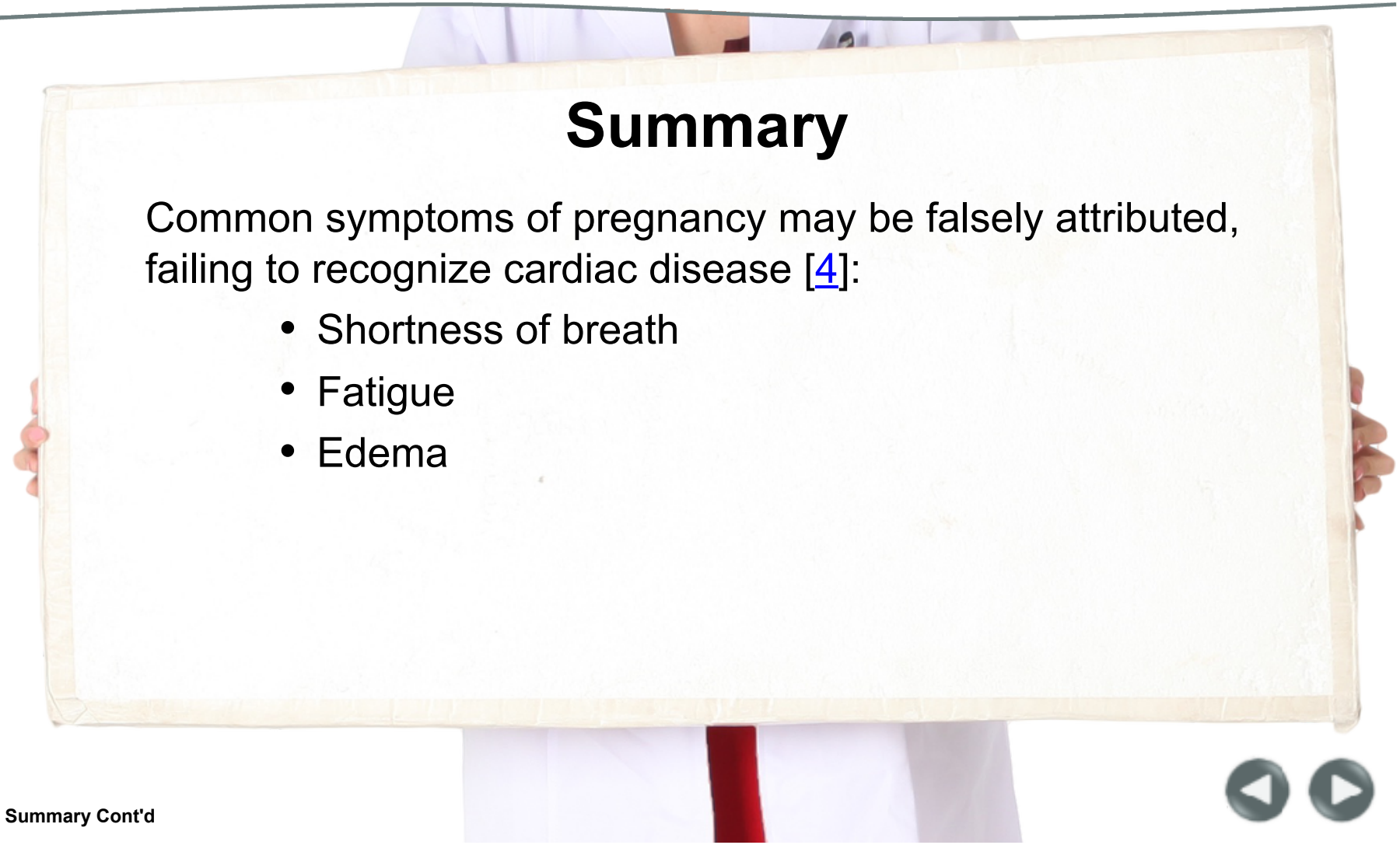
Preexisting cardiovascular disease and/or new-onset peripartum cardiomyopathy may initially present during pregnancy or in the postpartum period [4].

- By 2 weeks postpartum, the physiologic changes associated with pregnancy gradually return to baseline [55].
- Mostly, women with peripartum cardiomyopathy present in the 1st week postpartum with 75% of women with peripartum cardiomyopathy present in the 1st month [56].
- New-onset cough or shortness of breath are the most frequent complaints of women presenting with pregnant or postpartum women with CVD [6].
- A high index of suspicion for underlying CVD needs to occur by all providers (emergency, primary care and obstetrical providers) when a woman presents with symptoms, signs and risk factors concerning for heart disease for up to 5 months postpartum.

# Summary

Be certain to ask the following questions when a woman presents in the postpartum period with complaints of shortness of breath [4]:

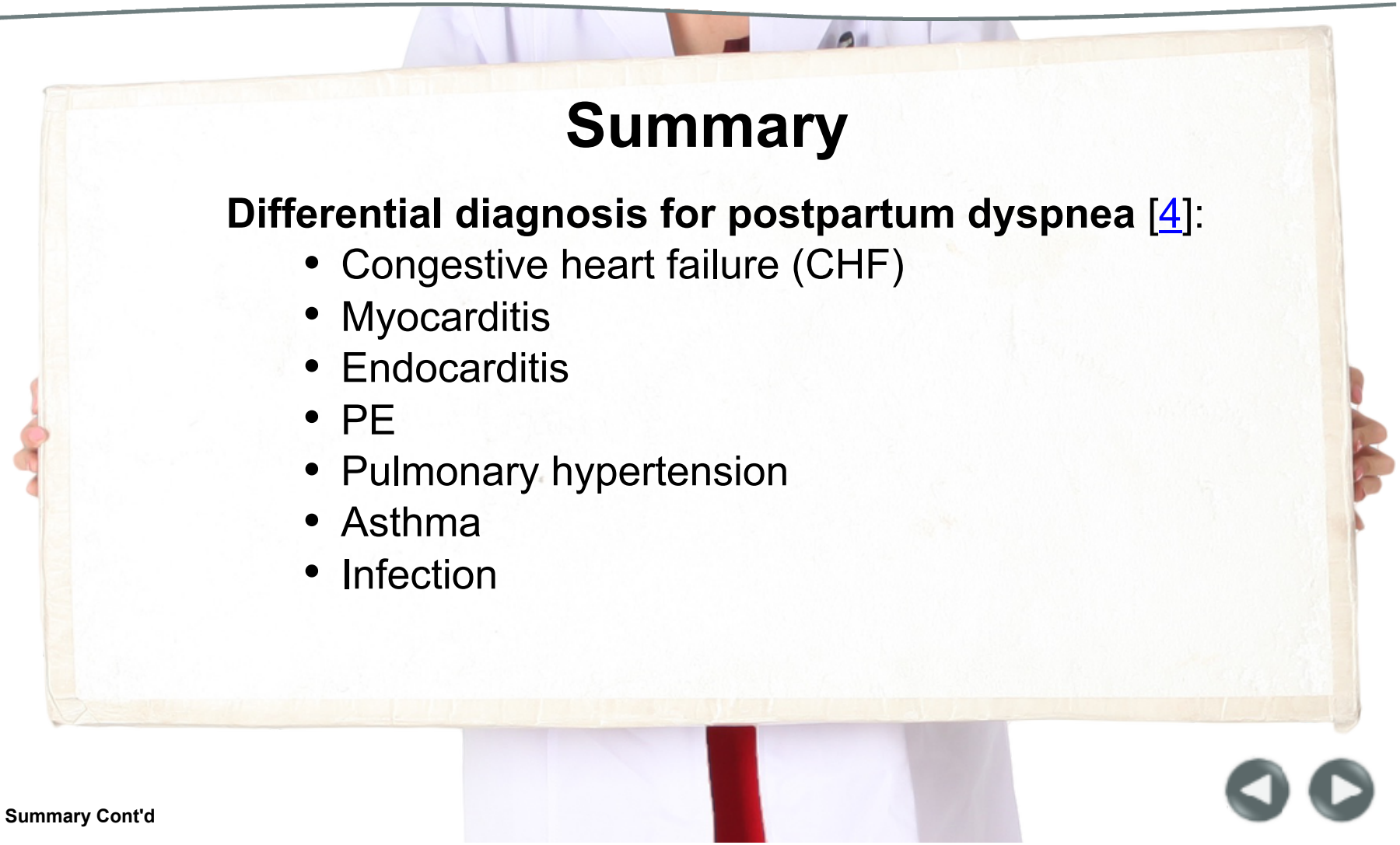
- Intolerance of exercise
- Activities of daily living are difficult to complete
- Deteriorating symptoms
- Dizziness
- Palpitations
- Chest pain
- New-onset cough
- Wheezing
- Lower extremity edema or pedal edema
- Fatigue that is not expected (i.e. frequent stops while out walking)
- Orthopnea (if present, ask how many pillows are used)
- Weight gain or inability to lose weight
- History of cardiac or pulmonary conditions
- History of tobacco and/or substance abuse
- Has received care by other providers or Emergency Departments (ED) during the postpartum period



# Summary

Common symptoms of pregnancy may be falsely attributed, failing to recognize cardiac disease [4]:

- Shortness of breath
- Fatigue
- Edema



# Summary

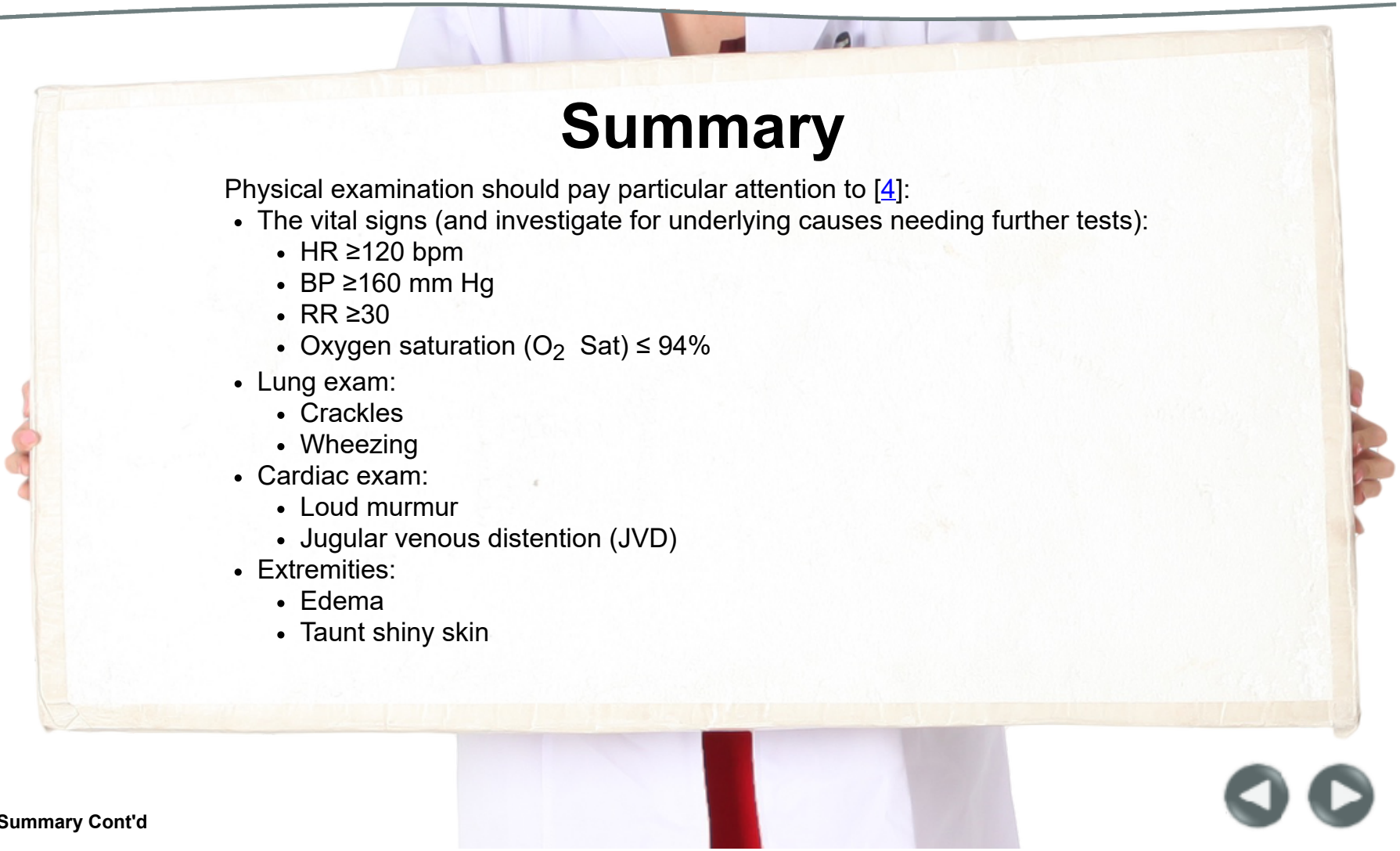
**Differential diagnosis for postpartum dyspnea** [4]:

- Congestive heart failure (CHF)
- Myocarditis
- Endocarditis
- PE
- Pulmonary hypertension
- Asthma
- Infection

# Summary

Key Points [4]:

- The postpartum period should provide improving symptoms related to physiologic changes of pregnancy.
- ED visits for dyspnea need to raise suspicion for CVD.
    - The women with these symptoms, of child bearing age, should be questioned about recent pregnancies and when her last menstrual period (LMP) occurred.
- Concerns for CVD should be raised when postpartum dyspnea or new-onset cough is present.



# Summary

Physical examination should pay particular attention to [4]:

- The vital signs (and investigate for underlying causes needing further tests):
  - HR ≥120 bpm
  - BP ≥160 mm Hg
  - RR ≥30
  - Oxygen saturation ($O_2$ Sat) ≤ 94%
- Lung exam:
  - Crackles
  - Wheezing
- Cardiac exam:
  - Loud murmur
  - Jugular venous distention (JVD)
- Extremities:
  - Edema
  - Taunt shiny skin

# Summary

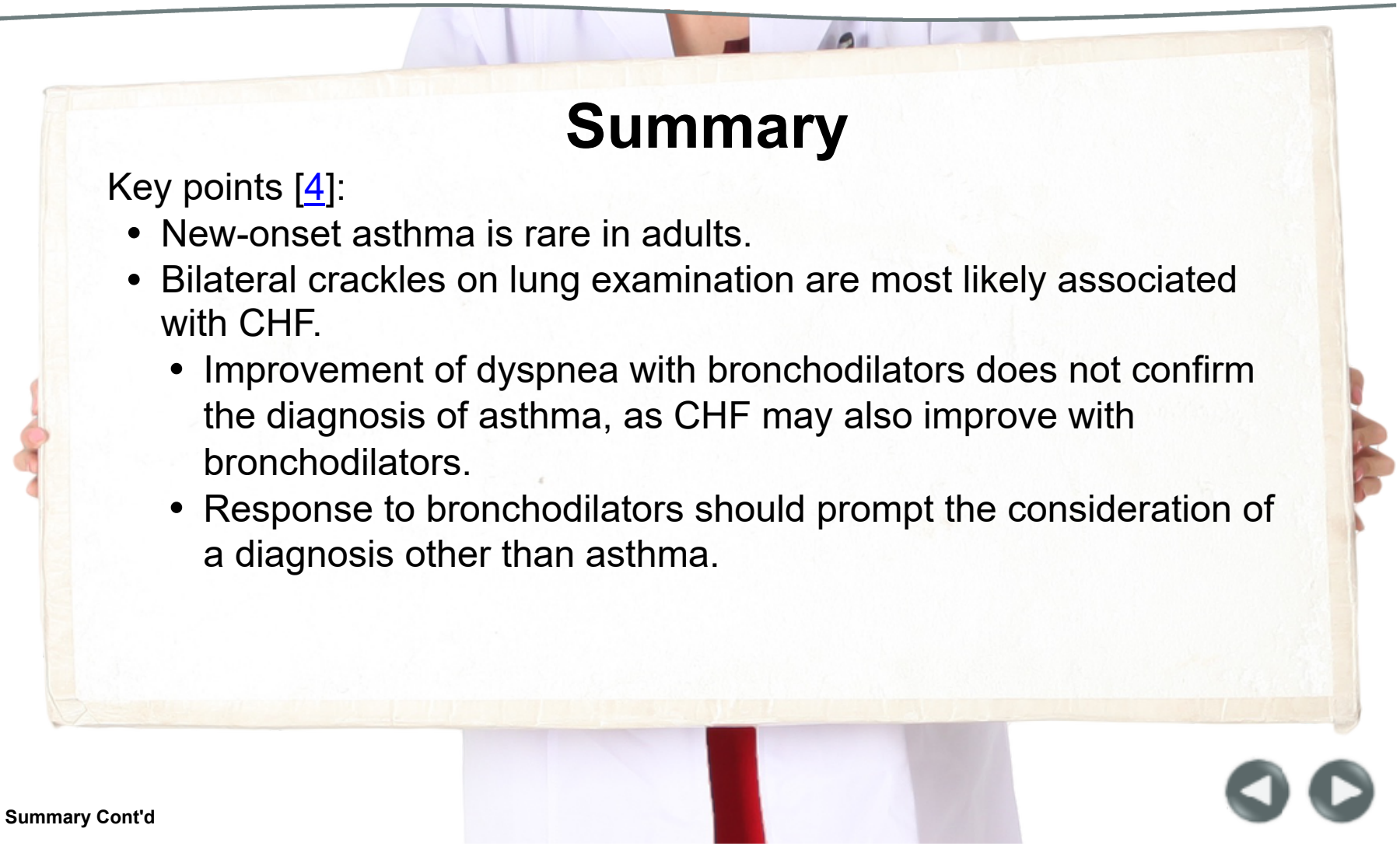
Workup considerations for postpartum dyspnea [4]:

- Chest Radiograph
  - Frequently normal in asthma
- EKG
  - May be normal in cardiomyopathy, except for sinus tachycardia
  - Should be obtained on an emergency basis if the patient has abnormal vital signs or is very symptomatic
    - Normal LV ejection fraction does not exclude heart failure
    - Normal RV function does not exclude pulmonary embolism

# Summary

Workup considerations for postpartum dyspnea [4]:

- Labs
  - CBC
  - Basic Metabolic Panel (BMP)
  - Thyroid Function Test
  - BNP  - An elevated BNP should raise suspicion for CHF
  - D-dimer - May normally be elevated in pregnancy, however, may be considered for negative predictive value
  - Toxicology screen - Substance use (e.g., meth or cocaine) is a strong risk factor for pregnancy-related CVD
- Venous doppler ultrasound and/or computed tomography (CT) pulmonary angiogram for PE
- Cardiology consultation as needed



# Summary

Key points [4]:

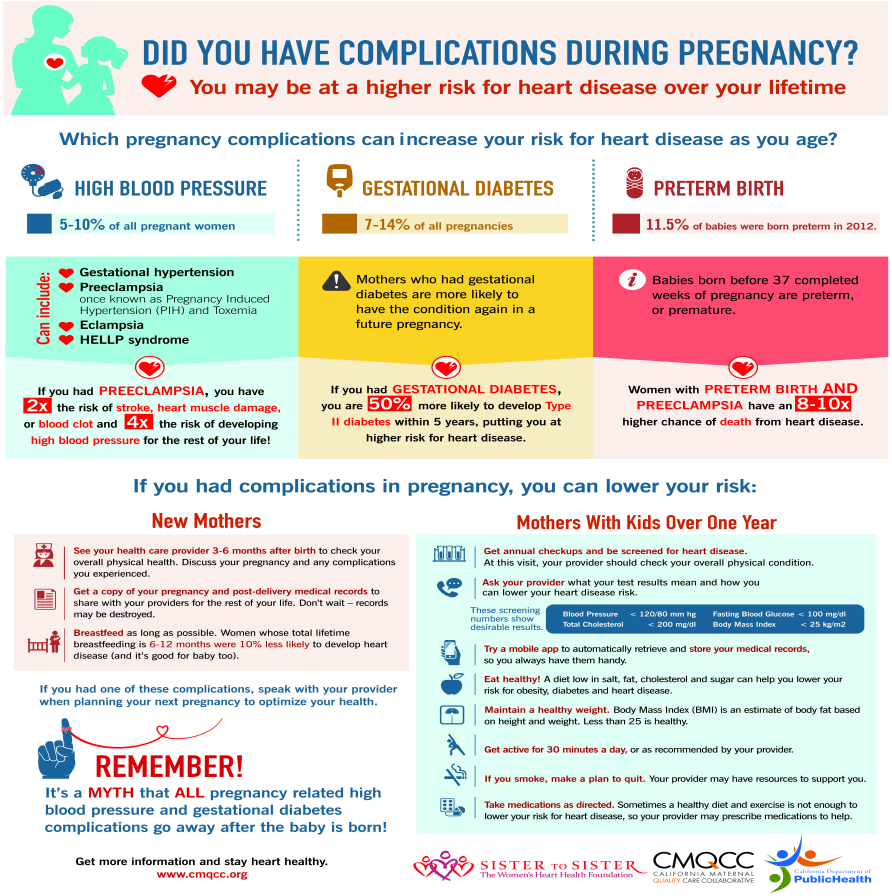
- New-onset asthma is rare in adults.
- Bilateral crackles on lung examination are most likely associated with CHF.
  - Improvement of dyspnea with bronchodilators does not confirm the diagnosis of asthma, as CHF may also improve with bronchodilators.
  - Response to bronchodilators should prompt the consideration of a diagnosis other than asthma.

# Summary

**Disposition:**

- If considering discharge:
  - Repeat vital signs to ensure they are persistently normal, the symptoms have improved, and the patient is stable for discharge.
  - Arrange for early follow-up with PCP or cardiologist as indicated.
- Admission and cardiology consultation may be indicated for:
  - Persistent symptoms or abnormal vital signs, in particular, HR >120 bpm, BP >160 mmHg, RR >30, and $O_2$ Sat <94%.
  - Lack of response to treatment.
  - Newly-diagnosed cardiomyopathy or pulmonary hypertension.

**Click the picture to download this infographic**




**Pregnancy Complications Infographic**

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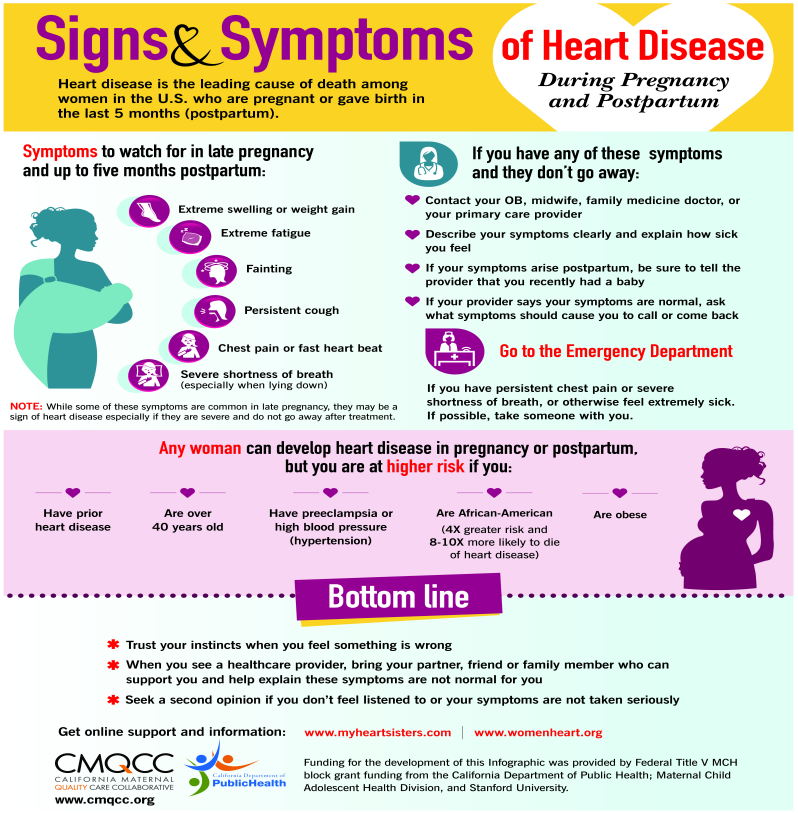

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