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Original Article

The Impact of Pregnancy on the Evaluation of Chest Pain and Shortness of Breath in the Emergency Department

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Background: Pregnant patients are at an increased risk for severe morbidity and mortality when compared to the general population. Imaging studies have become an integral part of the work-up for patients who present to the emergency department. However, lack of clear guideline has led to confusion regarding the appropriate indications and protocols for examining pregnant patients.
Objective: To investigate the comparative rates of imaging studies between pregnant and non-pregnant female patients who presented for emergent evaluation of chest pain and shortness of breath.
Study Design: All reproductive age females presenting to the emergency department at an academic teaching institution with a chief complaint of "chest pain" or "shortness of breath" from 2010 to 2015 were identified. Cohorts were divided based on pregnancy status and chief complaint. Utilization rates of imaging studies were compared between cohorts.
Results: Over the study period 4,834 women were included. One hundred and seventy-four were pregnant. Pregnant patients with "chest pain" or "shortness of breath" were significantly more likely to undergo a venous duplex, but less likely to undergo a chest X-ray as compared to non-pregnant patients. There was no difference in the rates of chest computed tomography (CT) imaging or magnetic resonance imaging (MRI) based on pregnancy status in our data set.
Conclusion: Imaging studies are an integral adjunct for evaluation in patients reporting "chest pain" and "shortness of breath." Pregnancy places patients at an increased risk of severe sequelae requiring prompt diagnosis to prevent harm to the mother and fetus. American College of Obstetrics and Gynecology (ACOG) Committee Opinion 656 clearly states that, with few exceptions, radiography should not be withheld from pregnant patients. This study suggests that pregnant patients are significantly less likely to undergo radiography, which could place them at increased risk for delayed diagnosis and treatment.

Key words: *pregnancy, radiology, dyspnea, angina*

Introduction

Pregnancy predisposes women to anatomic and physiologic changes that result in an increase in the incidence of conditions that may be life threatening to patients in this subpopulation.[1] Causes of chest pain or shortness of breath (SOB) in pregnant patients can often be attributed to anatomic and physiologic changes. SOB is common during pregnancy and occurs in 60% to 70% of healthy pregnant women.[2,3] Nevertheless, such complaints require investigation to rule out pathologic processes that may jeopardize maternal and fetal health. The

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differential diagnoses for SOB and chest pain in pregnant women vary. They include asthma, valvular heart disease, pulmonary edema, peripartum cardiomyopathy, aortic dissection, musculoskeletal issues, gastrointestinal reflux disease (GERD) and acute coronary syndrome. Moreover, life threatening conditions such as pneumomediastinum, pneumothorax, pneumonia and pulmonary embolism require prompt diagnosis and management to save both mother and fetus.[4-11]

Over the past two decades, there has been an increase in the use of radiologic examinations in pregnant women.[6-8] High radiation doses in pregnancy can result in growth restriction, microcephaly and potential fetal loss. Within the medical community, however, there are demonstrated gaps in the knowledge of providers regarding radiation in the pregnant population.[9,10]

In 2016, the American College of Obstetrics and Gynecology (ACOG) released a committee opinion centered on recommendations and guidelines for diagnostic imaging during pregnancy. Diagnostic imaging should be performed during pregnancy with an understanding of the maternal and fetal risks as well as benefits. These modalities should not be withheld where indicated or necessary. Ultrasonography and magnetic resonance imaging (MRI) are not associated with radiation risk. As such, they are the imaging techniques of choice for the pregnant patient but should be used prudently and only when use is expected to answer a clinical question or has medical benefit. This committee opinion, among other studies, has shown that the risk from radiation depends on the dose and gestational age.[1,12-16] Moreover, the radiation dose from a single diagnostic imaging is highly unlikely to exceed the estimated threshold dose of 100 mGy for the induction of malformations and carcinogenesis.[1,6-8,16,17] As a result, ACOG does note that radiation exposure through radiography, computed tomography (CT) scan, or nuclear medicine imaging is at a dose lower than the exposure associated with fetal harm.[17] Based on this, ACOG states withholding imaging studies due only to pregnancy status is not indicated.

Misconceptions about maternal and fetal risk of radiation exposure have led to the conservative use of these imaging modalities despite ACOG recommendations. In an attempt to evaluate and investigate complaints related to chest pain or SOB in pregnant patients, imaging may be necessary to develop an accurate diagnosis. There remains a lack of clear emergency department guidelines regarding the use of radiologic imaging studies in the pregnant population. This drives many clinicians to proceed cautiously and limit the use of imaging modalities that could prove beneficial in the diagnosis and timely management of life threatening conditions in pregnant women. Furthermore, pregnant patients often question the potential effects of the radiation exposure and may perceive the teratogenic risk of the test as high.[9,18-22]

Our objective in this article is to investigate the comparative rates of imaging studies between pregnant and non-pregnant female patients who presented for emergent evaluation of "chest pain" and "SOB."

Methods

This retrospective cohort study examined female patients who presented to the emergency department of an academic center with dyspnea or angina. It was approved by the institutional review board of the Pennsylvania State University (Study3466).

In this study data on adult females of reproductive age who presented to the emergency department with a chief complaint identified in the medical record as "chest pain" or "SOB" was collected. Records were collected on emergency room visits from 2010 to 2015. Reproductive age was defined as 18–52. Patients were excluded if there was a previously diagnosed venous thrombosis or if the patients left the emergency department against medical advice prior to completion of the evaluation. Cohorts were defined based on chief complaint and further divided by pregnancy status.

An electronic medical record (FirstNet) associated specifically with the emergency department was utilized for record collection. Chief complaints were placed into this database by the department's intake nurse. Patient tests and imaging studies were identified by extracting the provider orders which are uniformly inserted electronically. The discharge disposition of a patient from the emergency department is likewise tracked by the provider in the medical record. Patient characteristics, evaluation and disposition were abstracted by means of predefined criteria.

Statistical analysis was performed using SAS 9.4. For measuring binary outcomes logistic regression adjusting for age at the visit was utilized for calculating odds ratios. Continuous variables were compared with quantile regression adjusted for age at presentation.

Results

The overall cohort comprised 4,834 patients. Three thousand nine hundred and fifty-four patients presented with angina symptoms and were classified with a chief complaint of "chest pain." Of these 109 were pregnant at the time of evaluation. Patients who were not pregnant were significantly older; there was no significant difference in race or insurance status (Table 1).

Examination of demographic data for patients with angina symptoms revealed non-pregnant patients were significantly more likely to be older ($p < 0.001$) and have private insurance ($p = 0.013$). Pregnant patients were more often covered by Medicaid. There was no difference in race between the cohorts. There was no difference noted in the likelihood of patients having a primary care provider ($p = 0.039$).

As part of the analysis all variables were adjusted to account for the difference in age between cohorts. With regards to radiologic imaging there was no significant difference in frequency of CT ($p = 0.813$) or MRI ($p = 0.131$) studies. Pregnant patients had a significantly higher likelihood of having a venous duplex performed as part of their evaluation ($p < 0.001$). Chest radiographs were less likely to be performed if a patient was pregnant ($p < 0.001$). Length of time between ordering and performance of all imaging studies was not influenced by pregnancy status. There was no change in length of evaluation in the emergency department between groups.

Of the 880 patients who presented to the emergency department with dyspnea, coded as "SOB," 65 were pregnant. In a similar finding to the patients with angina non-pregnant patients were significantly older ($p < 0.001$). There was no difference in race, or presence of a primary care provider. Unlike patients presenting with angina, pregnant patients with dyspnea were more likely to have private insurance compared to their non-pregnant counterparts ($p = 0.012$).

After correcting for age, there was no difference in the likelihood of CT imaging between cohorts ($p = 0.222$). The pregnant population underwent more venous duplex imaging ($p = 0.002$). Pregnant dyspneic patients were less to likely to receive chest radiographs as part of their evaluation in the emergency department ($p < 0.001$). There was no difference in length of stay or time between ordering and performance of imaging studies between cohorts.

Discussion

The emergency department is the location for the initial evaluation of patients presenting with simple and complex conditions. Evaluation of pregnant women in this setting elicits some level of hesitancy especially when radiographic imaging is warranted. The objective of our study was to review the comparative rates of imaging studies between pregnant and non-pregnant female patients who presented for emergent evaluation of "chest pain" and "SOB." After review of the literature, this is the first study of its kind. Our retrospective analyses support studies that have highlighted the trepidation associated with radiologic imaging in the pregnant population.

There is a discrepancy in the evaluation of pregnant verses non-pregnant patients in respect to ordering chest X-rays. Pregnant patients who presented with SOB and chest pain were less likely to receive chest X-rays as part of their evaluation in the emergency department. This discrepancy may be due to a series of factors, uncovered by other studies, which point to concerns about radiologic imaging especially during pregnancy. Ntusi et al. report in their study

Table 1. Comparative rates of imaging studies in the emergency department adjusted for age

	Chest pain			Shortness of breath		
	Pregnant (n = 109) n (%)	Non-pregnant (n = 3,845) n (%)	*p* value	Pregnant (n = 65) n (%)	Non-pregnant (n = 815) n (%)	*p* value
Venous duplex	10 (9.2)	59 (1.5)	< 0.001	6 (9.2)	22 (2.7)	0.002
Chest CT	24 (22.0)	906 (23.6)	0.813	19 (29.2)	208 (25.5)	0.222
Chest X-ray	57 (52.3)	3,267 (85.0)	< 0.001	17 (26.2)	627 (76.9)	< 0.001
MRI	2 (1.8)	29 (0.8)	0.131	0 (0.0)	0 (0.0)	—

CT: computed tomography; MRI: magnetic resonance imaging.

that diagnostic X-rays and nuclear procedures emerge as the greatest source of concern, however, most diagnostic radiologic procedures do not expose the pregnant woman to a degree of radiation that would threaten the well-being of the developing pre-embryo, embryo or fetus.[12] The average estimated dose to the fetus from a single chest radiograph is 0.0005–0.0100 mGy.[1,10,12,17] This amount is significantly below the threshold of radiation dose that is deleterious to the fetus. The upper limit of radiation dose that is associated with growth restriction, central nervous system defects, malformations, carcinogenesis and intellectual impairment is 100 mGy. Some may even argue that the threshold dose is as low as 50 mGy.[17,23] Based on these studies, the average estimated fetal dose is significantly below the radiation threshold dose.

In an attempt to answer this question, studies have alluded to the possibility of knowledge gap that exists in physicians and residents about radiation risk and dose in patients.[18,20-22] In our study, we saw an increased likelihood for pregnant women to receive venous duplex as part of their evaluation as compared to non-pregnant women. This brings into question whether this knowledge deficit influences physicians to adopt alternative imaging techniques over others that are perceived as harmful to the mother and fetus. There is also a need to consider how the knowledge gap affects clinical management. Without guidelines, physicians may use their own discretion in selecting imaging modalities in the pregnant population. Studies support that they select a modality which is deemed as safest in order to avoid radiation exposure.[17] Consideration and utilization of safer imaging modalities in the initial evaluation process is prudent, however, this might come at a cost of delaying diagnoses and swift management.

This study did not reveal any significant difference in the frequency of CT or MRI usage in pregnant vs. non-pregnant patients. Compared to CT, chest X-ray was less likely to be used as a primary imaging modality. While studies have reported that chest radiograph and CT chest expose the fetus to similar amounts of radiation,[17] this study shows that physicians are less likely to order chest X-rays. The fetal dose from a single chest X-ray is 0.0005–0.0100 mGy. CT chest delivers a fetal radiation dose of 0.01–0.66 mGy.[17] This trend is not all that surprising due to reports of increase in the number of CT scans ordered over the past three decades.[7,24] Lazarus et al., were able to obtain results, which showed an increased utilization of CT pulmonary angiography in pregnant patient population.[7] Based on these results, we can safely speculate that this study's findings support this trend. This global change in practice is likely secondary to the increased clinical suspicion of severe disease processes in this patient population, and accordingly a need for more definitive testing.

There are several strengths to this study. This retrospective cohort study highlights an important area where there is a lack of research on pregnant populations. This study is the largest that we are aware of that examines imaging discrepancies in a pregnant population. Our study had several important limitations, as this study is a retrospective chart review from a single academic medical center we cannot infer causation from the associations we observed. Additionally, the results of this study to some degree may not be generalizable to other institutions. We did not account and correct for physician preferences in ordering specific imaging studies in the emergency department. Finally, we were not able to determine the final diagnosis that patients received at discharge. It is possible that a baseline difference in disease processes between the cohorts could contribute to the differences seen.

In conclusion, this study highlights a discrepancy in the evaluation of pregnant and non-pregnant patients in an emergent setting. Despite recommendations to the contrary pregnant patients were significantly less like to receive certain radiographic imaging specifically chest radiographs. Future efforts to promote the new recommendations and to improve knowledge about radiation exposure in the pregnant population are essential to address this issue in the emergency department. Previous research suggests that additional education and training of health care providers could limit this difference.

Conflicts of Interest Statement

The authors report no conflict of interest. There is no financial support to report. All authors certify that all my affiliations with or financial involvement in, within the past 5 years and foreseeable future, any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript are completely disclosed (e.g., employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, royalties).

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