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The Association Between Socio-demographic Factors, Dental Problems, and Preterm Labor for Pregnant Women Residing in Hawai'i

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Abstract

Periodontal disease during pregnancy has the potential to increase the risk of adverse perinatal outcomes including preterm labor (PTL), prematurity, and low birth weight (LBW). Despite professional recommendations on the importance and safety of dental assessments and treatments, the rate of dental care utilization during pregnancy remains low. The purpose of this study was to document the utilization of dental services and explore the relationships among socio-demographic factors, dental problems, and PTL in pregnant women residing in Hawai'i. Hawai'i Pregnancy Risk Assessment Monitoring System (PRAMS) survey results were analyzed from 4,309 women who experienced live births between the years 2009-2011. Results revealed that 2 in 5 women in Hawai'i had their teeth cleaned during pregnancy, while 1 in 5 reported seeing a dentist for a dental problem. Women who reported having a dental problem during pregnancy were more likely to experience PTL (OR=1.46, 95% CI=1.10-1.94, P=.008) compared to women without a dental problem. In addition, Native Hawaiian and Part-Hawaiian women were more likely to experience PTL (OR=1.73, 95% CI=1.22-2.46, P=.002) compared to Caucasian women. These findings document the underutilization of dental services in pregnant women in Hawai'i and reveal an association between poor dental care and PTL. Identification of groups at risk for maternal complications may assist in the development of programs that are sensitive to the diverse cultures and variability of community resources that exist throughout Hawai'i.

Keywords

pregnancy, preterm labor, dental, Hawai'i, PRAMS

Introduction

Preterm labor (PTL) is a leading cause of neonatal morbidity and mortality. In the United States, nearly 500,000 infants annually (11.4% of births) are born prematurely.[1] There are several known risk factors including low socioeconomic level; maternal use of tobacco, alcohol, and drugs; and pre-existing medical conditions such as asthma, diabetes, hypertension, and kidney infections.[1-3] However, in approximately 50% of women experiencing PTL, risk factors are not identified resulting in a lack of timely initiation of interventions that could reduce or prevent premature births.[3,4] There has been recent interest in whether poor maternal oral health prior to and during pregnancy, which is often overlooked, may be a critical risk factor for PTL. It is believed that existing oral health problems before and during pregnancy may facilitate the development of other infections as well as initiate an inflammatory cascade that can result in PTL.[5-7]

Physiological changes of pregnancy, primarily due to hormonal, anatomic, and biochemical alterations associated with gestation, can induce several oral conditions. These conditions include pregnancy-associated gingivitis, benign oral gingival tumors (ie, epulis of pregnancy), and loose teeth. Approximately 40% of pregnant women experience some type of periodontal disease.[8-10] Therefore, it appears that the pregnant state can contribute to the development or acceleration of oral tissue inflammation and enamel degradation resulting in periodontal disease.

Peridontal disease during pregnancy is associated with increased rates of pre-eclampsia, PTL, preterm birth (PTB), and low birth weight (LBW) infants.[6,11-13] The exact mechanisms by which these complications occur are not clearly delineated. Proper maternal dental care and regular dental visits have been documented to decrease the risk of perinatal complications, decrease the transmission of oral cariogenic bacteria from mothers to their infants, and reduce the development of early childhood caries.[14,15]

Disparities in both oral health services and oral health outcomes have been documented, with dental disease disproportionately impacting racial and ethnic minorities, persons living below the federal poverty level, persons with less than a college education, and those engaging in behaviors that contribute to overall poor health outcomes.[16-18] Pregnant women are among vulnerable populations that are at high risk for developing significant dental disease.[16,17] In addition to limited access to dental care for pregnant women, the lack of women's knowledge about the importance of dental care contributing to healthy pregnancy outcomes[19,20] and health professionals misperceptions about the safety of dental care during pregnancy are additional barriers that increase rates of dental disease and associated perinatal complications.[21,22]

Several studies have documented disparities in dental health service utilization leading to maternal dental disease and adverse perinatal health outcomes.[16-20] However, the majority of these studies combine most of Hawai'i's racial groups, making comparisons between these groups unavailable. In addition, Hawai'i faces unique challenges to improving oral health for its residents. Existing challenges for the State of Hawai'i include its geography, lack of water fluoridation, cultural diversity, the lack of a dental school in the State, and the lack of dental coverage for individuals with Quest (Medicaid) insurance. Currently in the State of Hawai'i, adults 21 years of age and older who have Quest coverage have limited dental benefits which consist of emergency care only. The purpose of this study was to report the utilization of dental health services, and to explore the relationships among socio-demographic factors, dental problems and PTL for pregnant women residing in Hawai'i.

Methods

Data Source

The Pregnancy Risk Assessment Monitoring System (PRAMS) is a partnership project developed and managed by the Centers for Disease Control and Prevention (CDC). Grant funds that are available through the CDC allow for state collaborations and data analysis. The PRAMS questionnaire collects population-based data on demographics, maternal attitudes, and experiences before, during, and after pregnancy.

The PRAMS questionnaire has two parts: (1) core questions asked by all states; and (2) additional questions chosen by each state from questions developed by the CDC or by the individual states based on their need. For Hawai'i, approximately 200 new mothers each month are randomly selected from available birth certificate data to receive a PRAMS survey (available at: http://health.hawaii.gov/mchb/files/2013/05/PRAMS3.pdf). A total of two additional surveys are mailed to women not responding, followed by a telephone survey for non-responders.

The study was approved by the Department of Health (DOH), Hawai'i PRAMS Program. During 2009-2011, 6,641 PRAMS surveys were sent to women in Hawai'i with 4,735 women responding, a response rate of 71%. The analysis for this study included 4,309 women with Quest (n=1,717) or private insurance (n=2,430) during pregnancy. Women with military (Tri-care) insurance were excluded due to coverage variability based on active duty versus reserve duty status (n=426).

Study Variables

Table 1 represents the PRAMS survey questions related to Health included in the study. Oral health variables included: teeth cleaning before, during, and after pregnancy, experiencing a dental problem during pregnancy, visit to a dentist or dental clinic during pregnancy for care, and oral hygiene counseling (ie, talked to dental or health care worker about how to care for teeth and gums) during their most recent pregnancy.

Maternal characteristics/predictors included: oral health variables, insurance coverage during pregnancy, income, mother's education, age, race, marital status, county of residence in Hawai'i, maternal behaviors (smoking, alcohol use, substance use [marijuana, amphetamines, cocaine/heroin, tranquilizers/hallucinogens or sniffing]), prescription drug use, pre-existing medical conditions (asthma, diabetes, and hypertension), and previous pregnancy outcomes (previous premature birth and previous normal weight infant) based on PRAMS survey question data. The perinatal outcome of our interest was PTL identified by maternal responses to PRAMS survey questions.

Table 1. PRAMS Survey Questions Related to Health Included in the Study	
PRAMS Question	**Variable**
Oral Health:	
• At any time during the 12 months before you got pregnant with your new baby, did you have your teeth cleaned by a dentist or a dental hygienist? (Yes/No)	Dental cleaning before pregnancy
• I needed to see a dentist for a problem during my most recent pregnancy. (Yes/No)	Dental problem during pregnancy
• I went to a dentist or a dental clinic during my most recent pregnancy. (Yes/No)	Sought dental care during pregnancy
• Dental or other health care worker talked with me about how to care for my teeth and gums during my most recent pregnancy. (Yes/No)	Oral hygiene counseling during pregnancy
• Did you have your teeth cleaned by a dentist or dental hygienist during my most recent pregnancy? (Yes/No)	Dental cleaning during pregnancy
• Did you have your teeth cleaned by a dentist or dental hygienist after my most recent pregnancy? (Yes/No)	Dental cleaning after pregnancy
Maternal Behavior:	
• Have you smoked any cigarettes in the past 2 years? (Yes/No)	Smoked in past 2 years
• Have you had any alcoholic drinks in the past 2 years? (Yes/No)	Alcohol drinking in past 2 years
Medications:	
• Did you use prescription drugs in the month before you got pregnant? (Yes/No) If yes, what kinds?	Use of prescription drugs before pregnancy
• Did you use any of these drugs when you were pregnant? For each item, circle Y (Yes) if you used it or circle N (No) if you did not. (Same as above)	Use of prescription drugs during pregnancy
• Did you use any of these drugs in the month before you got pregnant? b=Marijuana (pot, bud) or hashish (hash); c=Amphetamines (uppers, ice, speed, crystal meth, crank); d=Cocaine (rock, coke, crack) or heroin (smack, horse); e=Tranquilizers (downers, ludes) or hallucinogens (LSD/acid, PCP/angel dust, ecstasy); f=Sniffing gasoline, glue, hairspray, or other aerosols)	Substance use before pregnancy
• Did you use any of these drugs in the month when you were pregnant? b=Marijuana (pot, bud) or hashish (hash); c=Amphetamines (uppers, ice, speed, crystal meth, crank); d=Cocaine (rock, coke, crack) or heroin (smack, horse); e=Tranquilizers (downers, ludes) or hallucinogens (LSD/acid, PCP/angel dust, ecstasy); f=Sniffing gasoline, glue, hairspray, or other aerosols)	Substance use during pregnancy
Medical Conditions:	
• Before you got pregnant with your new baby, were you ever told by a doctor, nurse, or other health care worker that you had Type 1 or Type 2 diabetes? This is not the same as gestational diabetes or diabetes that starts during pregnancy. (Yes/No)	Diabetes before pregnancy
• During the 3 months before you got pregnant with your new baby, did you have asthma? (Yes/No)	Asthma before pregnancy
• During the 3 months before you got pregnant with your new baby, did you have hypertension? (Yes/No)	Hypertension before pregnancy
Previous Pregnancy Outcomes:	
• Did the baby born just before your new one weigh more than 5 pounds, 8 ounces (2.5 kilos) at birth? (Yes/No)	Previous normal weight birth
• Was the baby just before your new one born more than 3 weeks before his or her due date? (Yes/No)	Previous premature birth
Preterm Labor Outcome:	
• Did you have the signs and symptoms of preterm labor (labor more than 3 weeks before the baby is due) during your most recent pregnancy? (Yes/No)	Preterm labor

Analyses

Statistical analysis was conducted using SAS software, version 9.4 (SAS Institute Inc., Cary, NC). Initial data analysis generated descriptive statistics (Table 2) followed by bivariate analyses using chi-square tests (Table 3) to examine the association between maternal dental problems and PTL including potential confounders (eg, demographics, maternal behaviors, pre-existing medical conditions, prescription medications, and previous pregnancy outcomes). Bivariate analyses in Table 3 revealed an association of $P < .1$ between PTL and the following variables: age, race, education, marital status, insurance, county, dental problems during pregnancy, oral hygiene counseling during pregnancy, smoked in the past 2 years, alcohol drinking in the past 2 years, use of prescription drugs before and during pregnancy, asthma before pregnancy, previous premature birth, and previous birth with normal weight. These variables were included in the multivariable logistic regression. Using backward selection method, the final significant variables associated with PTL in the multivariable logistic regression model were race, age, dental problem during pregnancy, oral hygiene counseling during pregnancy, use of prescription drugs before pregnancy, asthma before pregnancy, and previous premature birth (Table 4). For all the analyses, the PRAMS' complex sampling design was taken into account using appropriate analytic modules (eg, PROC SURVEYFREQ, SURVEYMEANS and SURVEYLOGISTIC).

Protection of Human Subjects

The study was considered to be in the exempt category based on the current federal institutional review board regulations. All researchers agreed to the terms of the Hawai'i PRAMS data sharing agreement.

Results

A total of 4,309 women who experienced live births between the years 2009-2011 were included in the study. Table 2 provides the demographic characteristics of the study population. The largest represented group was Native Hawaiian/Part-Hawaiian women (34.4%). Over half (53.5%) of the women responding reported incomes of <$35,000, and 48% of women had a high school education or lower.

Maternal experiences with oral health services are also provided in Table 2. During pregnancy, almost 20% of women reported seeing a dentist for a dental problem. There is a stepwise decline in dental cleaning from before pregnancy (49.5%) of women, to during pregnancy (39.5%), and a further decline during the year after birth (25.9%). Before and during pregnancy, 7.1% and 3.4% of women reported substance use (eg, marijuana, cocaine, tranquilizer, sniffing, etc.), respectively. However, very few women reported using non-marijuana illicit drugs before and during pregnancy (<1% for each illicit drug).

Bivariate associations between PTL and the following variables were significant: age ($P < .001$), race ($P < .001$), education ($P = .0013$), insurance ($P < .001$), county ($P < .001$), dental problems during pregnancy ($P < .001$), oral hygiene counseling during pregnancy ($P = .016$), smoked in the past 2 years ($P < .001$), alcohol drinking in the past 2 years ($P = .039$), use of prescription drugs before ($P < .001$) and during pregnancy ($P < .001$), asthma before pregnancy ($P < .001$), previous premature birth ($P < .001$), and previous birth ($P = .006$) with normal weight.

Results of the multivariable logistic regression for PTL are displayed in Table 4. Native Hawaiian/Part-Hawaiian women were more likely to experience PTL (OR=1.73, 95% CI=1.22-2.46, P=.002) than Caucasian women. Women who reported having dental problems during pregnancy were more likely to have PTL (OR=1.46, 95% CI=1.10-1.94, P=.008). Conversely, women who received oral hygiene counseling during pregnancy were less likely to experience PTL (OR=0.72, 95% CI=0.57-0.92, P=.008). Predictably, women who had a previous premature birth were more likely to have PTL (OR=2.89, 95% CI=2.00-4.20, P<.001). The analysis also found that women who reported the use of prescription drugs prior to pregnancy were also more likely to have PTL (OR=2.13, 95% CI=1.58-2.87, P<.001), as were women who reported having asthma before pregnancy (OR=1.70, 95% CI=1.20-2.39, P=.003).

Table 2. Demographics, Clinical Features, and Oral Health Characteristics of Study Population			
Variable	N (Total=4,309)	Weighted %	Standard Error
Demographics			
Age (years)			
<20	356	7.9	0.5
20-24	953	22.9	0.9
25-29	1,141	25.7	0.9
30-34	1,042	24.6	0.9
≥35	817	18.9	0.8
Race			
Caucasian	811	15.5	0.7
Native Hawaiian /Part-Hawaiian	1,493	34.4	1.0
Filipino	856	19.6	0.8

Table 2 continues on the next page

Table 2. Demographics, Clinical Features, and Oral Health Characteristics of Study Population (Con't)			
Variable	**N (Total=4,309)**	**Weighted %**	**Standard Error**
Other Pacific Islander	277	8.2	0.6
Other Asian	656	17.9	0.8
All Others	216	4.3	0.4
Education			
Less than high school	364	8.5	0.6
Completed high school and/or graduated	1,711	39.5	1.0
Some college	993	22.3	0.8
Completed college/higher degree	1,184	29.7	0.9
Income			
<$10,000	870	21.9	0.9
$10,000-$24,999	905	21.2	0.9
$25,000-$34,999	414	10.4	0.7
$35,000-$64,999	923	22.4	0.9
≥$65,000	924	24.1	0.9
Marital Status			
Married	2,349	55.6	0.1
Other	1,960	44.8	0.1
Insurance			
Quest (Medicaid)	1,717	40.6	1.0
Private	2,430	59.4	1.0
County			
Hawai'i	981	15.0	0.1
Honolulu	1,628	66.9	0.1
Kaua'i	610	5.3	0.0
Maui	1,090	12.8	0.1
Maternal Oral Health Characteristics			
Dental cleaning before pregnancy	2,121	49.5	1.0
Dental problem during pregnancy	837	19.4	0.8
Sought dental care during pregnancy	1,070	39.5	1.0
Oral hygiene counseling during pregnancy	2,114	50.3	1.0
Dental cleaning during pregnancy	1,430	33.4	1.0
Dental cleaning after pregnancy	1,063	25.9	0.9
Maternal Behaviors			
Smoked in past 2 years	1,072	24.2	0.9
Alcohol drinking in past 2 years	2,680	60.6	1.0
Medications			
Use of prescription drugs before pregnancy	667	14.4	0.7
Use of prescription drugs during pregnancy	896	20.5	0.8
Substance use before pregnancy	350	7.1	0.5
Substance use during pregnancy	179	3.4	0.3
Medical Conditions			
Diabetes before pregnancy	114	2.6	0.3
Asthma before pregnancy	380	7.9	0.5
Hypertension before pregnancy	139	3.2	0.4
Previous Pregnancy Outcomes			
Previous premature birth	300	7.5	0.6
Previous normal weight birth	1,967	49.9	1.0

Notes: The weighted sample size was 47,402. Women with Tri-care insurance were excluded.

Table 3. Bivariate Analysis between Maternal Demographics, Clinical Features, and Oral Health Characteristics with Preterm Labor			
Variable	**Preterm Labor**		
	No (Weighted %)	**Yes (Weighted %)**	**Weighted *P*-value***
Age (years)			
<20	8.1	6.4	<.001
20-24	21.4	31.3	
25-29	25.9	24.1	
30-34	25.2	22.1	
≥35	19.4	16.1	
Race			
Caucasian	15.9	12.8	<.001
Native Hawaiian /Part-Hawaiian	31.7	51.6	
Filipino	20.7	13.4	
Other Pacific Islander	8.9	3.9	
Other Asian	18.8	11.7	
All Others	3.9	6.5	
Education			
Less than High School	8.5	8.5	.003
Completed high school and/or graduated	38.3	45.3	
Completed high school and/or Some college	22.1	24.4	
Completed college/higher (degree)	31.0	21.8	
Income			
<$10,000	21.6	23.8	.530
$10,000-24,999	20.8	23.5	
$25,000-34,999	10.5	10.3	
$35,000-64,999	22.6	21.3	
>$65,000	24.6	21.3	
Marital Status			
Married	48.5	6.6	.060
Other	38.4	6.5	
Insurance			
Quest	39.3	49.3	<.001
Private	60.7	50.7	
County			
Hawai'i	14.3	20.6	<.001
Honolulu	67.6	60.7	
Kaua'i	5.3	5.9	
Maui	12.8	12.7	

Table 3 continues on the next page

Table 3. Bivariate Analysis between Maternal Demographics, Clinical Features, and Oral Health Characteristics with Preterm Labor (Con't)			
Variable	**Preterm Labor**		
	No (Weighted %)	**Yes (Weighted %)**	**Weighted *P*-value***
Dental cleaning before pregnancy	49.4	49.7	.910
Dental problem during pregnancy	18.0	27.5	<.001
Sought dental care during pregnancy	38.9	41.9	.300
Oral hygiene counseling during pregnancy	51.2	44.3	.016
Dental cleaning during pregnancy	33.3	33.3	.990
Smoked in past 2 years	22.8	32.3	<.001
Alcohol drinking in past 2 years	59.9	65.8	.039
Use of prescription drugs before pregnancy	12.6	25.7	<.001
Use of prescription drugs during pregnancy	18.9	30.4	<.001
Substance use before pregnancy	6.0	0.9	.890
Substance use during pregnancy	2.9	0.4	.490
Diabetes before pregnancy	2.6	3.0	.600
Asthma before pregnancy	6.8	14.8	<.001
Hypertension before pregnancy	3.1	3.8	.450
Previous premature birth	6.1	15.8	<.001
Previous normal weight birth	48.9	56.8	.006

*Rao-Scott chi-square tests were used to account for complex sampling design.

Table 4. Adjusted Odds Ratio and 95% Confidence Interval for Preterm Labor			
Variable	**OR**	**95% CI**	**Weighted *P*-value**
Race:			
Native Hawaiian/Part-Hawaiian vs Caucasian	1.73	1.22-2.46	.002
Filipino vs Caucasian	0.69	0.45-1.05	.086
Other Pacific Islander vs Caucasian	0.52	0.26-1.04	.065
Other Asian vs Caucasian	0.79	0.50-1.24	.310
All Others vs Caucasian	1.75	0.96-3.19	.068
Age (years):			
<20 vs ≥ 35	0.93	0.55-1.59	.810
20-24 vs ≥ 35	1.77	1.20-2.60	.004
25-29 vs ≥ 35	1.23	0.84-1.78	.280
30-34 vs ≥ 35	1.21	0.82-1.78	.350
Dental problem during pregnancy: Yes vs No	1.46	1.10-1.94	.008
Oral hygiene counseling during pregnancy: Yes vs No	0.72	0.57-0.92	.008
Use of prescription drugs before pregnancy: Yes vs No	2.13	1.58-2.87	<.001
Asthma before pregnancy: Yes vs No	1.70	1.20-2.39	.003
Previous premature birth: Yes vs No	2.89	2.00-4.20	<.001

OR = Odds Ratio; CI = Confidence Interval.
Note: The multivariable logistic regression includes variables that generated a *P*-value <.10 in bivariate analyses in Table 3, accounting for PRAMS' complex sampling design. Backward selection method was to determine the final model.

Discussion

This study illustrates how the utilization of dental services for women in Hawai'i impacts PTL. We observed an association between poor dental care and PTL in Hawai'i. Our reported decline in preventative dental services (eg, dental cleaning) during pregnancy and the post partum periods is consistent with cohort studies of pregnant women residing in other states in terms of their oral health.[23]

Oral health is a predictor of individual wellbeing throughout life.[16,17] Dental disease is associated with increased rates of chronic conditions including cardiovascular, metabolic, and respiratory diseases.[24,25] It can also lead to inadequate caloric intake, decreased quality of life, decreased work productivity, and increased health care costs.[16,17] The risks associated with poor oral health for pregnant women in Hawai'i adds to our understanding of the negative consequences of having oral health problems before and during pregnancy and the importance of having access to regular dental care.

Access to dental services in Hawai'i can be challenging, especially for those living in rural areas.[8] However, for pregnant women this can be compounded by their need for regular and frequent (ie, at least once/month) prenatal visits. It is likely that prenatal health care is prioritized due to a strong desire to have a healthy infant, whereas dental care, which is not seen as being related to prenatal health, only becomes important when a problem occurs.[8,20] In addition, dental coverage is currently unavailable for pregnant women relying on Quest health insurance, creating an additional barrier for low-income women in need of dental services.

Dental Care for Pregnant Women Residing in Hawai'i

Professional organizations including the American College of Obstetrics and Gynecology (ACOG) and American Dental Association (ADA) currently recommend that pregnant women have a dental assessment every six months and, when indicated, preventive and restorative treatments. The support for these standards of practice are based on the literature documenting the importance of routine dental visits before and during pregnancy, as well as the safety of dental care during all stages of pregnancy.[7,8] However, during 2009-2011, PRAMS survey responses indicated that only 39% of pregnant women in Hawai'i reported having had their teeth cleaned during pregnancy. An equally concerning result from the analysis is the rate of pregnant women seeking dental care for a problem during pregnancy, noted to be one in every five women.

The results of this study are particularly concerning for pregnant women in Hawai'i based on existing evidence and our additional analyses documenting associations between dental problems and PTL. In this cohort, there were higher reported rates of PTL in women who reported a dental problem during pregnancy. Especially noteworthy is the significantly higher rate of PTL in Native Hawaiian women after adjusting for all other variables. This suggests a need for further studies to determine contributing factors that result in higher rates of PTL in Native Hawaiian women.

The use of prescription drugs prior to pregnancy was also found to be associated with an increased risk of PTL. Although the relationship between pre-pregnancy prescription drug use and an increased risk of PTL is unknown, it is possible that the women reporting this were taking medications to treat pre-existing chronic conditions (eg, asthma, etc) that could result in their being at higher risk for PTL.

Finally, the relationship between pre-pregnancy asthma and increased PTL is unclear. However, this may be indicative of a group of women who prior to pregnancy have a tendency for hyperactivity of bronchial and myometrial smooth muscle resulting in an increased risk for developing PTL during pregnancy.[27] In addition, the severity of asthma prior to pregnancy was not reported; however, moderate to severe asthma has been associated with PTL. [27-29]

Strengths And Limitations

This study explored some important gaps in the current literature about disparities in PTL associated with dental problems reported by pregnant women, specifically in the State of Hawai'i. Gaining more knowledge about these associations provides an opportunity to begin to develop and implement strategies that can improve outcomes for women and their infants in identified vulnerable populations. These strategies include educating women and health care providers, including dentists and dental hygienists, about the importance of maintaining/improving maternal oral health prior to and during pregnancy; and improving access to preventative and restorative dental services for pregnant women. Informing policy makers and legislators about the importance of including dental coverage in health insurance plans (both Quest and private) is an important and necessary step to preventing adverse perinatal outcomes associated with maternal dental disease.

This study has several limitations. The study relied on self-reported data. Women were asked to report on behaviors and events that occurred before, during, and after their pregnancy, which may increase recall bias. Additionally, self-reports may not reflect actual behaviors, particularly if questioning socially undesirable behaviors such as alcohol use, smoking, or other substance use/abuse during pregnancy. Also, varying interpretations of survey questions may be based on respondents' levels of education, native language, reading comprehension, and/or the use of an interpreter to assist in completing the survey.

Specific details regarding the use of prescription medications during pregnancy (medication dosage, frequency of administration, medical indications, and time frame during pregnancy [trimesters] when medications were being taken) could not be determined. This information may help clarify the severity of a medical condition and its possible effects on the outcome of the pregnancy. The survey question pertaining to having a dental problem during pregnancy that required a dental visit also did not allow for further elaboration about the onset or the severity of the dental problem (eg, gingival swelling, a dental abscess or pain due to caries formation, or a benign epulis formation). These details can help to more accurately determine possible

causes for PTL. It is also unknown when the dental problem occurred during the pregnancy or whether the problem existed prior to but progressed during pregnancy, requiring emergent care. Adults lacking dental coverage may not feel that preventive dental services are required and, therefore, may only seek care when a problem exists.

Since PRAMS does not collect data on dental insurance status it was difficult to determine if women covered by private medical insurance had dental coverage. However, for those women on Quest, only emergency dental services are included in their coverage. Since respondents with non-Quest medical insurance may or may not have dental coverage as part of the plan, it is probable that our analysis of the relationship between insurance and accessing dental care is under-estimated. There was a need to combine ethnic groups including Japanese, Chinese, Korean, Vietnamese and Other Asians based on Hawai‘i PRAMS guidelines stating that estimates based on un-weighted cell sizes of less than 10 or un-weighted marginal values of less than 30 cannot be published. Combining these ethnic groups limited our ability to determine the extent that ethnicity contributed to pregnancy outcomes for these five distinct ethnic groups.

Results from portions of the current analyses focusing on rural areas (eg, Hawai‘i County) may have significance for rural regions of the US with similar demographic challenges. However, these results will need validation through future studies comparing the findings from the current study with other states participating in PRAMS with similar geographical challenges.

Conclusions And Implications

Pregnancy is a unique opportunity for health promotion and disease prevention that impacts the health of a woman, her fetus, and her infant. This study provides a basis for increased efforts to improve the oral health of childbearing age women in Hawai‘i by educating primary care providers about the importance of oral health assessment, patient education, and patient referrals for preventive and restorative dental care; and by advocating for the expansion of health care benefits for pregnant women to include dental coverage.

Community oral health initiatives focused on identifying high risk groups in Hawai‘i, as well as encouraging interdisciplinary collaborations, are essential components to improving oral health services and outcomes for families in Hawai‘i. Changing oral health beliefs and behaviors of mothers in Hawai‘i could also help to create positive behaviors in their children, potentially reducing the rate of early childhood caries. There are important clinical and policy implications that may be gleaned from these findings. For example, promoting legislation to include dental coverage for pregnant women regardless of their current medical insurance has the potential to increase the utilization of dental services by the women for both preventive and restorative care. Education of primary health care providers about the importance of regular dental assessments and treatments in pregnant women is needed. Finally more research is needed in this area to understand the relationships between dental problems and perinatal complications, especially in Native Hawaiian and Other Pacific Islander women.

Conflict of Interest

None of the authors identify any conflict of interest.

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Disparate Rates of Utilization and Progression to Combined Heart Failure and Chronic Obstructive Pulmonary Disease among Asians and Pacific Islanders in Hawai'i

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Abstract

The objectives of the study were to compare ethnic differences in the rates of emergency department (ED) visits and hospitalizations, and to examine ethnic differences in how quickly patients with either chronic obstructive pulmonary disease (COPD) or congestive heart failure (CHF) developed both diseases. A large health plan in Hawai'i provided administrative data (2007 to 2010) on patients of Native Hawaiian, Japanese, Chinese, Filipino, and White race/ethnicity. The study found distinct patterns of health risks among the multi-ethnic population of patients with COPD, CHF, or both conditions. Native Hawaiians had the highest rates of ED visits and hospitalizations. Japanese, the largest ethnic group and relatively low health risks, were selected as the reference population. In adjusted regression models, Filipino patients with CHF developed COPD the most rapidly; 71% faster than Japanese patients. Compared to Japanese, Native Hawaiians with COPD transitioned to CHF 68% faster. The study highlights ethnic disparities in adverse events and disease progression in patients with COPD and CHF, with important implications for clinical practice. Health care providers may want to inform patients of ways to mitigate the risks.

Keywords

Introduction

Overall, 15 million adults, or 6.3% of the US adult population, have been told by a health-care provider that they have Chronic Obstructive Pulmonary Disease (COPD).[1] COPD is a preventable and treatable disease characterized by airflow limitation that is not fully reversible, associated with difficulty breathing, cough, and other symptoms.[2] Another debilitating chronic disease, chronic heart failure (CHF), affects 5.1 million Americans and is characterized by an inability of the heart to pump sufficiently to maintain blood flow to meet body needs.[3]

Not only do these two conditions significantly impact morbidity and mortality, they contribute substantially to costs of care in the US health care system. Among dual eligible beneficiaries, defined as having both Medicare and Medicaid coverage, CHF and COPD accounted for the greatest portion of potentially preventable hospitalizations at 21.1% and 19.6%, respectively, as well as some of the highest 30-day readmission rates (23%-27%) of any type of patient.[4,5]

While CHF and COPD may exist separately, approximately 26%-33% of patients with CHF also are affected by COPD and this number is increasing.[5-7] Having multiple comorbidities is known to significantly impact health care utilization including hospitalizations, office visits, and medications.[7-10] The combination may be particularly challenging because COPD may complicate assessment of important signs and symptoms of CHF, such as fatigue or shortness of breath, and vice versa. In addition, as polypharmacy is common in patients with CHF and COPD, patients with both conditions are at increased risk for adverse drug events and reduced medication adherence, increasing the likelihood of a hospitalization or ED visit.[11]

COPD and CHF are both highly prevalent chronic diseases that share smoking as an etiologic factor, so it is expected that many patients will experience both conditions. Smoking as well as environmental pollutants that can lead to COPD are thought to create a low-grade, systemic inflammation.[12,13] Over time, the inflammation may accelerate atherosclerosis in patients with COPD, weaken the heart, and increase risks of left ventricular dysfunction and heart failure. A heightened arterial stiffness observed in patients with COPD is consistent with this hypothesis.[14]

The purpose of this study is to: (1) examine transition rates from having either CHF or COPD to both by race/ethnicity; (2) assess the impact of having CHF and/or COPD on health care utilization among a primarily Asian American and Pacific Islander population in Hawai'i. Understanding ethnic differences may alert providers and patients to heightened risks of progression and of acute outcomes.

Methods

The study is a retrospective observational analysis of data obtained January 1, 2007-December 31, 2010 on members enrolled in a large health plan's care management programs for COPD or CHF. Patients were identified by the insurer's disease management algorithms. Diagnoses were confirmed whenever possible by contact of the members and their physicians. Exclusion of false positives required a physician's validation. We analyzed data from the start of the year following COPD or CHF identification until the end of the members' enrollment or 2010, whichever came first.

The study compared rates of hospitalizations, ED visits, and progression by ethnicity. Race/ethnicity, the predictor of primary interest, was based on self-report from member satisfaction surveys. Analyses are limited to the 76% of patients either self-identifying as part or full Native Hawaiian or who selected a single ethnicity from a list of the four other most common Hawai'i ethnicities (Japanese, White, Filipino, and Chinese). Because Japanese were the largest ethnic subgroup and had favorable outcomes, Japanese served as the referent population for comparisons. Besides ethnicity, covariates in regression models included age, gender, island of residence (O'ahu versus a Neighbor Island), years since diagnosis of

CHF or COPD, indicators of having diabetes, coronary artery disease, and chronic renal failure, and an indicator of high morbidity. High morbidity was defined as level 4 or 5 on the 5-point Johns Hopkins University's Adjusted Clinical Groups.[15] Morbidity levels were based on empirically derived weights determined by using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes.

Analyses used Cox proportional hazard models to examine progression from having only CHF or COPD to developing both diseases. Results are illustrated graphically using adjusted survival curves. In the proportional hazard models, chronic diseases and the index of high morbidity were modeled as time-dependent variables. A new line was created in the dataset for every change in a time-dependent variable, such as the onset of chronic kidney disease. The patient would be classified, for example, as not having chronic kidney disease on lines up to the onset, and as having chronic kidney disease on subsequent lines. In analyses in which emergency department (ED) visits and hospitalizations served as outcomes, negative binomial regression models were fit using generalized estimating equations with a compound symmetry correlation structure. The negative binomial model is appropriate where the outcomes are counts that occur more than rarely. These analyses were limited to patients with complete enrollment in a year and who, in addition, did not progress from COPD or CHF to having both conditions during the year. This approach excluded acute events related to new disease onset. In the dataset, patients had one line per year of inclusion. The regression model corrected for correlations between the repeated measurements from the same patients in different years. Results are presented as hazard ratios (HRs) or relative rates (RRs) with 95% confidence intervals (CIs). Analyses were performed using SAS version 9.3.

The University of Hawai'i institutional review board (IRB) granted the study an exemption from IRB review.

Results

Out of the plan's total enrollment of close to 700,000 members during this period, the analysis included 5,628 participants with COPD, CHF, or both and a total of 20,562 yearly observations from 2007 to 2010. Participants contributed from one to three years of observation. The study included Chinese, Filipinos, Whites, Native Hawaiians, and Japanese with prevalence ranging from 7% to 40%. Average ages by ethnicity ranged from 66 years for Native Hawaiian to 76 years for Japanese (Table 1). For all ethnicities, the majority resided on Oahu and had higher morbidity. At the start of follow-up, patients with CHF but not COPD were the most prevalent and patients with both diseases the least prevalent. Table 2 summarizes, by ethnicity, the number of patients with progression during follow-up and the mean numbers of ED visits and hospitalizations included in the analyses.

Transitions to COPD and CHF

During follow-up 114 patients with CHF (3.4%) developed COPD and 117 patients (5.9%) with COPD developed CHF. Figure 1 illustrates differences in the rates of progression using survival curves from adjusted proportional hazard models. Progression from having only COPD to having both CHF and COPD were greatest for Native Hawaiians (Figure1; Table 3). The hazard ratio relative to Japanese was 1.7 (95% CI=1.0, 3.0). Progression from having only CHF to also developing COPD was greatest for Filipinos. The HR relative to Japanese was 1.7 (95% CI=1.0, 2.8) (Table 3).

Table 1. Baseline characteristics of the study participants by ethnicity					
Characteristic	**Japanese**	**White**	**Native Hawaiian**	**Filipino**	**Chinese**
Number of participants	2,274	1,039	1,084	834	397
Mean age ± SD	76.3 ± 12.7	71.0 ± 13.4	65.8 ± 13.6	68.5 ± 13.5	75.6 ± 12.8
Female	1090 (47.9%)	518 (49.9%)	583 (53.8%)	378 (45.3%)	170 (42.8%)
High morbidity	1731 (76.1%)	818 (78.7%)	743 (68.5%)	573 (68.7%)	312 (78.6%)
Residence on O'ahu	1752 (77.0%)	600 (57.7%)	707 (65.2%)	564 (67.6%)	369 (92.9%)
CHF & COPD					
COPD only	714 (31.4%)	437 (42.1%)	375 (34.6%)	366 (43.9%)	109 (27.5%)
CHD only	1451 (63.8%)	544 (52.4%)	632 (58.3%)	419 (50.2%)	277 (69.8%)
CHF & COPD	109 (4.8%)	58 (5.6%)	77 (7.1%)	49 (5.9%)	11 (2.8%)
Co-morbidities					
Diabetes	842 (37.0%)	256 (24.6%)	494 (45.6%)	336 (40.3%)	149 (37.5%)
Coronary artery disease	1141 (50.2%)	454 (43.7%)	497 (45.8%)	361 (43.3%)	216 (54.4%)
Chronic kidney disease	342 (15.0%)	92 (8.9%)	165 (15.2%)	153 (18.3%)	84 (21.2%)

Table 2. Percentage of patients with progression and mean numbers of emergency department visits and hospitalizations by ethnicity

Ethnicity	Number (%) with Progression		Mean Number of Events Per Year	
	CHF to COPD	COPD to CHF	Emergency Department Visits	Hospitaliza-tions
Japanese	46 (3.2)	37 (5.2)	1.6	2.0
White	18 (3.3)	30 (6.9)	1.8	1.9
Native Hawaiian	20 (3.2)	22 (5.9)	2.3	2.1
Filipino	24 (5.7)	23 (6.3)	2.1	1.8
Chinese	6 (2.2)	6 (5.5)	1.7	1.8

Abbreviations: CHF (heart failure); COPD (chronic obstructive pulmonary disease)

Table 3. Odds ratios for associations of patient characteristics with transitions from having only chronic heart failure or chronic obstructive pulmonary disease to developing both chronic conditions

Characteristics	Transition from CHF to CHF & COPD	Transition from COPD to CHF & COPD
Chinese	0.6 (0.3,1.4)	1.3 (0.5,3.1)
Filipino	1.7 (1.0,2.8)	1.5 (0.9,2.6)
Native Hawaiian	1.0 (0.6,1.7)	1.7 (1.0,3.0)
White	1.2 (0.7,2.1)	1.4 (0.8,2.3)
Age (years)	1.0 (1.0,1.0)	1.1 (1.0,1.1)
Female	1.0 (0.7,1.4)	0.9 (0.6,1.3)
High morbidity	1.4 (0.8,2.4)	1.7 (1.0,2.8)
O'ahu	1.1 (0.8,1.7)	0.7 (0.5,1.0)
Diabetes	1.2 (0.8,1.8)	1.4 (0.9,2.2)
CAD	2.0 (1.3,3.1)	2.2 (1.5,3.2)
CKD	2.1 (1.0,3.2)	1.4 (0.8,2.6)
Years post diagnosis	1.4 (1.2,1.5)	1.4 (1.3,1.6)

Abbreviations: CHF=chronic heart failure; COPD=chronic obstructive pulmonary disease; CAD=coronary artery disease; CKD=chronic kidney disease
For the ethnicities the reference is Japanese, for females the reference is male, for O'ahu the reference is neighboring islands, for high morbidity the reference is low morbidity, and for the chronic diseases the reference is not having the disease.
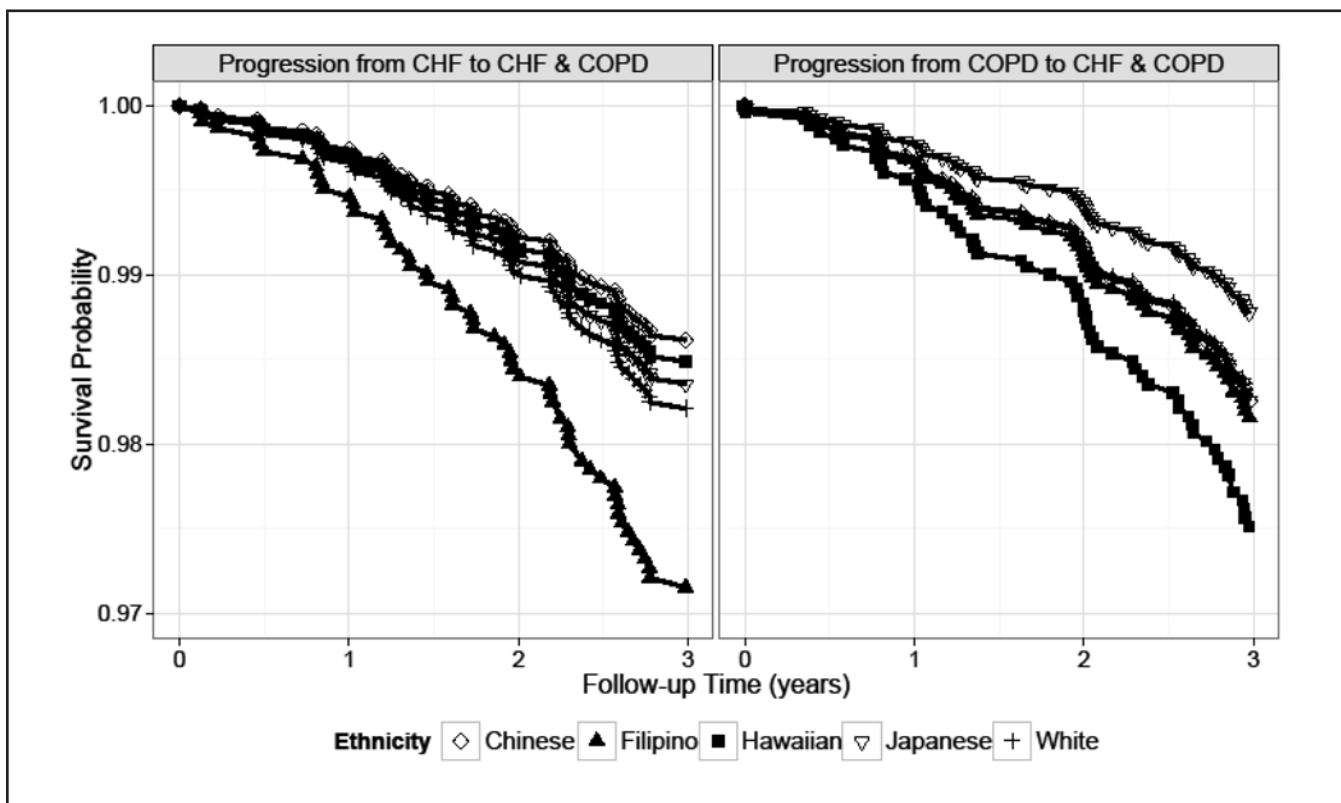
Figure 1. Adjusted survival curves illustrating the rates of transitions by ethnicity from having one of CHF or COPD to having both diseases

Curves were adjusted for age, gender, morbidity, years since diagnosis of CHF or COPD, residence on O'ahu or a neighbor island, diabetes, coronary artery disease, and chronic kidney disease.

ED visits and hospitalizations

The rates of ED visits were comparable for patients with only CHF or COPD, but increased for patients with both diseases (Table 4). Rates of hospitalization were a third higher for patients with CHF than for patients with COPD (RR=1.3, 95% CI=1.1, 1.6) and double for patients with both diseases compared to patients with only COPD (RR=2.2, 95% CI=1.7, 2.7). Among all participants 16.7% had one ED visit and 10.3% experienced two or more, whereas 11.7% incurred a single hospitalization and 7.1% had two or more.

The rates of acute events also differed by ethnicity and diseases (Table 5). Native Hawaiians with COPD had the highest rates of ED visits (RR=1.8, 95% CI=1.3, 2.5); ED rates for other ethnicities did not differ significantly from Japanese (Figure 2A). Japanese and Chinese with CHF had similar rates of ED visits; Filipinos, Native Hawaiians, and Whites had significantly higher rates (RR=1.4, 95% CI=1.2, 1.8; RR=1.5, 95% CI=1.2, 1.9; and RR=1.4, 95% CI=1.2, 1.8; Table 5). Rates of ED visits among patients with both CHF and COPD did not vary significantly by ethnicity. Hospitalizations showed less variability by race (Figure 2B). Native Hawaiians with COPD

had the highest rates of hospitalizations (RR=1.4, 95% CI= 1.0, 2.0) compared to Japanese, although this difference was not significant (Table 5).

Discussion

The study found racial/ethnic differences in the rates of progression to developing both conditions with heightened risks of ED visits and hospitalizations. Filipinos with CHF most rapidly developed COPD; Filipinos transitioned 70% faster than Japanese, the referent group. Other groups progressed at rates within 20% of the rate of Japanese. Although not significant, Native Hawaiians with COPD had the greatest estimated transition rate to CHF. We are not aware of other studies looking at racial/ethnic differences in progression from having either CHF or COPD to developing both.

Even after adjustment for demographic factors and comorbidities, Native Hawaiians with COPD but not CHF stood out with high rates of ED visits: 80% greater than the rates of Japanese. The rates of hospitalization among Native Hawaiians with COPD and CHF were 70% greater than Japanese. Filipinos, Native Hawaiians, and Whites with CHF, but not COPD, had significantly greater rates of ED visits compared to Japanese. Rates of hospitalizations among patients with CHF and without COPD did not differ appreciably by ethnicity. Native Hawaiians with CHF who also develop COPD appear the most vulnerable to hospitalizations.

Other studies have examined ethnic or racial rates of hospitalization for either CHF or COPD. Among patients with COPD in Kaiser Permanente, adjusted models found hospitalization rates compared to Whites to be 10% lower in African Americans, 40% lower in Hispanics, 60% lower in all Asians and 70% lower in both Chinese and Japanese.[16] The rates of Filipinos were in between the rates of Asian ethnicities and Whites. Among Medicare beneficiaries in Maryland, African Americans with CHF had 62% higher adjusted rates of potentially avoidable

Table 4. Relative rates of emergency department visits and hospitalizations among patients with chronic obstructive pulmonary disease, heart failure, or both		
Co-morbidities	**ED Visits**	**Hospitalizations**
COPD only	1.0	1.0
CHF only	1.1 (0.9, 1.3)	1.3 (1.1, 1.6)
COPD &CHF	1.7 (1.1, 2.6)	2.2 (1.7, 2.7)

Negative binomial regression models included age, gender, ethnicity, morbidity, O'ahu or other residence, diabetes, coronary artery disease, chronic kidney disease, ethnicity, and listed co-morbidities.
Abbreviations: CHF (heart failure); COPD (chronic obstructive pulmonary disease); SD (standard deviation), ED (emergency department)

Table 5. Odds ratios for associations of patient characteristics with emergency department visits and hospitalizations						
Characteristic	**Emergency Department Visit**			**Hospitalization**		
	COPD only	**CHF only**	**Both**	**COPD only**	**CHF only**	**Both**
Chinese	0.9(0.6,1.6)	0.9(0.7,1.3)	1.2(0.6,2.5)	1.4(0.7,2.8)	0.8(0.6,1.0)	1.0(0.5,2.2)
Filipino	1.2(0.9,1.6)	1.4(1.2,1.8)	0.7(0.4,1.4)	1.0(0.7,1.5)	1.0(0.8,1.2)	0.9(0.5,1.5)
Native Hawaiian	1.8(1.3,2.5)	1.5(1.2,1.9)	0.8(0.4,1.5)	1.4(1.0,2.0)	1.0(0.8,1.3)	1.7(1.0,2.8)
White	1.2(0.9,1.6)	1.4(1.2,1.8)	0.8(0.4,1.4)	1.2(0.8,1.6)	1.1(0.9,1.4)	1.0(0.6,1.6)
Age (years)	1.0(1.0,1.0)	1.0(1.0,1.0)	1.0(1.0,1.0)	1.1(1.0,1.1)	1.0(1.0,1.0)	1.0(1.0,1.0)
Female	1.1(0.9,1.4)	1.7(1.0,1.4)	0.6(0.4,1.1)	1.0(0.8,1.3)	1.0(0.9,1.2)	0.7(0.5,1.0)
O'ahu	1.1(0.8,1.4)	0.9(0.8,1.1)	1.1(0.7,1.7)	1.0(0.7,1.3)	1.0(0.9,1.2)	1.0(0.7,1.5)
High morbidity	2.6(2.0,3.4)	2.0(1.6,2.4)	2.6(1.3,4.9)	2.2(1.6,3.1)	2.1(1.6,2.6)	2.3(1.3,4.1)
Diabetes	1.2(1.0,1.6)	1.1(1.0,1.3)	0.9(0.5,1.4)	1.3(0.9,1.7)	1.2(1.1,1.5)	1.0(0.7,1.5)
CAD	1.4(1.1,1.7)	1.2(1.1,1.4)	1.0(0.5,1.9)	1.4(1.0,2.0)	1.2(1.0,1.5)	1.3(0.9,1.8)
CKD	1.0(0.7,1.5)	1.3(1.1,1.6)	1.1(0.7,1.7)	0.9(0.5,1.6)	1.5(1.3,1.8)	1.1(0.8,1.7)

Abbreviations: CHF=chronic heart failure; COPD=chronic obstructive pulmonary disease; CAD=coronary artery disease; CKD=chronic kidney disease
For the ethnicities the reference is Japanese, for females the reference is male, for O'ahu the reference is neighboring islands, for high morbidity the reference is low morbidity, and for the chronic diseases the reference is not having the disease.

Figure 2A. Relative rates of emergency department visits stratified by ethnicity among patients with chronic obstructive pulmonary disease (COPD), heart failure (CHF) or both diseases

Negative binomial regression models included age, gender, morbidity, years since diagnosis of CHF or COPD, residence on Oʻahu or a Neighbor Island, diabetes, coronary artery disease, chronic kidney disease, and ethnicity. Separate models were fit for patients with COPD only, CHF only, and CHF & COPD.

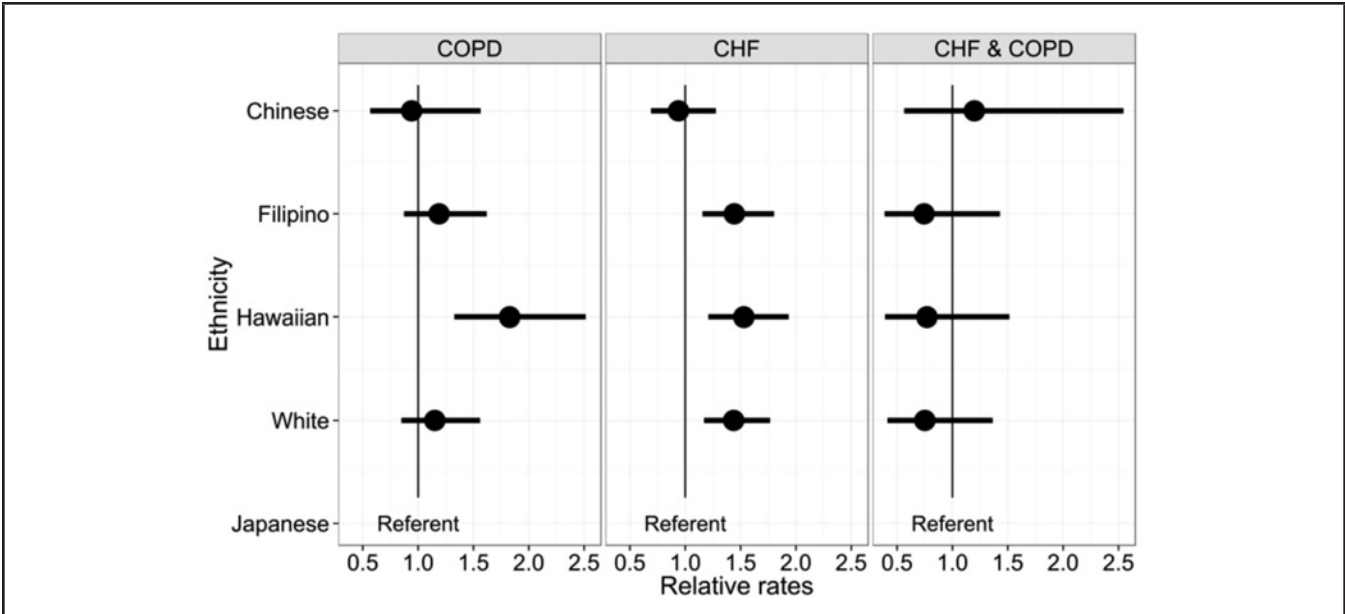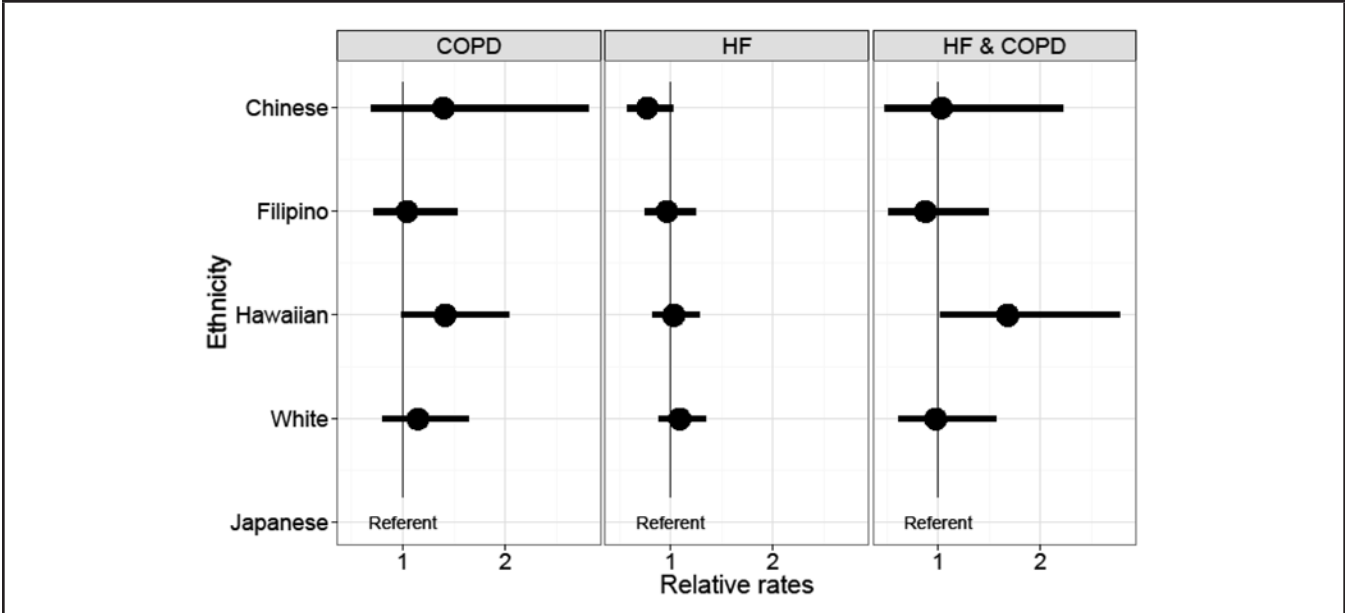Figure 2B. Relative rates of hospitalizations stratified by ethnicity among patients with chronic obstructive pulmonary disease (COPD), heart failure (CHF) or both diseases

Negative binomial regression models included age, gender, ethnicity, morbidity, years since diagnosis of CHF or COPD, residence on Oʻahu or a neighbor island, diabetes, and coronary artery disease, and chronic kidney disease.

hospitalizations then Whites.[17] By contrast, African Americans with COPD had 26% lower rates. An analysis of national data reported that the age- and sex-standardized rates of African American and Hispanics patients with COPD were within 10% of Whites.[18] Admission rates among the African American and Hispanic patients with CHF, by contrast, were 40% to 50% higher than White rates. A study of patients with CHF in the Military Health System's TRICARE program reported no significant racial/ethnic differences in potentially avoidable hospitalizations.[19] The study concluded that equal access to care might lessen racial/ethnic health disparities.

Earlier studies have reported increased risks of adverse events in patients with both COPD and CHF, as observed in our population.[12,14] An analysis of Medicare beneficiaries found patients with CHF had a 40% increased risk ambulatory care sensitive hospitalization when COPD was a comorbidity.[7] Age-adjusted results from the National Hospital Discharge Survey showed more than double the proportion of discharges when COPD was listed with CHF on discharge diagnoses.[20] Among Kaiser-Permanente patients with COPD, CHF as a comorbidity increased the age-adjusted rate of hospitalizations more than 5-fold.[21] Recent results from the Worchester Heart Failure Study examined community based hospitalizations for acute decompensated heart failure among a predominately White population.[22] A third of patients hospitalized with heart failure had a history of COPD. Patients with both conditions incurred a 10% higher risk of dying in the year after hospitalization, and a 40% higher risk at 5 years.

Our study has limitations to consider in interpreting the results. The study population derives from a single health plan in Hawai'i, and the results may not generalize to other populations. The health plan, however, is the major insurer in Hawai'i, covering close to half the state's total population of approximately 1.3 million people in 2007-2010. The insurer's disease algorithms are proprietary, a limitation in interpreting the results. Ethnicity is based on self-report and may have inaccuracies. Information on smoking, socioeconomic status, blood pressure, and body mass index is not available for this analysis. Aspects of health care such as frequency of utilization and being screened for the study conditions could also confound the results. The study results therefore are descriptive and limited by the data available from the health plan. The transitions investigated are fairly rare limiting the statistical power to assess ethnic disparities. The results, however, offer a starting point for more detailed studies.

The study offers evidence of ethnic disparities in two major chronic diseases, individually and in combination. In the coming decades Asians, Filipino, and Native Hawaiian populations, are projected to grow faster in numbers than Whites or African Americans.[23] Studies of the health and health care of Asians and Native Hawaiians have been limited by past studies that grouped them together in analyses, a practice that can obscure important disparities.

Our results show differences in the risks of adverse events among Asians, Filipinos, and Native Hawaiians with CHF, COPD, or both diseases. Filipinos transitioned the most rapidly from CHF to having CHF and COPD. Filipinos, particularly males, have a high smoking prevalence in Hawai'i[24], which may contribute to the rapid transition rates. Filipinos tend to have a poor medication adherence that may accelerate disease transitions.[25] Further, Filipinos have a high prevalence of hypertension and metabolic syndrome, important risk factors for major chronic diseases,[26,27] and relatively rapid rates of onset of hypertension and hyperlipidemia.[28] The study identifies possible disparities in adverse outcomes among Native Hawaiian patients with COPD. Native Hawaiians are one of the highest risk populations for cardiometabolic diseases in the United States.[29] In addition to Native Hawaiians, Whites and Filipinos with CHF were more likely than Japanese to have ED visits. Further study is needed to better understand what causes racial disparities in ED and hospitalization rates.

Conclusion

Our study findings contribute to the emerging literature on health and disparities among the multi-ethnic population of Hawai'i. The results highlight differences in rates of progression to having both diseases, differences that could lead to ethnic disparities in the prevalence of patients with COPD and CHF. Understanding the evolution of multiple from single chronic diseases in general could guide strategies to thwart the onset of the more complex and serious health conditions as well as the need to increase our knowledge of optimal co-management of these conditions. Our results showing increased rates for Filipinos and Native Hawaiians suggest that physicians and other health care providers may want to inform patients with one of the two conditions of their potential increased risk of developing the other and to emphasize ways in which they might mitigate these risks. Moreover, recognizing ethnic differences in risks of multi-morbidity can help the public health community target efforts for prevention.

Conflict of Interest

None of the authors identify any conflict of interest.

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What's the Plan? Needing Assistance with Plan of Care Is Associated with In-Hospital Death for ICU Patients Referred for Palliative Care Consultation

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Abstract

To inform earlier identification of intensive care unit (ICU) patients needing palliative care, we examined factors associated with in-hospital death among ICU patients (N=260) receiving palliative care consultations at a 542-bed tertiary care hospital (2005-2009). High pre-consultation length of stay (LOS, ≥7 days) (adjusted odds ratio (aOR)=5.0, 95% confidence interval (95% CI)=2.5-9.9, P<.01) and consultations for assistance with plan of care (aOR=11.6, 95% CI=5.6-23.9, P<.01) were independently associated with in-hospital death. Patients with both consultation for plan of care and high pre-consult LOS had the highest odds of in-hospital death (aOR=36.3, 95% CI=14.9-88.5, P<.001), followed by patients with consultation for plan of care and shorter pre-consult LOS (aOR=9.8, 95% CI=4.3-22.1, P<.001), and patients with long pre-consult LOS but no consultation for plan of care (aOR=4.7, 95% CI=1.8-12.4, P=.002). Our findings suggest that ICU patients who require assistance with plan of care need to be identified early to optimize end-of-life care and avoid in-hospital death.

Keywords

Prognosis, Death, Intensive Care Unit, Palliative Care, Referral, and Consultation

Introduction

Previous studies reported that 59% to 91% of the general population prefers to die at home.[1,2] However, preferred and actual place of death are frequently incongruent.[2-4] Hospital death is common, and previous studies have found that over 50% of patients died in hospitals,[4-7] with even higher rates among non-white ethnicities.[8]

Patients in intensive care units (ICU) are at especially high risk for in-hospital death compared to non-ICU hospital patients.[9,10] Providing palliative care for ICU patients is an important goal for palliative care providers in the hospital.[11] Often, the ICU is an important site for providers to initiate discussions regarding the patient's and family's goals of care.[12] Hospital death may be avoidable if patients at high risk for dying can be identified and appropriate plans made for safe discharge to a desired location, such as home with hospice care.

ICU patients with certain conditions, such as global cerebral ischemia, stage IV malignancy, and status post cardiac arrest are at high risk for in-hospital death.[9,11,13] However, research on the risk of in-hospital mortality for ICU patients receiving palliative care consultation has been limited to studies on intervention[14] or cost reduction.[15] We previously found that plan of care (POC) was associated with increased likelihood of in-hospital mortality among elderly patients receiving palliative care consultations on the medical floors.[16] Among elderly patients receiving palliative care consultations in the ICU, length of stay (LOS) but not POC was associated with in-hospital mortality.[16] There have been no previous observational studies comparing predictors of mortality in a general (not limited to elderly patients), non-surgical ICU population receiving palliative care.

The objective of this study was to compare factors associated with the outcome of in-hospital death for ICU patients receiving palliative care consultation. We hypothesized that the ICU patients at highest risk of in-hospital death required more assistance with POC and had longer pre-consultation lengths of stay than patients at lower risk of in-hospital death. The results of this study will guide palliative care services to identify patients at highest risk for in-hospital death, and add to the growing research on triggers for proactive palliative care consultation in the ICU.

Methods

Design, Participants, and Setting

Data was collected prospectively on all adult patients who received Pain and Palliative Care (PPC) consultations from January 1, 2005 through December 31, 2009 (n=4,932). All consultations were performed at The Queen's Medical Center, a 542-bed community-based teaching hospital in Honolulu, Hawai'i that serves as the major tertiary care referral center for the Pacific basin. The hospital established an interdisciplinary PPC Department in 2004, building on an existing nurse-run pain management service. The department has two functions, pain management and palliative care, to meet the needs of patients with acute pain from surgical intervention or acute exacerbations of chronic pain, those with palliative care needs including management of pain and other symptoms, and POC needs related to progressive or life-limiting illness.[16,17] Among the 4,932 consultations performed from 2005 through 2009, 531 were for ICU patients. We excluded 229 ICU patients with surgical diagnoses who received consultations for post-operative acute pain management, patients who left the hospital against medical advice (n=2), and patients for whom the PPC team signed off before discharge (n=40), as data on survival to hospital discharge was not available. The final analytic sample consisted of 260 patients. The study was approved by the University of Hawai'i and the Queen's Medical Center Institutional Review Boards.

Data Collection

The PPC team prospectively collected data and recorded patient demographic characteristics, primary diagnosis, Karnofsky

score,[18] and pre-consultation hospital LOS in days at the time of consultation, and updated the information as the patients' care progressed. At the initial consultation visit, the palliative care physician or advanced practice nurse recorded one or more reasons for consultation, including pain, non-pain symptom management, and assistance with POC. Consultations for assistance with POC required more intense consultation and included prolonged higher-level palliative care team discussions with the patient, family, and medical team to clarify goals of care, appropriate use of medical interventions, disposition, and coordination of care. Non-POC consultations addressed straightforward management issues, were performed by a single team member, and generally required less time and fewer visits.

Outcomes

At the close of the consultation, the palliative care team recorded disposition after hospital discharge, including whether the patient survived to hospital discharge or died in the hospital. The main outcome of interest was death during that hospital admission among patients who received PPC consultation in the ICU.

Covariates

At the time of hospital admission, patients reported their race and ethnicity. Hawai'i has a uniquely diverse population with Japanese, Okinawan, Korean, Chinese, Filipino, East Indian, White, Native Hawaiian, part-Native Hawaiian, Micronesian, Pacific Islander, Hispanic, African American, Native American, Middle Eastern, and mixed races and ethnicities. The races were clustered into the four largest groups: Asian (including Japanese, Okinawan, Korean, Chinese, Filipino, East Indian, and "other Asian") (n=112), White (n=85), Native Hawaiian and Other Pacific Islander (NHOPI)(n=51), and other races or ethnicities (n=12), including African American, non-white Hispanic, and unknown.

Primary diagnosis was obtained from the medical record at the time of the initial consultation, determined by the PPC team to be the primary diagnosis related to the palliative consultation. These diagnoses were categorized as cancer, cardiac disease, pulmonary disease, other medical diagnoses (including liver disease, stroke/coma, renal disease, dementia, diabetes, and HIV/AIDS), and other diagnoses (not specified).

Consultation indication for assistance with POC was considered a measure of intensity of consultation and was analyzed as a dichotomous "yes/no" variable. Pre-consultation LOS was dichotomized as ≥7 days versus <7days.

Analyses

Baseline characteristics of patients were compared by survival to hospital discharge (yes vs no) using Chi-square analyses for categorical variables, and *t*-test analyses for continuous variables. Factors associated with in-hospital death were analyzed using multivariable logistic regression models, including only variables significant (*P*<.05) on univariate logistic regression analyses. Age, gender, and race were included in the model despite a non-significant *P* value on univariate analyses due to their importance with regard to death. The final multivariable logistic regression model examined the relationship between consultation for assistance with POC and pre-consultation LOS, by four categorical groups: intense consultation for assistance with POC and pre-consult LOS ≥7 days; intense consultation for assistance with POC and pre-consult LOS<7 days; consultation not for assistance with POC (this included less intense consultations for pain and/or symptom management only) and pre-consult LOS ≥7 days; and consultation not for assistance with POC and pre-consult LOS<7 days (reference group).All analyses were performed using SAS 9.2 (Cary, North Carolina).

Results

Baseline demographic and clinical characteristics by survival to hospital discharge (yes vs no) are displayed in Table 1. A total of 260 patients with non-surgical diagnoses received palliative care consultations in the ICU during the five calendar years from 2005 through 2009. Over 60% of patients who received palliative care consultation were aged 64 years old or younger and 43% were of Asian ethnicity. Cancer was the most common admission diagnosis (47.7%), followed by pulmonary disease (15.8%), cardiac disease (8.9%) and other medical conditions (8.5%).Assistance with POC was one of the indications for 49.2% of the palliative care consultations; the rest of the consultations were for pain and/or symptom management only but not assistance with POC. The mean total LOS was 22.9 days (median=12days), with a mean pre-consultation LOS of 10.0 days (median=4days), and a mean LOS after initial palliative consultation to discharge or in-hospital death of 12.8 days (median=7days).

Table 2 displays the unadjusted univariate models and the final multivariable logistic regression model of factors associated with in-hospital death (yes/no). Older age and high pre-consultation LOS were significantly associated with an increased likelihood of in-hospital death (aOR=2.89, 95% CI=1.10-7.57, *P*=.03 and aOR=5.00, 95% CI=2.52-9.90, *P*<.01 respectively), whereas primary admission diagnoses were not significantly associated. Having a consultation for assistance with POC was associated with over an 11-fold increased likelihood of in-hospital death (aOR=11.58, 95% CI=5.60-23.93, *P*<.01).

Table 3 displays the model examining the relationship between high pre-consultation LOS and consultation for assistance with POC on the outcome of in-hospital death. Having both high pre-consultation LOS and consultation for assistance with POC was associated with over a 36-fold increase in odds of in-hospital death (aOR=36.3, 95% CI=14.9-88.5, *P*<.001) compared to patients with low LOS and consultation for pain and/or symptom management without assistance with POC. Having only one of these two factors present was associated with lower but still significantly increased odds of in-hospital death(POC only, aOR=9.8, 95% CI=4.3-22.1, *P*<.001; LOS only, aOR=4.7, 95% CI=1.8-12.4, *P*=.002).

Table 1.Baseline Demographic and Clinical Characteristics for Whole Cohort, and by Survival to Hospital Discharge					
		Total (N=260)[a]	Survivor (%) (n=145, 55.8%)	Non-Survivor (%) (n=115, 44.2%)	*P*-Value
Age Group	≤64 years	160 (61.5)	102 (63.8)	58 (36.3)	.002
	65-74 years	56 (21.5)	27 (48.2)	29 (51.8)	
	≥75 years	44 (16.9)	16 (36.4)	28 (63.6)	
Gender	Male (%)	153 (58.9)	89 (58.2)	64 (41.8)	.351
	Female (%)	107 (41.2)	56 (52.3)	51 (47.7)	
Ethnicity[b]	White	85 (32.7)	56 (65.9)	29 (34.1)	.074
	Asian	112 (43.1)	61 (54.5)	51 (45.5)	
	NHOPI	51 (19.6)	23 (45.1)	28 (54.9)	
	Other	12 (4.6)	5 (41.7)	7 (58.3)	
Primary Admission Diagnosis	Cancer	124 (47.7)	57 (46.0)	67 (54.0)	.016
	Cardiac Disease	23 (8.9)	17 (73.9)	6 (26.1)	
	Pulmonary Disease	41 (15.8)	26 (63.4)	15 (36.6)	
	Other Medical[c]	22 (8.5)	11 (50.0)	11 (50.0)	
	Other	50 (19.2)	34 (68.0)	16 (32.0)	
Reason for Consultation	Pain or other symptom management only	130 (50.8)	111 (85.4)	19 (14.6)	<.001
	Plan of Care (POC)	126 (49.2)	34 (27.0)	92 (73.0)	
Mean hospital LOS (days±SD)		22.9±29.7	15.8±17.5	31.5±38.2	<.001
Mean Days before consultation (days±SD)		10.0±17.1	4.4±6.9	17.0±22.7	<.001
Mean Days from consultation to discharge/death (days±SD)		12.8±19.9	11.4±14.4	14.5±25.1	.211
Long Pre-consultation LOS (≥7 days)		103 (39.6)	30 (29.1)	73 (70.9)	<.001
Neither POC nor Long Pre-consult LOS		100 (39.6)	92 (92.0)	8(8.0)	<.001
Long Pre-consult LOS but not POC		30 (11.7)	19 (63.3)	11 (36.7)	
POC but no Long Pre-consult LOS		56 (21.9)	23 (41.1)	33 (58.9)	
POC and Long Pre-consult LOS		70 (27.3)	11 (15.7)	59 (84.3)	

[a]n (%), categorical; means + standard deviation, continuous. Not all numbers/percentages add up to totals due to missing data and rounding.
[b]NHOPI: Native Hawaiian and Other Pacific Islander. Other ethnicities (n=12, African American, non-white Hispanic, and unknown).
[c]Including liver disease, stroke/coma, renal disease, dementia, diabetes, and HIV/AIDS.
LOS=length of stay, POC=plan of care, SD=standard deviation

Table 2. Multivariate Logistic Regression: Factors Associated with In-Hospital Death

	Unadjusted Model				Adjusted Model			
	OR[a]	95% CI	P-value	Wald Chi square P-value	aOR	95% CI	P-value	Wald Chi square P-value
Age								
Age ≤64	1	Ref	Ref		1	Ref	Ref	
Age 65-74	**1.89**	**1.02-3.50**	**.04**	**<.01**	1.32	0.58-3.03	.51	.10
Age ≥75	**3.08**	**1.54-6.16**	**<.01**		**2.89**	**1.10-7.57**	**.03**	
Sex								
Female	1	Ref	Ref	.35	1	Ref	Ref	.84
Male	0.79	0.48-1.30	.35		1.07	0.54-2.14	0.84	
Ethnicity								
White	1	Ref	Ref		1	Ref	Ref	
Asian	1.61	0.90-2.89	.11	.08	0.57	0.25-1.31	.19	.27
NHOPI	**2.35**	**1.16-4.79**	**.02**		1.16	0.45-3.02	.76	
Other Ethnic Group	2.70	0.79-9.27	.11		1.75	0.34-9.06	.50	
Diagnosis								
Cancer Diagnosis	1	Ref	Ref		1	Ref	Ref	
Heart Diagnosis	**0.30**	**0.11-0.81**	**.02**	**.02**	0.57	0.16-1.98	.37	.51
Pulmonary Diagnosis	0.49	0.24-1.02	.06		0.49	0.17-1.36	.17	
Other Medical Diagnosis	0.85	0.34-2.11	.73		0.49	0.14-1.71	.26	
Other Diagnosis	**0.40**	**0.20-0.80**	**<.01**		0.56	0.21-1.46	.23	
High Pre- consultation LOS	**6.66**	**3.83-11.58**	**<.01**	**<.01**	**5.00**	**2.52-9.90**	**<.01**	**<.01**
Plan of Care	**15.81**	**8.46-29.56**	**<.01**	**<.01**	**11.58**	**5.60-23.93**	**<.01**	**<.01**

[a]OR= odds ratio (univariate). aOR= Adjusted odds ratio, controlling for age, sex, ethnicity, diagnosis, LOS, and Plan of Care.
LOS=length of stay, Ref=reference, NHOPI=Native Hawaiian and Other Pacific Islander, CI=confidence interval, OR=odds ratio

Table 3. Multivariate Logistic Model of Factors Associated with In-Hospital Death, Examining the Relationship Between High Pre-Consult Length of Stay and Consultation for Assistance with Plan of Care

	OR	95% CI	P-value
Age≥75years (Oldest vs <75 years)	2.5	1.1-5.8	.037
Cancer	1.7	0.9-3.3	.093
Not consulted for POC and Short LOS (<7 days)	Ref		
Long Pre-consult LOS but not Consulted for POC	4.7	1.8-12.4	.002
Consulted for POC but not Long Pre-consult LOS	9.8	4.3-22.1	<.001
Consulted for POC and Long Pre-consult LOS	36.3	14.9-88.5	<.001

OR=odds ratio, LOS=length of stay, POC=plan of care, Ref=reference, CI=confidence interval

Discussion

We found that pre-consultation LOS and POC indication for palliative care consultation were the two strongest predictors of in-hospital death for our ICU patients. When both of these factors were present, there was a more than additive effect on likelihood of in-hospital death.

To our knowledge, data are limited on predictors of in-hospital death in a general non-surgical ICU population receiving palliative care. Our previous work noted that among elderly patients in the ICU who received palliative care consultations, LOS but not POC was associated with increased likelihood of in-hospital death.[16] The current study found that both POC and LOS were associated with in-hospital mortality among non-surgical ICU adult patients (aged older than 18 years) receiving palliative care consults. We hypothesize that the difference in findings regarding significance of POC between these studies may be because of the different age groups examined in the two studies. The Sekiguchi study examined an older population,[16] and we suspect that for these older adults, once they were in the ICU for a long enough period of time (ie, seven days or longer), it was no longer relevant why the palliative care consultation was ordered, and the prognosis for these older patients was poor regardless of reason for consultation. In contrast, among the more mixed aged non-surgical ICU population in the present study, POC was a significant factor associated with hospital death, and when combined with LOS, was an even more powerfully associated with hospital death.

At least four previous studies have identified triggers for palliative care consultation for ICU patients.[11,13,19,20] High in-hospital death rates were reported for specific conditions in ICU patients, including global cerebral ischemia and multiple organ system failure.[11,13,21,22] Other conditions, such as terminal dementia were associated with general mortality, but in-hospital death was not specifically examined.[19] One study reported that patients who received palliative care consultations in the ICU had higher mortality rates than those who did not receive these consultations, but another recent study found palliative care did not change mortality rates for ICU patients.[14,23] One study examined hospital mortality rates by individual medical ICU patient characteristics, including total hospital stay >10 days, age 80 years and older with 2 or more co-morbidities, stage IV cancer, status post cardiac arrest, intracerebral hemorrhage with mechanical ventilation, but did not compare likelihood of in-hospital death by other characteristics or compare the strengths of associations of the individual characteristics.[13] Thus, while triggers for ICU palliative care consultation have been developed based on hospital mortality rates for individual conditions,[11,13,19,20] more observational studies are needed to examine predictors of mortality for general medical ICU patients receiving palliative care consultations.

This palliative care population in the ICU had a median LOS of 12 days, compared to several large ICU studies not focused on palliative care, which reported median LOSs between 16.4 to 24.5 days for ICU patients receiving usual care.[11,13,24] LOS has been suggested as an important trigger for palliative care consultation among ICU patients.[10,20] Other triggers suggested for palliative care consultation for ICU patients have included age >80 years, more than 5 days on a ventilator, more than 7 days in the ICU, and "problematic cases" identified by the ICU clinical staff.[10] The IPAL-ICU (Improving Palliative Care in the ICU) Project is using the following triggers for palliative care intervention in the ICU: pre-existing functional dependence, age>80 years, advanced-stage malignancy, global cerebral ischemia after cardiac arrest, prolonged multi-organ failure, ICU LOS, referral for tracheotomy or gastrostomy, or patient/family's decision to forego life-sustaining therapy such as hemodialysis for renal failure.[20] Norton's study found that patients with a pre-ICU admission hospital LOS of >10 days had a 54% in-hospital mortality rate, but mortality rate of patients with shorter lengths of stays were not reported.[13]

Decision-making is perceived by patients and families to be a key feature of palliative care in an acute hospital setting,[25] yet families also report feeling unprepared for inpatient palliative care consultation and for discussing prognosis.[26] The uncertainty of primary team providers in academic hospital environments has been identified as a barrier to quality end-of-life care in hospitals,[27] and the complexity and emotional labor involved in prognostication by hospital specialist palliative medicine teams has been recognized.[28] Previous research has identified the need to examine outcomes of different levels of palliative care consultation, comparing more intensive interventions versus those with lower levels of contact with patients.[29] We feel that the most intense palliative care consultations are for patients and families who need assistance in determining an achievable POC. More intense POC consultations have been associated with increased code status changes and referrals to hospice among hospital patients with cancer,[30] and have been associated with in-hospital death among elderly non-ICU medical patients.[16] In a previous study, many patients admitted to an academic hospital ICU did not have informed discussions on end-of-life or palliative care before ICU admission.[31] Although basic palliative care is often provided by intensivists or attending physicians, our findings indicate that many ICU patients close to death require intensive palliative care interventions. These intensive interventions include coordination of care among multiple specialists and family meetings for family members struggling to cope with tragic situations, uncertain prognosis and needing assistance in developing an achievable POC. These time-intensive interventions may be best served by palliative care specialists.[32] The high risk of in-hospital mortality for ICU patients makes it critical to identify triggers for palliative care consultation earlier during the ICU stay, to alleviate family and patient suffering and promote patient-centered plans of care.[32,33]

In our study, 43% of the study sample of ICU patients receiving palliative care consultations were of Asian ethnicity. Unlike previous studies of general hospitalized patients,[34,35] ethnicity was not significantly associated with likelihood of in-hospital death in this study, after adjusting for LOS. Hawaiian, Pacific Islander and Micronesian ethnicities, reported to have higher rates of late-stage presentation of illness,[36] were associated with

increased likelihood of in-hospital death on univariate analysis, but not in the final model.

Cancer diagnoses were associated with increased likelihood of in-hospital death in models that did not include POC. In one previous study, shortness of breath and hematological cancer were associated with higher in-hospital mortality among patients in the acute palliative care unit of a comprehensive cancer center.[37] Another study identified admission from another oncology floor, hypernatremia or hyponatremia, and supplemental oxygen use as additional risk factors for in-hospital mortality.[38]

In our study, Karnofsky score was not associated with risk of in-hospital death among ICU patients receiving palliative care consultation. This is in contrast to a previous study of patients with advanced cancer, which reported that a Palliative Prognostic Index of more than 6 was associated with a significantly higher risk for in-hospital death.[39] In our study, all the patients' Karnofsky scores were very low, regardless of in-hospital death outcome, allowing too little variation for significance on analyses.

Strengths and Limitations

This study has several strengths. Data on all the patients who received PPC consultations (almost 5,000 consultations in 5 years) were prospectively collected by the PPC Department since the opening of this service. The patient population included both cancer and non-cancer patients, and was representative of a general hospital in-patient population.

There are several limitations to this study that should be acknowledged. The wide confidence intervals reflect the relatively small number of patients in these analyses as we focused on only ICU patients who had non-surgical diagnoses to avoid including healthier, non-palliative, acute post-surgical pain patients. Data on the indication for the ICU admission were not available, although the palliative care team recorded the diagnosis most likely to be underlying the need for the consultation. Additional information on severity of illness such as Acute Physiology and chronic Health Evaluation (APACHE) scores, tracheostomy status or other factors was not available. This study was conducted in a hospital setting with the longest standing and most experienced PPC team in the state. However, based on our findings, we suspect that needing help with plan of care and being in the ICU for more than seven days is a powerful predictor of in-hospital mortality in most hospitals.

The findings of this study have important implications for research and practice. The two strongest predictors of in-hospital death for ICU patients in this study, long pre-consultation hospital stay and requiring assistance with POC, should be further examined in research to use as a trigger for proactive palliative care consultation in the ICU. The findings about intensive consultations for assistance with POC can also be used by palliative care teams starting new ICU services. Discussions with hospital administrators regarding staffing and time commitment required to provide palliative care to ICU patients need to consider that the patients at highest risk of in-hospital death require the most intense (in terms of time and effort) palliative

care consultations. With adequate support, proactive efforts to initiate palliative care interventions for patients and their families can be smoothly implemented.[11,13] Further studies are needed to examine if proactive palliative care intervention in the ICU will effectively reduce in-hospital death and improve quality of life for ICU patients.

Conclusion

High pre-consultation LOS and consultations for assistance with POC were associated with increased likelihood of in-hospital death among ICU patients receiving palliative care consultation. Further research is needed to determine if earlier intense palliative care consultations for assistance with POC in the ICU may reduce the likelihood of in-hospital death.

Conflict of Interest

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MEDICAL SCHOOL HOTLINE

A Canadian's Journey through JABSOM's Waters

Aniket Natekar MD

Editors note: Each year the John A. Burns School of Medicine, University of Hawai'i receives applications from approximately 2,000 graduates of American and Canadian universities. Of the 70 applications accepted for matriculation, approximately 12 are non-residents. Of this number, one to two are Canadian citizens. As noted in this article, all are warmly welcomed by their student counterparts, the entire school, and the people of Hawai'i.

I was filled with joy and trepidations while reading the John A. Burns School of Medicine's (JABSOM) letter of acceptance. My anxiety waned when I learned there were other Canadian medical students at JABSOM.

It was a daunting undertaking as a Canadian coming to Honolulu. When I first arrived, it was hard for me to adjust due to the many contrasts with Canada. I am writing this editorial to help future Canadians' transitions to living in Hawai'i. As such, JABSOM has been very supportive of my goal to create a resource for incoming Canadian students. I have touched on the major topics that I found needed forethought and planning.

Expenses

The cost of living on O'ahu is comparable to downtown Toronto. The rent in Honolulu is between $800-$3000/month depending on the type of apartment and location. Also, the tuition is significantly higher than Canadian medical schools, as well as many American medical schools. This ranges between $65,000-$73,000 USD, but is subject to change as fares increase. However, the tuition is comparable to some Australian and Caribbean schools. With the fluctuating Canadian dollar (as of today it was $1.40 CAN to $1 USD), this can be very expensive. However, don't let the cost be a limiting factor; as a future doctor, you will make the money back after completing your education and training. Thus, do not use this as a reason for not applying to JABSOM. There are a few tips that you can use to reduce expenses. First, the major banks in Canada offer professional student loans up to $250,000 (CIBC and BMO are preferred). If both parents file for a loan separately, then you can obtain two separate amounts of $200,000-$250,000, totaling $400,000 over 4 years. Second, government education loans (ie, OSAP) can help with the cost. It is important to remember that government loans will not exceed $10,000 as you are going to a non-Canadian school.

Food can be expensive since everything is shipped to the islands. This can be remedied by cooking at home. If you eat out, the portions will be larger than in Canada, so one meal could potentially last you another one or two meals.

If you're tempted to get a job to help offset some of the costs, it is unlikely to happen. Being on an F-1 Visa (student visa) limits you to working no more than 10 hours/week. If you don't already have a social security number (SSN), companies may not help you file the required paperwork for foreign workers. You should be warned though that the curriculum is academically challenging and requires a lot of time dedicated to studying. There is a two month break between your first and second year, which would allow you to return to Canada for work.

Why JABSOM?

When people say there is no place like Hawai'i, they are not joking. Of course there is the natural beauty and beaches that attract tourists, but Hawai'i is much more than what you see on TV shows and commercials. There is a unique and diverse community here that you cannot find anywhere else. The people in this State are extremely kind and friendly. This is easily one of the best learning environments to be in as a medical student. Right from the beginning, the school is very responsive to student feedback, having regular meetings between students and faculty to discuss ongoing issues. As the years go on, you will notice the endless evaluations, so there is ample opportunity to provide useful feedback. Another great thing about JABSOM is that the faculty and staff are all open to student ideas for improving the academic environment. As mentioned previously there are few resources for out-of-state students (OOS). JABSOM encouraged me to write a resource list for OOS, which is now an official JABSOM document. That is just one of the many examples where students have been able to contribute to the betterment of the student experience at JABSOM.

Above all else, the people are amazing. There is a rich and deep culture rooted in community and family. People are very warm and welcoming, and offer assistance. This helps make the transition to Hawai'i easier. Don't be surprised if classmates offer you rides, or even help you move. As you go through

the first year and make friends, you will notice that they will recommend hikes and beaches that tourists don't know about. During various holidays (ie, Thanksgiving) many classmates and faculty invite OOS students to their homes to celebrate the holiday(s). This sense of community is not found in many other places. Outside of these experiences, you will see other aspects of community. Many of the clinical faculty volunteer their time to teach medical students, demonstrating that everyone in the community wants to see medical students succeed. The organization "Friends of the Medical School" routinely purchases stethoscopes and other resources for medical students.

Another positive aspect of JABSOM is that it is a community-based medical school; we are able to rotate through many hospitals and clinics throughout the State. Thus, you have the opportunity to work with doctors in the different hospitals and clinics that directly affect patient care in Hawai'i's population. Several of the attendings are amazing teachers. JABSOM is unique in the sense that you see patients within the first three months of starting medical school. This will prepare you for out-of-state rotations.

Yet another reason to choose JABSOM is the problem-based learning (PBL) curriculum. PBL is based on small-group learning, working with five to six of your classmates under the guidance of a PBL-trained professional who guides the group through the mock clinical cases. This style of learning can be challenging to adjust to, especially at the beginning. Once you get the hang of it, you will realize that you tend to retain more information than conventional lecture based curriculums.

If that is not enough to motivate you to attend JABSOM, just know that you will be studying in Hawai'i. When you do have free time (which is not often), you can enjoy beaches, oceans, and the best hiking trails you can experience. The weather is consistently in the mid-20° C (mid 70°-80° F) year-round, so you won't be shoveling snow. Also, Honolulu has many of the main amenities found in other large cosmopolitan cities, so you will be able to enjoy an active lifestyle for the entire year.

Saving Money

You will definitely incur a lot of debt while attending medical school, but there are ways to minimize your costs. A few were mentioned previously, but there are other factors to consider. You can get away without having a car for the first two years, thus reducing your costs for maintenance, insurance, and gas. During your third year rotations, you can politely ask each rotation coordinator if you could be placed in a hospital or clinic site near your apartment to reduce travel costs. More often than not, they will do their best to accommodate the request. If you choose not to get a car throughout your time (not recommended but has been done), you can rent a car and get discounts for prolonged periods. Lastly, while it's great to go home and see family, that can be expensive; using alternative methods of communication (ie, Skype, Google Hangout, etc) keeps you connected. Not to mention it gives your family an excuse to vacation in Hawai'i.

Getting Scholarships

There are a few opportunities to earn income while at JABSOM. There are very few scholarships available for Canadian students. During the first year, you can qualify for some, but there are few scholarships for the remaining years. The medical school offers some scholarships that are tremendously helpful—anywhere between $4,000 and $10,000 for the year. These are not significant time commitments, and Canadians are considered equal when applying for these scholarships. The main scholarship system called "STAR" is what you would use when applying for all the other scholarships. When you first open it, you might be discouraged as most of opportunities are meant for US citizens/Hawai'i residents, but keep looking and you'll find a scholarship for which you qualify. However, a previous Canadian student received approximately $40,000 in scholarships over his four years at JABSOM. My advice is to apply for numerous scholarships and hopefully you will be awarded one of them.

If you don't have a Social Security Number (SSN), you can apply for an International Tax Identification Number (ITIN). You should apply for this during your first year at JABSOM. When receiving scholarships and other funding, an ITIN will allow you to apply for tax refunds; without a SSN or ITIN, you may lose up to 30% of the scholarship.

International Opportunities

There are many schools in the United States that do not have opportunities for medical students to travel internationally for credit. However, JABSOM has memoranda of understanding (MOU) with many schools in East Asia and the Pacific Basin. Many of these opportunities include funding. If you have a SSN, then you will receive the full amount. However, if you are like me, University of Hawai'i will keep approximately 30% of the money since I am not a US citizen and have no SSN. Despite this, there is enough money left to help fund the trip. The summer after my first year I had the opportunity to travel to Micronesia and the school paid for the rental car, the apartment's rent, and almost all of my flight cost. It was an amazing chance for me to see how medicine is practiced in a different country with disparate medical challenges. While I was there, I had the opportunity to go snorkeling in some of the clearest and crystal blue waters in the world, and in one of the most popular diving sites on the planet. Other students in the past have gone to Japan, Samoa, and Taiwan during their first year. During my fourth year, the school helped me go to Thailand for a month-long elective.

When you are in your fourth year, JABSOM allows up to 12 weeks to do rotations away at other ACGME-accredited schools. Several students in the past have done electives in Canada. Recently I did a month long inpatient neurology rotation at Sunnybrook Hospital affiliated with the University of Toronto. The best part was that US residency programs accepted the reference letters I received from Sunnybrook Hospital. In addition to Canada, there are international rotations in Bali,

Japan, Korea, Philippines, Taiwan, and Thailand. Some of these experiences provide stipends and travel expenses. More importantly, these international rotations do not count towards your 12 weeks of away rotations.

Residency Considerations

I highly encourage you to stay in Hawai'i or the United States for your residency. Graduating from JABSOM, you will be considered an American Medical Graduate, meaning you can apply for residency programs throughout the United Sates. As a Canadian medical student you would be on an F-1 Student Visa. When you enter residency, you either transition to a J-1 or H-1B Visa (both are working Visas). If you stay in Hawai'i, you will be on a J-1 Visa. Most eligible schools only offer J-1 Visas. There are very few schools which offer H-1B Visas. If a school offers the H-1B Visa (it fast-tracks you for a Green Card), it is highly recommended that you take it. For example, about 70%-80% of neurology residents go on to do a Fellowship, making the job market that more competitive. Canadian physicians who pursue residency in the United States tend to rank their schools based on US Visa requirements.

If you match in a US residency program that only offers J-1 Visa, you will need to get a "Letter of Need" from the Canadian government. You should do this as soon as you find out where you will be doing your residency since this letter is given on a first-come basis and there are limits to how many approvals the Canadian governments will grant. There are also programs that the government will not write a letter for, meaning you should not rank those US residency programs. The reason for this is to encourage Canadian students to return to Canada to complete residency even if they studied in the United States. The Canadian government has a website explaining these requirements. You also need to show proof that you were accepted into a residency program and that that program has ACGME accreditation. Lastly, you need to have your passport notarized by an international lawyer. Another thing to remember is that many programs will tell you that you need to cross a US border from Canada at least 30 days prior to the residency's start date in order for the Visa to take effect. In other words, you should just stay home and then drive across a border at least 30 days before you start residency. A disadvantage of the J-1 Visa is that if you want to practice in the United States, you will require a waiver from the Canadian government which is valid for two years. As you can imagine, they may not give the waiver.

However, if you are accepted to a school that offers an H1B Visa, then you would encounter a different process. You will not require a letter of need from the Canadian government. Instead, you would have to apply for an F-1 extension, called Optional Practical Training. This extension allows you to be employed for one year and earn a salary. You then apply for the H-1B the following year. The reasoning behind this is that the H-1B is valid for six years, allowing you one year of employment after most residencies with fellowships. Also, this allows a future employer to begin the process of the green card application, which can be time-consuming. Thus, if you are given the opportunity, I would HIGHLY recommend getting the H-1B over the J-1 Visa.

Canadian Residency Requirements

If you want to return to Canada for residency, then there is a lot of forethought and planning you will need to do. One advantage of coming to JABSOM or any other American medical school is that you are still considered a Canadian Medical Graduate, meaning you can compete for Canadian residency positions without prejudice or penalties. This is another incentive for us to return to Canada. As such, do not let this fact discourage you from applying to JABSOM.

In order to enter a residency program in Canada, you will have to sit for the Licenciate of the Medical Council of Canada Exam (LMCCE) I and II exams just like the Canadian students. The LMCCE I is only offered once or twice a year so you have to plan accordingly. You will be applying for residency using CaRMs, the Canadian application system. This system is complex so make sure you learn it well in advance of the deadline dates.

You should also do at least one elective block at a Canadian institution. This will greatly improve your chances of being accepted at a Canadian residency program, plus it is helpful to obtain a letter of recommendation from this institution. You apply through the Association of Faculties of Medicine of Canada portal. There is a $500 fee to activate the portal, and there may be additional costs that the program requires. Contact the school ahead of time and explain that you are coming from Hawai'i and are wondering if they have open spots during the dates you have set aside for your 4th year electives. These 4th year electives show the residency programs you are interested in them and allow the faculty to get to know you. If you work hard during these electives you can demonstrate your abilities and dedication to the field and thus improve your chance for acceptance.

Summary

Attending JABSOM will probably be one of the best decisions you will make in your life. While there is a significant cost to living in Hawai'i, consider it a short-term investment for your life-long goals. JABSOM is one of the most nurturing learning environments in the United States, and you can thrive here. Your chances are better at JABSOM compared to schools that have no history of accepting Canadian students. Come to JABSOM, and enjoy swimming through the calm waters of Hawai'i for four years.

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INSIGHTS IN PUBLIC HEALTH

Climate Change: A Public Health Challenge and Opportunity for Hawai‘i

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Keywords

Climate Change, Public Health, Co-Benefits, Vulnerability, Hawaii, Hawai‘i, Flooding, Critical Infrastructure, Heat, Sea Level Rise

Introduction

Hawai‘i has been at the forefront of climate change for decades beginning in the 1950s when atmospheric measurements taken atop Mauna Loa provided the first reliable indicator of key changes in global climate trends.[1] Hawai‘i also has a longstanding record of innovative planning, including the establishment of the first comprehensive state land use zoning system in the United States in 1978.[2] In 1984, the state Department of Planning and Economic Development was charged with assessing the potential impacts from sea level rise induced by climate change.[3] Serving as the guide for the future long-range development of the State, the 1978 State Planning Act was amended in 2012 to incorporate climate adaptation into county and state actions.[4] The State has championed the Hawai‘i State Green Growth and Aloha Plus Challenge Initiative, as well as adopted the Hawai‘i Climate Adaptation Initiative Act.[4] Efforts are currently underway to assess climate vulnerability and advance climate adaptation planning.[5] In 2014, an Interagency Climate Adaptation Committee (ICAC) comprised of representatives from across the state was established as the official body to lead statewide efforts to address climate change. The ICAC is tasked with delivering a statewide climate adaptation report that emphasizes coastal resources and sea level rise to the State Legislature by 2018.

Hawai‘i State policies and actions historically focused on mitigating the environmental impacts of climate change. More recently, the State is drawing attention to the impacts of climate change on human health. In 2015, the State convened a temporary Climate Change and Health working group (CCHWG) to work independent of ICAC to identify and plan for the impacts of climate change on population-based human health and well-being.[4] The CCHWG served a critical role in facilitating dialogue with public and private sector health actors from across the state regarding emerging threats of climate change to human health. With the CCHWG concluding its efforts in Summer 2016, the outcomes are poised to integrate with on-going initiatives and advance State efforts to leverage cross-disciplinary expertise to elevate health concerns in all climate change discussions.

As in Hawai‘i, communities around the world are taking steps to understand and address the health impacts resulting from climate change. Evidence at the global, national, and regional scales indicates that the impacts to health due to climate change will be generally adverse. However, research of the specific local level health impacts of climate change is in its nascence, meaning that policy makers striving to take action must often draw from macro level findings in order to design local level actions. Recognizing this limitation in the state of scientific research, this article seeks to contribute to the local level dialogue on these issues. Specifically, this article explores the connections between climate change, planning, and public health with a focus on implications for Hawai‘i.

What is Climate Change?

According to the United States Environmental Protection Agency (EPA), climate change refers to any significant change in the measures of climate, such as temperature, precipitation, or wind patterns, lasting for an extended period of time — generally several decades or longer.[6] As such, the impacts of climate change are most often described in terms of extreme weather events, such as record breaking temperatures, swells, or winds, and the damaging effects that follow.

Abbreviations
USGCRP: United States Global Change Research Program
EPA: United States Environmental Protection Agency
CCHWG: Climate Change and Health Working Group
ICAC: Interagency Climate Adaptation Committee

Why is Climate Change a Public Health Issue?

Climate change is a public health issue for all communities because everyone, everywhere is susceptible to changes in their surrounding environment. Among the greatest challenges for society and public health are risks posed by an increased frequency and intensity of extreme weather events, as well as risks posed by new or unexpected threats that emerge from changes in the surrounding environment.[7] Humans may experience direct exposures due to a discrete hazard or extreme weather event; and indirect exposures due to changes in intermediate factors, such as an increase in the presence of allergens. Extreme weather, temperatures, flooding, and precipitation are examples of direct exposures. Indirect exposures include sewage overflow into the ocean, air pollution, pollen production, and changes in the range of certain vector illnesses. Direct exposures can also trigger cascading indirect exposures. An example is the hazardous mold that may proliferate in buildings following direct exposure to flooding, which subsequently leads to asthma and other respiratory illness.[8,9]

Health Disparities and Social Vulnerability

In addition to challenges posed by direct and indirect exposures, non-climatic factors such as the social and health characteristics of a community are critical for understanding the effects of climate change to a particular place. Climate change and natural hazard events do not target specific communities, but instead the outcomes are shaped by modifying factors within a given community. These factors influence the vulnerability and sensitivity of a community or individual to a hazard event, as well as the ability for a community or individual to prepare, respond, and recover from a hazard event. Factors such as age, race, health, income, and community cohesion often greatly influence the magnitude of impacts, as well as the duration or longevity of their effects.[9,10] This means that some communities and individuals face a greater range of potential negative impacts than others.[9,10] Assessing and understanding these conditions at the community level is important for determining who is at risk, the potential degree of harm, and formulating responses.[11] Among the factors, some are linked to increased vulnerability to a range of exposure events, while others influence hazard-specific vulnerability.[9] Additionally, the relative influence of the different factors varies between communities and is often amplified (or reduced) by other local characteristics such as economic development, technology, and access to health services.[12]

On the whole, the number of people considered vulnerable to the impacts of climate change is growing and climate change will exacerbate challenges related to existing health disparities. This is due to several factors such as natural changes in population and is also linked to individual lifestyle choices, such as smoking or diet, and where people choose to reside, such as in cities or coastal areas.[12] Pre-existing health conditions are also a key factor and research finds that individuals already being treated for certain health conditions, such as asthma or heart disease, are more susceptible to worsening health impacts due to climate change and hazard events.[9] Importantly, vulnerable age groups are often most burdened by these conditions. Individuals 65 years and older, children and adolescents, and infants (1 year of age or less) are particularly vulnerable to heat-related stress and poor air quality.[9,10] Age also influences the ability for individuals to move out of harm's way during hazard events.[13] Geographic location also has implications, with the most vulnerable areas at risk from concurrent environmental or socioeconomic stresses most often having little capacity to adapt. These factors underlie concepts such as climate justice, in which certain populations face a greater risk of experiencing negative effects from climate change.[14] Overall, these characteristics have implications for public health and subsequent health outcomes, with disproportionate health burdens associated with certain social vulnerability factors.[7,15] The relationship between these factors is dynamic and unique to every community, which contributes to the complexity of identifying causal connections for the impacts of climate change on health.

Healthcare Facilities and Critical Infrastructure

Healthcare facilities and emergency services are integral to treating and responding to the health impacts of climate change. These are core components of the critical infrastructure that provides services that underpin society, which also includes transportation and energy infrastructure.[16] Climate change will challenge the quality and continuity of care provided by these facilities and services. Not only will there be events of greater magnitude and complexity, but critical infrastructure itself is vulnerable to direct exposure to climate events.[17] In this way, health impacts may also be caused by disruptions to critical infrastructure, such as hospitals, roadways, and power and water supply.[8] Importantly, the critical infrastructure that supports hospitals and healthcare, such as power and passable roadways, is dependent on other partner entities to manage and maintain to ensure preparedness in an emergency. The resulting dynamic of compounding vulnerability is a challenge for local communities.

Research and Action

An understanding of this broader community context is a critical part of planning and preparation, in part due to the increasing influence of climate change on the frequency and type of hazards experienced within communities.[11] As such, local public agencies and officials are being called upon to prepare for and adapt to the emerging health challenges presented by climate change.[7] This trend is underscored in *The US Global Change Research Program (USGCRP) Climate and Health Assessment* that was released as part of the President's Climate Action Plan in April 2016.[7] As the first stand-alone national assessment focused on the impacts of climate change to public health, the publication is a marker for the advancement of scientific understanding and a signal for action. The findings included in the USGCRP report underscore the need for deliberate and expeditious responses at the local level with particular emphasis on the need for concurrent advancements in surveillance and research, as well as

preparation and adaptation. In addition, upstream determinants of health may present actionable areas to be considered during planning processes.[18] Importantly, this underscores the growing opportunity for actions that yield co-benefits by reducing or removing particular vulnerabilities, while continuing to mitigate threats. Such actions enable communities to focus on improving long term mitigation, adaptation, and readiness, rather than solely focusing on relief efforts.[19]

Understanding Climate Change and Public Health Connections in Hawai'i

Climate change is a long-term process that is measured over decades. Sea level rise, variations in precipitation patterns, and increasingly frequent storm surges and high-intensity extreme precipitation events are well documented in the historical climate record for Hawai'i.[20-22] From 1958 to 2007, the State recorded an increase in the intensity of rainfall, with the amount of rain falling during the very heaviest downpours increasing approximately 12% over the time period.[21] This increase in rainfall intensity compounds with rising sea level, which has increased at a rate of approximately 0.6 inches per decade over the past century, to expose more people to the potential adverse health impacts experienced due to flooding events.[7,20] Health impacts related to flooding may be immediate or manifest over longer periods of time. As experienced during times of heavy precipitation in Hawai'i, floods may cause health concerns due to the potential for exposure to pathogens when sewage overflows and is discharged into local waterbodies. This commonly triggers the closure of public beaches due to health and safety concerns. Overall, climate change is causing an increase in the frequency and severity of storms, which is anticipated to lead to a rise in similar flooding events.[22]

Historically, Hawai'i has demonstrated resilience to significant weather events, in part due to the vibrant social fabric of the community. Community cohesion was a key factor that contributed to the recovery and resilience of Kaua'i residents following the tremendous destruction caused by Hurricane Iniki when it struck the Garden Island on September 11, 1992. As the most powerful hurricane to strike the state in recorded history, Iniki's intensity was strong enough to destroy over 1,400 homes, including 63 homes destroyed by storm surge or wave action, damage to more than 5,000 additional homes, and six deaths.[23] Despite the staggering destruction, longtime Kaua'i residents were reported to have taken the storm in stride and supported each other with acts of selfless service and heroism.[24]

Factors such as the community cohesion experienced following Iniki are often best captured anecdotally, while other social and health factors are readily measurable in shorter time scales. Table 1 and Table 2 integrate climate, health, and demographic data sets from 2013 to provide an initial assessment of the segments of Hawai'i's population that are expected to experience magnified vulnerability to the health impacts of climate change.[7,25-27] Although more recent data is available for demographics and certain health indicators, data from 2013 was used in order to provide consistency across timescales.

Table 1 incorporates scientific findings regarding pre-existing health conditions and climate change influences with Hawai'i-specific indicators that are derived from the Hawai'i Health Connector website.[7,25] Table 2 incorporates social vulnerability factors, their relationship to climate change and hazard events, and demographic data from the US Census Bureau: State and County QuickFacts 2013 for Hawai'i.[7,26,27] It is important to note that as Hawai'i's population dynamics change due to broader trends, such as the increase of climate refugees displaced from other Pacific Islands due to rising sea levels, vulnerability is also likely to worsen.

Among other concerns, atmospheric changes associated with climate change are expected to lead to an increase in both average and extreme temperatures, with even small changes in seasonal average temperatures resulting in adverse health effects.[7] This is particularly relevant for Hawai'i given the increasing rate of warming air temperature, which has quadrupled in the last 40 years to over 0.3°F (0.17°C) per decade.[20,21] Research demonstrates direct linkages between heat and health effects for specific population groups. For instance, research focused on heat impacts in the New England region found that a rise in summer mean temperature of 1°C was associated with a 1.0% higher death rate in people 65 years or older.[30] Beyond specific population groups, anyone who spends time outdoors is vulnerable to the adverse health effects of increasing temperatures driven by climate change.[31] This is among the factors contributing to the consensus that rising temperatures will lead to an increase in heat-related deaths and illnesses.[7] Table 1 and Table 2 highlight the proportion of the population most vulnerable to these impacts in Hawai'i. Importantly, pre-existing health conditions such as obesity, which affects nearly 22% of adults in the State, are areas of increasing concern for the broader local population due to climate change.[25]

There are also issues surrounding critical infrastructure vulnerability in Hawai'i. For example, Farrington Highway (Route 93) is a primary infrastructure asset for the Leeward Coast of O'ahu.[32] There are no alternate routes available for the community to utilize in an emergency situation if Farrington is not passable.[32] The Leeward Coast also lacks a major emergency medical facility and many of the evacuation shelters are located in close proximity to the ocean. This vulnerability compounds with the social vulnerability of Waianae Coast residents, which includes a large proportion of elderly (over 65), youth (under 18), and people living below the poverty line.[32] Flooding from storm surge and heavy rains have led to closures of Farrington Highway in the past. Sea level rise and more extreme storm events will increasingly contribute to erosion of the roadway. Given the interdependence of these systems, a large portion of which is beyond the control of health providers, there is a need for cross-sector planning and collaboration that assesses critical infrastructure vulnerabilities holistically, rather than on an individual system-level basis.

In the case of Farrington Highway, the cross-sector planning would involve a multitude of stakeholders, each with varying levels of responsibility and authority. A cursory review of

Table 1. Overview of Pre-Existing Health Conditions, Influences of Climate Change, and Related Indicators for Hawai'i - 2013		
Pre-Existing Health Condition	**Possible Related Influences of Climate Change[7]**	**State of Hawaii Indicator(s)[25]**
Alzheimer's disease	Persons with cognitive impairments are vulnerable to extreme weather events, which are predicted to become more frequent and require evacuation or other emergency responses.	• 9.7%: percentage of Medicare beneficiaries who were treated for Alzheimer's disease or dementia.
Asthma	Asthma is exacerbated by changes in pollen season and allergenicity and in exposures to air pollutants affected by changes in temperature, humidity, and wind.	• 9.4%: percentage of adults who have been told by a health care provider that they currently have asthma. • 12.8%: percentage of children under 18 years of age that currently have asthma.
Cardiovascular disease	Cardiovascular disease increases sensitivity to heat stress.	• 28.5%: percentage of adults who have been told they have high blood pressure. Normal blood pressure should be less than 120/80 mm Hg for an adult. Blood pressure above this level (140/90 mm Hg or higher) is considered high (hypertension).
Mental illness	Mental illness may impair responses to extreme events; certain medications increase sensitivity to heat stress.	• 54.6%: percentage of adults aged 18 years and older with serious mental illness who received treatment in the past 12 months.
Disability	Persons with disabilities may find it hard to respond when evacuation is required and when there is no available means of transportation or easy exit from residences.	• 18.4%: percentage of adults who report having difficulty with any activities because of a physical, mental, or emotional condition
Obesity	Obesity increases sensitivity to high ambient temperatures.	• 21.8%: percentage of adults aged 18 years and older who are obese according to the Body Mass Index (BMI) • 13.4%: percentage of public school students in grades 9-12 who are obese

Note: Scientific findings linking pre-existing health conditions and climate change influences included in table are adapted from USGCRP.[7] All State of Hawai'i data is for year 2013 and represents the average of all counties in the State.[25]

Table 2. Overview of Social Vulnerability Factors, Relationship to Climate Change and Hazard Events, and Related Indicators for Hawai'i - 2013		
Factor	**Relationship to Climate Change and Hazard Events**	**State of Hawai'i Indicators[26,27]**
Age	• Children and elderly populations demonstrate greater vulnerability to a range of hazards. Individuals 65 years and older, children and adolescents and infants (1 year of age or less) are particularly vulnerable to heat-related stress and poor air quality.[10] • Age also influences the ability for individuals to move out of harms way during hazard events with elderly and people under 18 experiencing increased vulnerability.[13]	• 15.6%: percentage of persons 65 years of age and over • 21.9%: percentage of persons under 18 years of age • 6.5%: percentage of persons under 5 years of age
Income	• Low-income individuals tend to lack the resources needed to respond and recover from hazard events. For example, these individuals are less likely to have a vehicle to use to evacuate during certain hazard events.[9,10] • Individuals living in poverty often live in substandard housing, and lack insurance and social safety nets.[13]	• $29,305.00: Per capita money income in past 12 months (2013 dollars) • $67,402.00: Median household income • 11.2%: percentage of persons below poverty level
Race and Ethnicity	• Minority populations are disproportionately impacted by hazard events because they often tend to experience greater socioeconomic disparities as compared to others. This correlates with factors such as lower income, limited access to transportation, poor housing quality and lack of insurance.[9,12,14] • Residential areas with high concentrations of racial and ethnic minorities also tend to be located in high hazard areas. Language and cultural barriers can also serve to limit access to post-disaster funding.[9,11,14]	• 2.3%: Black or African American • 0.4%: American Indian and Alaska Native alone • 37.7%: Asian alone • 10%: Native Hawaiian and Other Pacific Islander alone • 23.1%: Two or More Races • 9.8%: Hispanic or Latino • 17.9%: Foreign born persons • 25.4%: Language other than English spoken at home, % age 5+
Vulnerable Occupations	• Jobs that involve working outdoors, such as farming, landscaping and construction, are more likely to be exposed to specific hazards, including heat stress.[36]	• 26,030: Employment in Construction and Extraction Occupations.[27] • 1,420: Employment in Farming, Fishing and Forestry Occupations (does not include self-employed or seasonal workers).[27]
Behavior and Attitudes	• Risk perception and self-perception influence vulnerability and resilience. Individuals may perceive themselves as more or less vulnerable to hazard events, which influences their behavior. In particular, this can influence both individual and community preparation, response and long term recovery from hazard events.[28]	• 58%: Approximate percentage of public health professionals were "very concerned" about the potential impacts of Climate Change on health on Hawaii residents or felt that it was the number one health issue today.[29] • 66% Approximate percentage of public health professionals felt that the impacts of Climate Change on health in Hawai'i received "little or no attention".[29]

Note: All State of Hawai'i indicator data is for year 2013 and from US Census Bureau: State and County QuickFacts unless noted otherwise.[26,27,29] Behavior and Attitudes State of Hawai'i data is for year 2014.[29]

these stakeholders includes: State Department of Transportation, responsible for managing and maintaining the highway; City and County of Honolulu Department of Transportation Services, responsible for managing and maintaining feeder roadways; City and County of Honolulu Department of Emergency Management, Hawai'i State Civil Defense, and other private organizations, responsible for managing and providing evacuation shelters; and numerous State, City and County, and private organizations, responsible for managing and providing the range of healthcare and social services.

Call to Action

As the climate continues to change, it is anticipated that it will have widespread impact on nearly every aspect of life in Hawai'i and the Pacific Island region.[22] Recent climate models find a greater likelihood of observable changes, such as rising sea levels, occurring at increasing rates and becoming impactful sooner than previously projected.[33] In the midst of the growing body of scientific research on climate change there is consensus that climate change is presently and will continue to affect human health, which presents a pressing need and an unprecedented opportunity to prepare for the effects of climate change.[34,35]

The health concerns and related climate drivers discussed in this article provide a limited glimpse of the anticipated influence of climate change on health outcomes. Several critical and potentially catastrophic health concerns that have implications for Hawai'i are not addressed in this article.[7,22] These include: food-related infections—driven by increases in temperature, humidity, and season length; outdoor air quality—driven by increasing temperatures and changing precipitation patterns; vector-borne infections and diseases—driven by changes in temperature extremes and extreme weather patterns; water related infections—driven by warming sea surface temperature and changes in precipitation patterns; and mental health and well-being—driven by climate change impacts, especially extreme weather.[7] Expanded discussion of these health concerns is available in the USGCRP report.[7]

Hawai'i has the opportunity to build on its longstanding history of innovative planning and addressing the concerns of climate change. Resources such as the EPA's EJSCREEN online mapping tool are publically available and are being utilized by ICAC and others to identify vulnerable populations and specify areas of focus. Additionally, the case of Farrington Highway underscores the need for greater collaborative planning among all entities responsible for public health, such as the leadership shown and engagement underway by groups such as ICAC and CCHWG. Doing so aligns with well-established best practices that underscore the unprecedented opportunity for achieving co-benefits, as well as the necessity of interdisciplinary collaboration. Positive environmental outcomes often arise naturally from management responses that aim to improve health conditions. To achieve these win-win situations, it is essential to consider health concerns in both short- and long-term planning for climate change so that communities and citizens will thrive through these times of change. Good health is a great blessing achieved through good planning.

Conflict of Interest

The author does not identify any conflicts of interest.

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Hawai'i Health
DATA WAREHOUSE

QUICK ACCESS TO STATISTICS ON TOPICS OF PUBLIC HEALTH IMPORTANCE TO HAWAII

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THE WEATHERVANE
RUSSELL T. STODD MD; CONTRIBUTING EDITOR

YOU'VE COME A LONG WAY, BABY.

In times past, running was almost strictly a man's endeavor and the feminine gender only came along as an afterthought. Now that ticket is inverted and women own distance running. They made up 57% of the 17 million US race finishers in 2015 according to *Running USA*. The events varied from 3.1 mile trots before Thanksgiving dinner to 26.2 mile marathons. When Joan Benoit Samuelson won the first women's Olympic marathon in 1984, 88 years after the first men's Olympic marathon, only a trickle of females followed her. Just a decade later Oprah Winfrey finished the 1994 Marine Corps Marathon in just under 4 and ½ hours wearing number 40, reflecting her age. She had thousands cheering her on and three reporters ran with her to cover her great effort. Of course, part of the attraction for female runners has been the avalanche of wearing apparel now offered by major manufacturers and boutique designers. Nike predicts that sales of women's running products will double by 2020. Toni Carey and a college friend, Ashley Hicks-Rocha, turned their running blog into "Black Girls Run," a nationwide organization to promote running for African-American women. Today they have about 70 groups and 200,000 participants nationwide. A positive side effect might be the mental health of women who suffer from more depression than men. Fresh air, sunlight and aerobic exercise is a pick-up for everybody.

WELL KNOWN HEALTH CARE MEDDLING OR WORSE.

At this time 35 states mandate a lengthy, expensive application process before a health-care provider can open or expand a facility. Legislatures believe that restrictive market forces will benefit consumers by controlling costs. A new study at George Mason University's Mercatus Center shows Certificate of Need laws make critical care harder for patients to get. MRI scans, CT scans, PET scans are often thwarted. On the island of Maui the situation is truly desperate. The state has refused to continue funding their bankrupt facility. 160,000 residents and visitors on the island are without a second hospital, and many patients are forced to travel, often at considerable expense. Physicians are very difficult to recruit to Maui. The health care tragedy for this island is magnified by the CON law that prevented a well-planned, well-funded alternative to our failing Maui Memorial Health Center from being constructed. Testimony at hearings was almost uniformly in support of the plan, but Hawai'i state leaders shot it down with the CON statute. It is more than meddling with health care; it is legislative malpractice.

IT COULD BE THE POWER OF LIFE—OR DEATH.

The hour has arrived that genetic scientists have been striving for. Since the 1970s scientists have pondered the power of gene engineering to combat disease and prevent congenital malformations or other birth defects. Now all that is changing as a groundswell (tidal wave?) of activity has been brought on by the emergence of CRISPR/Cas9. CRISPR is an acronym for "clustered regularly interspaced short palindromic repeats." Hugo Bellen, geneticist at Bellen Lab, states, "Everything is possible with CRISPR." This technology can eradicate an entire species, as when the species are pests, eg, mosqitoes or invasive Asian carp. As yet, no such CRISPR gene drives have been released in the wild, few have even been built. There remain many technical hurdles to overcome, and there is an awareness of the peril accompanying the promise. Researchers have ways to keep gene drives confined to the lab, but no such safety nets exist in the wild. Researchers and organizations have asked the US National Academy of Sciences to weigh in on gene drives. That report will not be in until next year, but that has not slowed the research nor stifled the debate on gene drive science.

SHE IS LOVELY AND HAS A GREAT FIGURE, BUT SHE STINKS.

Yoga pants and other garments are designed to be worn two or three times a week for work-outs. The synthetic fabric quickly wicks away moisture, making it comfortable and attractive to wear. Because the body and the pants are dry there is a perception that they are clean and the wearer may follow a physical session with lunch or dinner. In fact a problem lingers because the pants stink. The weave of synthetic fabics include "moisture channels" which allow perspiration to pass through quickly. The channels also create extra nooks and crannies that allow dirt and odor molicules to settle in and hide, leading to malodor. These garments are very popular and athletic wear sales are climbing with sales at $67 billion in2015, up 38% since 2010. About 69% of Americans are working out three or more times a week, so it is distressing to don pants that look good, but smell even after washing. Proctor and Gamble, maker of Tide detergent, claims they use electron microscopy to see how dirt and body soil manifest between complex fibers. Much as you love her, no one likes to take a stinky sweetie to dinner.

HOW MANY PhDs PUT THEMSELFS AT RISK EVERY SUNDAY?

John Urschel looks like any offensive lineman in the team photo of the Baltimore Ravens. He is six foot three, weighs in at 310 lbs, but there the similarity ends. He is the only NFL lineman seeking a PhD in mathematics (or any subject) at the Massachusetts Institute of Technology. The Ravens call him a promising young player (age 24), now in his third year with a contract that pays him $2.4 mllion a year. He spends his off-season studying spectral graph theory, numerical linear algebra and machine learning. He has published articles in peer reviewed journals. One of his favorites was "Spectral bisection of graphs and correctedness" published in Linear Algebra and its Applications in 2014, because it contains his own Urschel-Zikatanov Theorum. He understands and accepts the risks of pro football. He suffered a concussion last August, and endured headaches and insomnia for three weeks. He tested himself with advanced math problems during recovery. To completely recover his higher level reason, he says, took a few months. He rationalizes football concussions with boxing, saying no one makes a big deal out of boxing. He is misinformed. The American Medical Association took a strong stand decades ago that boxing destroys the brain and should be banned. John Urschel would be wise to stick with his math career. Pro football and the Baltimore Ravens would survive without him.

HEY, BABY, YOU MAKE MY SKIN CRAWL.

Mexico's latest female accessorizing craze is shellacking tiny dead scorpions onto fingernails. They use the second-most venomous species of the arachnid, selling briskly at the Miss Unas parlor in Durango. In fact, while in town (according to the London Daily Mail), shoppers may check out the Raices restaurant. They pioneered tacos filled with wriggling scorpions (previously soaked in alcohol to neutralize the venom). Now that must be a charming place to dine.
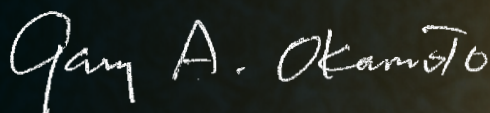
ADDENDA

- A diet popular as an alternative treatment for autism (gluten-free) doesn't appear to alter behavior nor symptoms of the condition, according to a recent *Journal of Autism and Developmental Disorders*.
- Ask your Congressperson how long we must continue to support this albatross ethanol just to satisfy the corn and grain growers.
- An average person blinks 28,800 times per day.
- Line dancing was started by some Irishmen waiting to use the bathroom.
- Is sex better than drugs? It depends on the pusher.
- National condom week is coming soon. Now that's a parade you won't want to miss.

ALOHA AND KEEP THE FAITH rts
(Editorial comment is strictly that of the writer.)