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IN THIS ISSUE

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ST. VINCENT CHARITY
MEDICAL CENTER

The St. Vincent Charity Medical Center family is committed to the healing mission of Jesus. We serve with: a deep respect for the dignity and value of all persons; our practice of quality care; our dedication to the poor; and, our commitment to education. St. Vincent Charity Medical Center, with the commitment of its caregivers and physicians, will be a leading model for health care delivery in Northeast Ohio based on its faith-based mission, dedication to education, commitment to the communities it serves, excellence in the patient experience it provides, focus on surgical services, and partnerships with physicians and other constituencies.

JOURNAL ARTICLES AND AUTHORS

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As director of graduate medical education, I find it deeply rewarding to help educate and train the next generation of physicians, especially in this setting.

St. Vincent Charity Medical Center is Cleveland's faith-based, high quality health care provider – with a 4-star overall rating from CMS and "A" Safety Grade from Leapfrog.

For 152 years, this hospital has combined clinical excellence with compassionate care to the most vulnerable. Located in Central Neighborhood, where median household income is less than $10,000 a year, St. Vincent Charity's mission as a safety net hospital is critical to the community.

We are a vital teaching hospital for primary care physicians. St. Vincent Charity distinguishes itself from other local residency programs by our ability to ensure rotations in behavioral health and addiction medicine settings. And, we are deeply proud that our medical residents have achieved the highest board passage rate in the state for the past three years.

However, in working with tomorrow's physicians, we see the need to adjust federal health quality programs, which currently have unintended consequences.

Providers can and do face genuine lapses in quality care. However, there are many factors outside the hospital that affect health outcomes. Failing to adjust for that in the hospital readmission reduction program harms physicians serving the most vulnerable patients and communities.

Our federal leaders must change health care quality programs to adjust for social determinants, which greatly factor (more than 80%) into health outcomes. Without action, we are concerned new physicians will choose practice locations outside of medically underserved communities.

We believe everyone should have access to high quality, affordable health care.

The future of the health care system is concerning. Based on research and statistics gathered globally, our nation requires enhanced quality programs that ensure we are improving the overall health care outcomes of the entire U.S. population. Changes to the Affordable Care Act should ensure we are moving steadfast toward the triple aim of better care, better health and lower costs.

Keyvan Ravakhah MD MBA FACP
Editor in Chief

Dissemination of Pathogens by Mobile Phones in a Single Hospital

By **Michael B. Canales, DPM, FACFAS; Grace C. Craig, DPM; John Boyd, Jr., DPM; Mario Markovic, MS, SM(ASCP)MT; Richard A. Chmielewski, MD**

ABSTRACT

Mobile phones are frequently used in the hospital setting, regardless of their microbial load. This study aimed to: 1) determine the level of bacterial contamination of mobile phones from resident physicians at St. Vincent Charity Medical Center (SVCMC) in Cleveland, Ohio; 2) determine the effectiveness of quaternary ammonium compound (QAC) wipes; and 3) heighten awareness of potential dissemination of pathogens by mobile phones in the hospital setting. A total of 50 mobile phones were randomly sampled from podiatric surgical resident physicians and internal medicine resident physicians at SVCMC. For each mobile phone, a swab was collected from the touch screen prior to use of QAC wipes and following use of QAC wipes. The results demonstrated that 82% (41/50) of mobile phone touch screens possessed polymicrobial organisms and of those, 37% (15/41) of mobile phones possessed pathogenic organisms. The vast majority of residents, 98% (49/50) used their phones within the hospital and 37% (18/49) used their phones inside patient room. Most of the residents, 86% (43/50), did not clean their phones on a daily basis and of the residents who did, a majority of them, 71% (5/7) used either dry wipes or alcohol wipes. Sanitizing mobile phones with QAC disposable wipes was shown to be an effective infection control intervention as mobile phone touch screens showed no growth after two minutes of sanitization. QAC could potentially decrease the transmission of microorganisms that cause diseases and reduce the risk of cross contamination infections from mobile phones.

INTRODUCTION

Today, mobile phones have become one of the most essential accessories to both personal and professional life. Mobile phones are frequently handled throughout the day and are held close to the face and mouth. They are placed on various surfaces in a variety of rooms (i.e. bedroom, bathroom, floor, and kitchen) and are used during various activities (i.e. driving, showering, breastfeeding, bathroom use, and cooking) (1-6) (Figure 1). Mobile phones are a health hazard and have been identified as one of the carriers of bacterial pathogens (7). Research has demonstrated that a square inch of a mobile phone contains 10,000 microbes, which is significantly more than the sole of a shoe or a door handle (8). The consistent heat generated by phones creates a breeding ground for colonization of microorganisms. The regular use of mobile phones

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makes them a potential source for transmission of microorganisms that cause disease (9,10).

Hospital-acquired infections in United States (U.S.) hospitals cause 1.7 million infections per year and are associated with approximately 100,000 deaths each year. It is estimated that one third of these infections could be prevented by adhering to standard infection control guidelines (11). The Center for Disease Control and Prevention (CDC) and World Health Organization (WHO) guidelines on hand hygiene in health care require decontamination of hands with preferentially alcohol-based hand rub, or alternatively, soap and water before and after direct patient contact, after removing gloves, and after contact with inanimate objects in the patients' immediate environment (12). Rusin, et al. documented both gram-positive and gram-negative bacteria in hand- to-mouth transfer during casual activities. This implies that mobile phones may serve as vehicle of transmission for diseases such as diarrhea, pneumonia, boils, and abscesses (13). Mobile phones are often used in hospitals by patients, visitors, and health care workers. Unlike hands, which are more readily sterilized with hand sanitizers, mobile phones are cumbersome to clean and users rarely make the effort to sanitize them.

The first study of bacterial load on mobile phones was conducted in a teaching hospital in Turkey with a bed capacity of 200 and one intensive care unit. One-fifth of the mobile phones examined in a study conducted in New York were found to harbor pathogenic microorganisms. Health care workers' mobile phones provided a reservoir of bacteria known to cause nosocomial infection (14). Cleaning of mobile phones throughout the day has been shown to decrease the bacterial load, but it requires effort from health care workers (15). Other studies have shown that health care workers do not often comply with cleaning protocols (16-18).

The CDC guidelines for cleaning and disinfecting environmental surfaces in health care facilities suggests to disinfect noncritical medical devices such as bedpans, blood pressure cuffs, crutches, and computers with an Environmental Protection Agency (EPA)-registered hospital disinfectant (19). High-touch environmental surfaces (HTES) (i.e. bed rails, bedside tables, call buttons, telephones, chairs, wall-mounted vital signs equipment, intravenous medication stands, door knobs and handles, bathroom hand rails, and toilet seats) require appropriate decontamination to reduce the risk of contamination of hands of health care personal (20). Disinfectant pre-soaked wipe (DPW) utilize the microbicidal action of disinfectant coupled with physical removal by way of wiping the HTES (21).

Touchscreen phones have been found to harbor fewer microbes than equivalent keypad devices due to the irregular surfaces of keypad phones, but data are limited regarding effective disinfecting protocols (22). Apple, Inc. forbids the use of wet cleaning wipes citing possible screen damage as the reason (23). However, in order for mobile phones to be successfully used in a clinical setting, appropriate and effective cleaning must be demonstrated. Disinfectants with quaternary ammonium compounds are commonly used in hospitals for surface decontamination. Sani-Cloth® has not only shown that a single disinfection prevents further contamination, it has also shown it could be effective for up to 12 hours despite the opportunity for repeated contamination (24). The active ingredient in Sani-Cloth® (Professional Disposables International Ltd, Flint, UK) wipes are quaternary ammonium compounds (QAC) (25, 26) which chemically consist of nitrogen cations covalently bonded to alkyl groups some of which contain long carbon chains.

Table 1: QUESTIONNAIRE FOR EACH PARTICIPANT AT TIME OF SWAB

QUESTION	RESULTS	
1. Do you use your mobile phone within the hospital?		
Yes	98%	49
No	2%	1
2. How many hours per day do you use your mobile phone?		
>12H	18%	9
8-12H	26%	13
4-8H	26%	13
1-4H	30%	15
3. Which locations do you use your phone?		
Hospital	98%	49
Patient's Room	37%	18
Restroom	40%	20
Home	90%	45
4. How frequently do you clean your phone?		
1x/day	14%	7
Occasionally	38%	19
Rarely	36%	18
Never	10%	5
5. What cleaning agent do you use? (Check all that apply)		
Dry Wipe	42%	21
Alcohol	34%	17
Purple Sani-Cloth	10%	5
Orange Sani-Cloth	2%	1
Other (Clorox, Lens Cleaning Solution, Soap Water)	16%	8
6. How long ago did you last clean your phone?	≈ 19.74 DAYS	
7. Do you wash your hands		
a. Before using your phone		
Yes	10%	5
No	90%	45
b. After using your phone		
Yes	6%	3
No	94%	47
8. Do you use your phone to check the time?		
Yes	82%	41
No	18%	9

In this study, investigation was performed to determine 1) the microbiological flora (qualitative and quantitative) of St. Vincent Charity Medical Center (SVCMC) residents' mobile phones, 2) the effectiveness of QAC disposable wipes on disinfecting mobile phones, and 3) increase awareness

Table 2: NUMBER OF ISOLATES AND TYPES OF MICROORGANISMS FROM TOUCH SCREEN MOBILE PHONE DEVICES OF RESIDENTS

Total number of cultivated swab samples	50		
Positive Culture	41 (82%)		
TYPE OF MICROORGANISMS	**TOTAL COLONIES (CFU/ML)**	**AVERAGE TOTAL COLONIES (CFU/ML)**	**# OF PHONES WITH ISOLATE**
Non-Pathogenic			
CoNS	385	12	32
Diphtheroides sp.	163	6	26
Dematiaceous	1	1	1
Penicillium	4	1	4
Bacillus sp.	89	11	8
Micrococci sp.	21	5	4
Alpha Strep sp.	63	6	10
Aspergillus sp.	5	3	2
Mold sp.	11	6	2
Pathogenic			
S. aureus	312	31	10
Proteus sp.	6	3	2
Pseudomonas sp.	5	3	2
Enterobacter sp.	2	2	1
Strep sp.	8	8	1

and concern of mobile phones as potential vehicle of transmission of pathogenic microorganisms among hospital settings.

MATERIALS AND METHODS

SAMPLES COLLECTION

The study was conducted at St. Vincent Charity Medical Center in Cleveland, Ohio. SVCMC has 450 inpatient beds, 20 intensive care unit beds, and 24 emergency department beds. A total of 50 mobile phones were randomly selected from internal medicine and podiatric medicine and surgery residents during the hours of 8 a.m. to 4 p.m. After cleaning of hands with an alcohol-based instant hand sanitizer, powder-free disposable nitrile gloves were worn. A moistened sterile cotton swab with normal sterile saline was used to swab the touch screen surface across an approximate 28cm^2 area (Figure 2) after which the swab was immediately placed into a sterile container and sealed with the cotton end soaked in 1 milliliter of sterile normal saline. The phone surface was then cleaned thoroughly with QAC wipes (Figure 3) and remained wet for two minutes and air- dried as recommended by the manufacturer's technique. After the surface was allowed to dry for five minutes, the phone was re-swabbed in the same fashion. The same technique was employed for each of the 50 samples.

QUESTIONNAIRE

A questionnaire was distributed and completed by all participants pertaining to mobile phone use (Table 1).

ORGANISMS IDENTIFICATION

Swabs collected from mobile phones were vortexed for 60 seconds to elute the microbes. Samples were then plated onto 5% Trypticase™ Soy Agar and incubated in a CO2 incubator for 48 hours. Identification was performed by standard microbiological methods.

SOURCE OF FUNDING

There was no source of external funding for this study.

RESULTS

Of the 50 mobile phones sampled, only 18% (9/50) revealed no growth. Polymicrobial growth was detected in 82% (41/50) of the mobile phones. Pathogens isolated from the phone samples included: coagulase negative staphylococcus (CoNS), Staphylococcus aureus (S. aureus), Bacillus species (sp.), Diphtheroides, Micrococcus sp., Proteus sp., Pseudomonas sp., Alpha Streptococcus (Strep) sp., Enterobacter sp., Strep sp., Aspergillus, Penicillium, Mold sp., and Dematiaceous (Table 2). After cleaning the mobiles phones with QAC wipes, mobile phones were swabbed in an identical fashion and all phones revealed no growth. Among the organisms isolated, CoNS was most prevalent and harvested from 32 phones with an average of 12 colony-forming units (CFU)/ml. Microorganisms known to be pathogenic (S. aureus, Proteus sp., Pseudomonas sp., Enterobacter sp., Strep sp.,) were isolated from 36% (15/41) of mobile phones.

The vast majority of residents, 98% (49/50) used their phone within the hospital and 37% (18/49) used their phones inside patients' rooms. 40% (20/50) of residents used their phones in the restroom. 82% (41/50) of residents used their phone regularly to check the time (Table 2).

10% (5/50) of residents never cleaned their phones and 74% (37/50) occasionally or rarely cleaned their phones. On average, residents had not cleaned their phones for 19.74 days at the time of the initial random swab. Only 14% (7/50) of the residents cleaned their phones daily; however, a majority of the residents 71% (5/7) used either dry wipes or alcohol and all residents had

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Figure 1

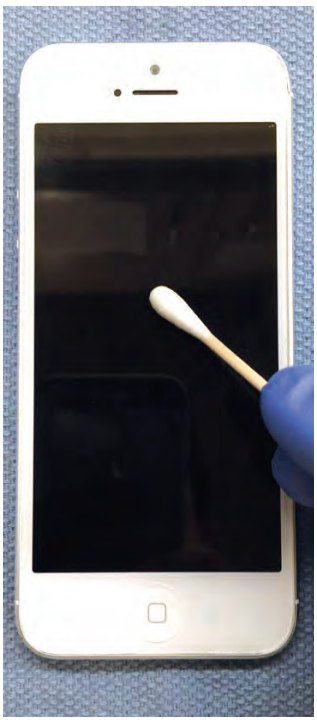

Figure 2

Fig 1 Various locations of mobile phone use in the hospital setting. Fig 2 Moistened sterile cotton swab used to culture the touch screens of 50 mobile phones.

organisms isolated from their mobile phones. A total of 42% (21/50) of residents used dry wipes to clean their phone and only 10% (5/50) of the residents used QAC disposable wipes. Only 10% (5/50) of the residents washed their hands before using their phones and 6% (3/50) washed their hands after using their mobile phones. None of the residents washed their hands before and after using their mobile phones.

DISCUSSION

Mobile phones are multipurpose, non-medical devices used in health care facilities. Health care facilities have few restrictions on mobile phone use even in sensitive areas such as intensive care units and operating rooms.

Greater than 5 CFU/cm^2 of microorganisms is considered unacceptable in health care environments (27). This study demonstrated 88% of mobile phones had polymicrobial organisms isolated from residents' mobile phones and 30% of the mobile phones had pathogenic organisms. Of the pathogenic organisms isolated on mobile phones in this study, all had ≤ 1 CFU/cm^2, which is still considered acceptable in health care environments; however, the vast majority of residents (98%) used their phones within the hospital, and 37% used their phones inside patients' rooms. This raises concern for potential spread of pathogenic bacteria to patients from microorganisms on the mobile phones.

Many of the residents (86%) did not clean their phones on a daily basis and of the ones who did, a majority of them used either dry wipes or alcohol wipes. When wiping with 70% isopropanol, it has been shown to not adequately disinfect surfaces with high titers of pathogenic microorganisms (28). A few of the residents (6%) used Clorox® Disinfecting Wipes (Clorox, Oakland, CA, USA) to clean their mobile phones. Although Clorox® reduced pathogenic counts, it has been shown to have a short-lived effect and immediate repeat contamination resulted in microbial growth when swabbed. In a clinical environment, repeated cleaning with Clorox® would be required after every potential contamination (24).

QAC wipes have shown that a single disinfection prevents further contamination and could be effective for up to 12 hours in spite of repeated opportunistic contamination (24). Ammonium compounds within QAC is well known to have a wide spectrum of antimicrobial activity including some antifungal and antiviral properties, although it is ineffective against norovirus and Clostridium difficile (C. Difficile) (29). In this study, QAC wipes were an effective method of disinfecting mobile phones with no microorganism growth approximately five minutes after cleaning mobile phones with them.

QAC wipes have demonstrated that repeated usage does not have long-term damaging effects on the Apple iPad®. Both the appearance and functionality of the touch screen on the iPad® are not affected (24). One of the downsides of QAC wipes is the 'residual effect' causing a white residue on the touch screen (Figure 4), which would require users to polish the device to remove the residue which would consequently reduce the efficacy of the QAC wipes (24).

None of the dry wipes, alcohol wipes, Clorox® wipes, or QAC wipes have the ability to eradicate C. difficile. Tristel wipes system has been shown to be effective in

Figure 3

Figure 4

Figure 5

Fig 3 Surface of mobile phones cleaned post-culture with QAC wipes.
Fig 4 Post QAC wipe mobile phone was left wet for two minutes and air dried per manufactures instructions. Post-wipe residue present.
Fig 5 Protective sleeves for use in operating room setting with no interference of talk and touch function. The principle drawback is the cumbersome nature of the sleeve.

reducing C. difficile colony counts. Tristel is a chlorine-based cleaning wipe system, which includes a sporicidal component. There is evidence that sodium hypochlorite may be effective against C. difficile, but its safety for use on iPads® has yet to be established (30).

The use of mobile phones is a concern within the operating room setting. Mobile phones are commonly used in the operating room by staff, vendors, residents, and physicians and have been found to possess a high rate of pathogenic bacterial contamination and organic material such as food, human secretions, and excretions (31). The bacterial and organic material load was decreased after a single disinfecting process with commercially available cleaning wipes safe for mobile phone use.

The use of mobile phones by inpatients is also a concern. 1) Demographics, 2) characteristics of mobile phones, and 3) phone surface microbial contamination used by inpatients were examined by Brady, et al (32). A majority of the inpatients (70.3%) completed a questionnaire about the utilization of mobile phones and also provided their mobile phones for bacteriological analysis and comparative bacteriological swabs from their nasal cavities. The majority of the patients (94%) supported utilization of mobile phones by inpatients and 24.5% of patients stated that mobile phones were vital to their inpatient stay.

In addition to mobile phones as potential vehicles of pathogenic bacterial dissemination, multiple studies have shown that white coats, neckties, keyboards, and stethoscopes (33-36) are also potential vectors. White coats' sides, collars, and pockets were the most highly contaminated areas (33). Neckties are 'poor practice' (other than bowties) when in contact with patients as they 'serve no beneficial function' in patient care, are rarely laundered, and have colonized pathogens in health care settings (34). More than half of the keyboards in hospitals had isolated pathogens (35). Lastly, stethoscopes have been shown to have significant bacterial contamination resistant to multiple classes of antibiotics (36). Disinfections before and after each patient contact of any potential vector is recommended to avoid the spread of pathogenic microorganisms.

CREATING A POLICY

The results of this study and others suggest a feasible policy of mobile phone usage among patients, visitors, and health care workers could be formulated for hospital settings. Mobile phones are essential devices for professional and social lives of users and restrictions on the use of mobile phones is difficult and not a practical solution.

Mobile phone users need to be regularly advised on the use of effective sanitizer wipes in order to decrease the bacterial load of mobile phones. Sanitizing mobile phones regularly will reduce the risk of recontamination while allowing the use of mobile phones in the hospital setting. Specific software applications have been developed to remind users to regularly disinfect their devices. Using the wipes is economical and not time consuming (37).

In addition, a standard infection guideline should be implemented for before and after mobile phone use such as hand washing and sound hygienic practice in order to prevent mobile phones as vehicles of transmission of both hospital and community acquired diseases.

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Furthermore, possible abstinence from use of mobile phones within a patient's room and operating room or use of a protective sleeve (Figure 5) could be helpful in preventing the transmission of pathogens.

CONCLUSION

Mobile phones have become a part of personal and professional life and accompany patients and health care providers everywhere. Furthermore, they are a principal source of communication among health care providers within the hospital. The regular use of mobile phones within the hospital setting may serve as a vehicle of transmission of microorganisms that can cause disease in human beings. Consequently, it is important to regularly disinfect mobile phones, especially health care professionals whose hygiene can directly impact patients' wellbeing.

Further research including phenotyping and genotyping organisms may discover a direct link between mobile phones and hospital-acquired infections. Awareness and concern among health care providers of mobile phones use can help control infection and avoid transmission of diseases. Possible solutions include guidelines for curtailing mobile phone use among patients and health care providers.

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Reducing the Rate of Patients Leaving Against Medical Advice, A Pilot Intervention

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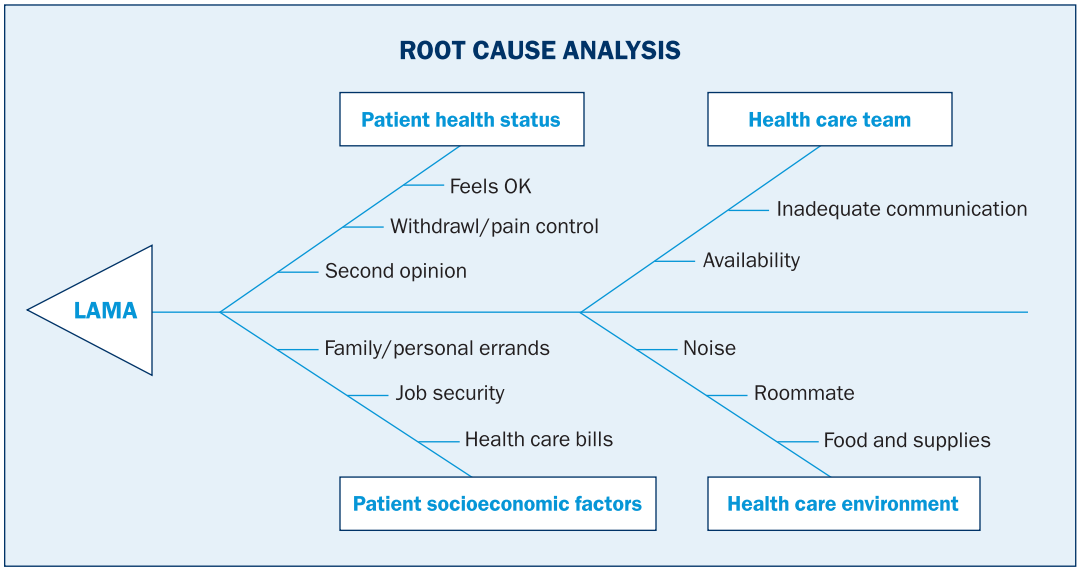
ABSTRACT

Patients leaving the hospital against medical advice (LAMA) affects patient safety and health care quality. We set out to examine the reasons patients leave inpatient service at St. Vincent Charity Medical Center and to develop an intervention to reduce LAMA. We performed a root cause analysis of LAMA after examining the records of LAMA in 2016. Our intervention focused on bridging the communication gap between patients and the health care team. The pastoral care team (interventionist) at St. Vincent Charity carried out intervention over a one-month period. The interventionists were able to abort 8 out of 12 (67%) potential LAMA. We learned from our experience that bridging gaps in communication between clinical care teams and patients may help prevent LAMA.

Appendix 1 (*LAMA=Leaving Against Medical Advice)



INTRODUCTION

LAMA is not an uncommon phenomenon across hospitals in the U.S. About 1 to 2% of all inpatient stays result in LAMA. [1] LAMA has implications for patient safety and health care quality. Patients who leave the hospital against medical advice are twice as likely to be readmitted or die within 30 days of discharge compared to patients whose discharges are planned. [2] Furthermore, the cumulative cost of care during a 30-day readmission is estimated to be 56% higher than expected from an initial hospitalization. [3]

Risk factors associated with LAMA have been well documented by various studies. These risk factors include: African American race, young age, male sex, low socioeconomic status, lack of medical insurance, previous LAMA, and substance abuse [3-7]. Additionally in about 75% cases of LAMA, there was warning of impending LAMA and documentation of LAMA disposition was found to be suboptimal. [7] Even though much is known about the harms, risk and cost of LAMA, barely any study has looked at the phenomenon from a quality improvement standpoint, or to test interventions to reduce of LAMA.

At St. Vincent Charity, LAMA accounts for 1.8% of all inpatient discharges and, every month, approximately 15 patients leave the hospital against medical advice [8].We set out to examine the reasons patients leave inpatient service at St. Vincent Charity and to develop intervention to reduce LAMA. We also sought to improve the documentation of LAMA disposition.

METHOD

The quality improvement project was carried in two phases, Phase 1 and Phase 2.

PHASE 1

We conducted a review of patients who were admitted at St. Vincent Charity between January 2016 and December 2016, but left the hospital against medical advice. The chart review and data abstraction was performed by 5 reviewers using a designed electronic data abstraction form. A sixth researcher then reviewed and checked all the abstracted data for consistency and accuracy of information. The data abstraction included: patient demographics, day

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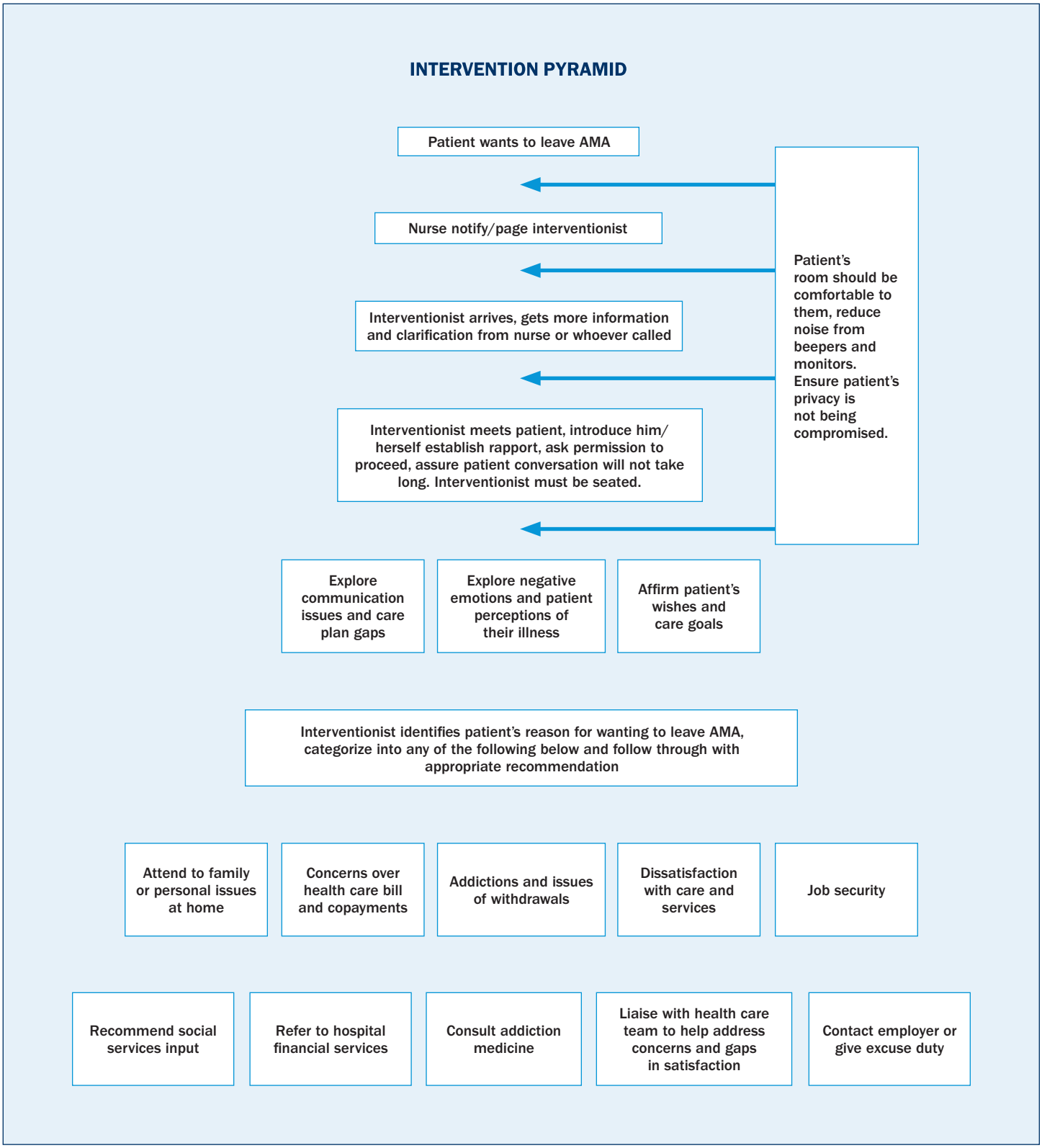
Appendix 2 (Nannette Woldin 216.363.7426 and Trina Steward-Burpo 216.363.2526)**



of LAMA, month of LAMA, length of stay, pain on admission, admitting diagnosis, number of co-morbidities, urine toxicology, patient reason for LAMA, whether patient signed LAMA form, prescription of medication, follow up, and 30-day readmission.

PHASE 2

Phase 2 of the quality improvement included performing a root cause analysis of LAMA (appendix 1), developing an intervention, and rolling out evaluating the intervention.

INTERVENTION AND INTERVENTIONIST

A quality improvement (QI) team was constituted. The core of the QI team included six internal medicine residents, supervising attending and pastoral care team. Other members of the QI team were case managers from each medical floor and nurse in-charges on the various medical floors. Creating this team is consistent with previous QI studies which have shown that staffs are more likely to support change if they are involved in developing solutions and have opportunity to voice their concerns. [9]

The focus of our intervention was to bridge gaps in communication between patients and clinical care teams, and make available to patients resources to help address their concerns. SVCMC pastoral care team carried out intervention. Pastoral care is an integral clinical resource at St. Vincent Charity. Members of pastoral care hold masters degree in divinity and are skilled in communication and handling of challenging conversations with patients. Pastoral care brings spiritual and emotional support to bear on patients' hospital experience.

The intervention included a pastoral team member (interventionist) getting called to the room of a patient who threatened LAMA, effectively listening, being non-judgmental, exploring patient concerns and challenges, and liaising with the clinical care team to have the patient's concerns resolved. Role plays were performed using actual clinical scenarios to further equip the interventionists. The intervention was carried out over a 4-week period and, per availability of interventionist, weekend calls were excluded. The goal of the intervention was to reduce LAMA by 50%. Details of intervention are presented in appendix 2.

ROLL OUT OF INTERVENTION

Intervention was rolled out on April 11, 2017. Stakeholders including nursing staff, case managers, pastoral care, and medical doctors were made aware. Alert posters were displayed on notice boards on the inpatient floors. Post intervention survey was incorporated into the EMR to help improve documentation of LAMA disposition. Weekly evaluation of intervention was done using the plan-do-study-act model.

RESULTS

Interventionists were called to see 12 patients who had informed their nurse about wanting to leave against medical advice. Eight out of the 12 (67%) patients decided to stay after their encounter with an interventionist. There were four other patients who were not seen by intervention, either because LAMA event occurred after interventionist work hours or was a case of absconding, which brought the total number of LAMA at the end of month to 8.

CONCLUSION AND RECOMMENDATIONS

We learned from our experience that bridging the communication gap between the clinical care team and patients may help reduce the rate of LAMA. Effective communication, including timely delivery of results, care plan, seeking patient input regarding care, may go a long way to reduce patient anxiety and feelings of uncertainty regarding their health. Effective communication during physician-patient encounter is known to lead to better outcomes, including patient satisfaction. [10, 11]

CHALLENGES AND LIMITATIONS

The study was limited by the availability of interventionists who were themselves engaged in other work in the hospital. The interventionists were not available on weekends and were available for only a month. This limited the volume of data. This notwithstanding, 50% reduction in LAMA was achieved.

Medical residents involved in the quality improvement were not always available because of their work schedule and residency demands.

Applicability of our study to other hospital settings may be limiting because of the unique setup of St. Vincent Charity, a faith-based organization and teaching hospital. Nevertheless, the study provides a model that can be adapted to suit every hospital's unique setting. The findings may also provide motivation to care givers to reduce LAMA.

RECOMMENDATIONS

Dissemination of the findings of this report to health care staff to raise awareness of the problem of LAMA, so as to promote collaboration and engagement among care givers to find a lasting solution. We identified that some patients' reasons for LAMA can directly be addressed by the nurses and doctors.

Seek funding to scale up intervention to reduce LAMA, promote timely monitoring and data collection.

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Utility of Ankle-Brachial Index in Screening for Peripheral Arterial Disease in Rural India: A Cross Sectional Study and Review of Literature

By **Ramyashree Tummala, MD; Kapil Mahajan, MD; Anjan Gupta, MD; Keyvan Ravakhah, MD**

BACKGROUND

Peripheral arterial disease (PAD) is an under-diagnosed illness often affecting the elderly population. Ankle brachial index (ABI) is a good diagnostic tool for PAD in outpatient practice, but remains underused. Materials and Methods: Patients were recruited from an outpatient medical camp in rural India, and assessed for symptoms and pre-existing risk factors. Measured ABI ≤ 0.9 was considered abnormal and considered PAD. Results: out of 100 patients recruited, PAD was diagnosed in 57 common. Associated risk factors were: like age >55 years (67%); hypertension (66%); smoking (69%); and diabetes mellitus (35%). Conclusion: PAD is a very common and underdiagnosed illness in rural India. A simple tool like ABI can help diagnosis in underserved areas.

KEY WORDS

Peripheral Arterial Disease; Ankle Brachial Index; screening

INTRODUCTION

Peripheral Arterial Disease (PAD) is a major cause of morbidity and mortality predominantly affecting the elderly population. [1] PAD is largely undetected due to its silent progression which warrants pre-symptomatic screening. [2] Screening for PAD is based on the definition of ankle brachial index (ABI) ≤ 0.90 (American College of Cardiology/American Heart Association (ACC/AHA) 2005 guidelines.) [3] ABI is a symptom independent, simple, cost effective reliable screening tool for PAD in primary care but remains underused. [4] For diagnosis of PAD, ABI of less than 0.9 is 95% sensitive and close to 100% specific. [1,3] In a rural population with limited access to health care, PAD remains understudied. In this study, we wanted to measure the disease burden and risk factors of PAD in a rural part of Gujarat, India.

Table 1: DEMOGRAPHICS OF STUDY SUBJECTS

Parameter	Overall n = 100	Male n = 64	Female n = 36	p-value
Age (yrs)	59.3 ± 11	59.9 ± 12	58.2 ± 9	0.45
BMI (kg/m2)	22.2 ± 1.8	22.2 ± 1.8	22.3 ± 2.1	0.78
HTN	66 (66)	38 (59)	28 (78)	0.06
DM	35 (35)	21 (33)	14 (39)	0.54
CAD	30 (30)	21 (33)	9 (25)	0.41
Smoking	69 (69)	47 (73)	22 (61)	0.2
Hyperlipidemia	3 (3)	1 (2)	2 (6)	0.29
FBS	106.4 ± 15	107.4 ± 15	104.4 ± 16	0.34
Brachial pressure	137 ± 24	138 ± 23	136 ± 25	0.78
Ankle pressure	119 ± 25	121 ± 28	116 ± 28	0.35
ABI	0.87 ± 0.12	0.88 ± 0.13	0.85 ± 0.11	0.17
Foot Ulcers	8 (8)	4 (6)	4 (11)	0.39

Table 1: RISKS ASSOCIATED WITH PAD

Parameter	Overall (n = 100)	PAD (n = 57)	No PAD (n = 43)	p-value
Female	36 (36)	26 (46)	10 (23)	0.02
HTN	66 (66)	44 (77)	22 (51)	0.007
DM	35 (35)	30 (53)	5 (12)	< 0.001
CAD	30 (30)	30 (53)	0	< 0.001
Smoking	69 (69)	48 (84)	21 (48)	< 0.001
Hyperlipidemia	3 (3)	3 (5)	0 (0)	0.26
Family history	3 (3)	2 (4)	1 (2)	1
Age	59.3 ± 11	61.9 ± 8.7	55.8 ± 12.9	0.006
BMI	22.2 ± 1.8	22.9 ± 1.9	21.2 ± 1.4	< 0.001

Binary outcomes are expressed as n(%)

MATERIALS AND METHODS

This study was carried out in a tribal belt of Gujarat with poor access to health care facilities. At an outpatient medical camp, patients were screened for study participation. All men and women between 18 and 80 years of age were considered, excluding patients with prior history of amputation of any limb. After screening, patients were randomly recruited using pre-randomized, sealed envelopes. After informed consent, a thorough history and physical examination was obtained. Resting brachial and ankle blood pressures were measured in supine position on both extremities, 5 minutes apart. The mean pressure recorded and ABI was calculated. All measurements were carried out with a mercury sphygmomanometer and handheld pulse Doppler using a standard technique. Patients with ABI ≤ 0.9 were considered to have PAD.

STATISTICAL ANALYSIS

Continuous variables were expressed as mean ± SD and compared using student's t-test. Categorical variables were expressed as numbers (percentage) and compared with a x^2 or Fisher exact test as appropriate. Level of significance was set at 5% for the analysis. Adjusted odds ratios (OR) for potential risk factors were calculated using multivariable logistic regressions, using univariable regressions to choose variables. All statistical analysis was done in Stata® v13.1 (StataCorp LP, College Station, TX).

RESULTS

Due to resource constraints, the study was limited to 100 patients. Mean age was 59.3 ± 11 years and 36% were females. Smokers comprised 69% of the sampled population, 66% of subjects were hypertensive, and 35% were diabetic. There was no statistically significant difference between sexes in terms of demographics.

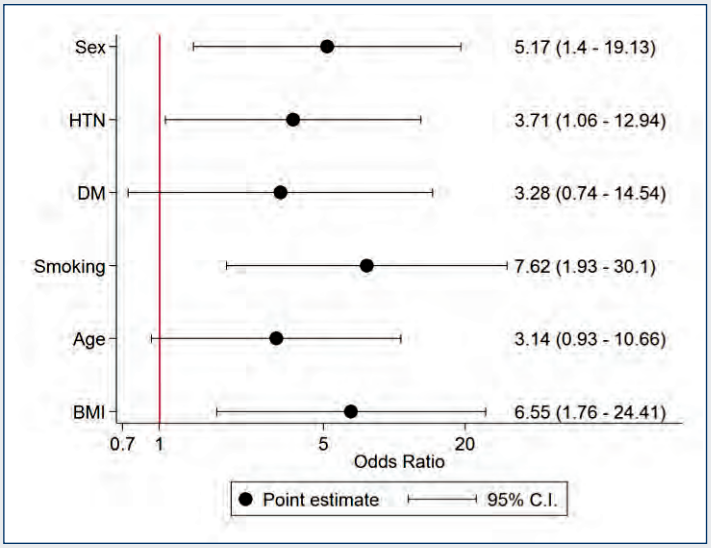
Mean ABI for all subjects was 0.87 ± 0.12. A cut-off value of ABI ≤ 0.9 was used, resulting in 57 patients being diagnosed with PAD. Patients with PAD were more frequently females (46% vs 23%, p = 0.02), hypertensive (77% vs 51%, p = 0.007) and diabetic (53% vs 12%, p < 0.01). All patients with a history of known coronary artery disease (CAD, 30 patients) were found to have PAD. Smokers were commonly found to have PAD (84% vs 48%, p < 0.01). These observations are described in Table 1.

Female sex, hypertension, diabetes mellitus and smoking were found to be predictors of PAD in univariable analysis. Multivariable analysis showed smoking to be the strongest independent predictor of PAD (OR 7.62, 95% CI: 1.93–30.1, p=0.004). On multivariable analysis, age did not show a correlation to prevalence of PAD (OR 3.14, 95%CI 0.93–10.66, p=0.066). Odds ratios and confidence intervals obtained on multivariable analysis are plotted graphically in Figure 1.

DISCUSSION

PAD is a disease of peripheral arteries of lower extremities. [1] After CAD and stroke, PAD is the third leading cause of cardiovascular morbidity. [5] The pathology of PAD is predominantly due to atherosclerotic narrowing of arteries. While prevalence of PAD from developed countries has been widely studied, data are lacking from underdeveloped nations. There are very few published accounts of PAD in rural India.

Figure 1: ADJUSTED ODDS RATIOS FROM MULTIVARIABLE ANALYSIS



Since PAD is primarily asymptomatic, diagnosis in a limited health care setting is difficult. ABI is a cheap and simple diagnostic test to screen for PAD in the community. It is defined as the ratio of highest systolic pressure at the ankle to that of the brachial artery. [6] It has a high sensitivity and specificity, which combined with low costs, make ABI an excellent screening test of choice in populations at risk. [2,3] Well-known risk factors for PAD include smoking, diabetes, hypertension, dyslipidemia, obesity and cardiovascular disease [7]. In our study we found a very high proportion of smokers (69%), hypertensive patients (66%) and diabetics (35%). On multivariable analysis, female sex, hypertension, and smoking were strongly associated with PAD. Smoking showed a strong association with PAD (Adjusted OR 6.75, p<0.01). Most diabetics in our study were also smokers. Since smoking is a known predictor of PAD, we could not investigate the association of diabetes with PAD.

Solanki et al. have studied PAD in diabetics in urban India. Among 110 diabetics included, 46% had symptomatic PAD and 35% had low ABI. [8]. Premalatha et al. conducted a larger study in urban South India. 1,262 eligible subjects above the age of 20 participated. Oral glucose tolerance test was used to classify subjects into normal, impaired glucose tolerance (pre-diabetic) and diabetic. Prevalence of PAD in normal, pre-diabetics and diabetics was 2.7%, 2.9% and 6.3% respectively with overall being 3.2%. They found age over 50 years was a significant risk factor but observed no association with smoking. [9] However, ABI was measured in only 50% of subjects. This, in addition to the fact that this study was conducted in an urban area, may explain the reports of low prevalence of PAD in the study. Sarangi et al. studied the correlation between PAD and CAD using ABI in an inpatient setting in India. All patients were above the age of 45 years. Out of 182 patients only 32 (18%) had PAD, of which 15 patients

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The Correlation Between Procalcitonin Level and SOFA Score in Patients Diagnosed with Pneumonia in the Intensive Care Unit Setting

By **Yasser Al-khadra, MD; Fahed Darmoch, MD; Mohammad Alkhatib, MD; Richard Chmielewski, MD**

BACKGROUND

Numerous studies have demonstrated a tight link between serum procalcitonin (PCT) levels and bacterial infections. Also, septic shock patients were found to have higher PCT levels. Multiple studies were conducted to establish that serum PCT levels could be used to assist in clinical decisions regarding starting antibiotics, de-escalating antibiotics and prognosis. However, there have been no studies to identify a correlation between Sequential Organ Failure Assessment (SOFA) score and PCT levels in pneumonia diagnosed patients in the critical care unit setting (ICU). Our aim was to investigate the correlation between SOFA score and PCT levels in patients diagnosed with pneumonia in the ICU, and to further identify the possible prognostic value of procalcitonin given the proven prognostic value of the SOFA score.

METHODS

We conducted a retrospective study, reviewing 271 medical charts of patients who had been admitted to ICU with a diagnosis of pneumonia from January 2013 through December 2016. PCT level was obtained at time of diagnosis and SOFA score was calculated for each patient. The correlation between PCT and SOFA score was measured by the Pearson product-moment correlation coefficient, r. The p-value cited is for rejecting the hypothesis of zero correlation in a two-tailed test. SPSS software package was used for the analysis.

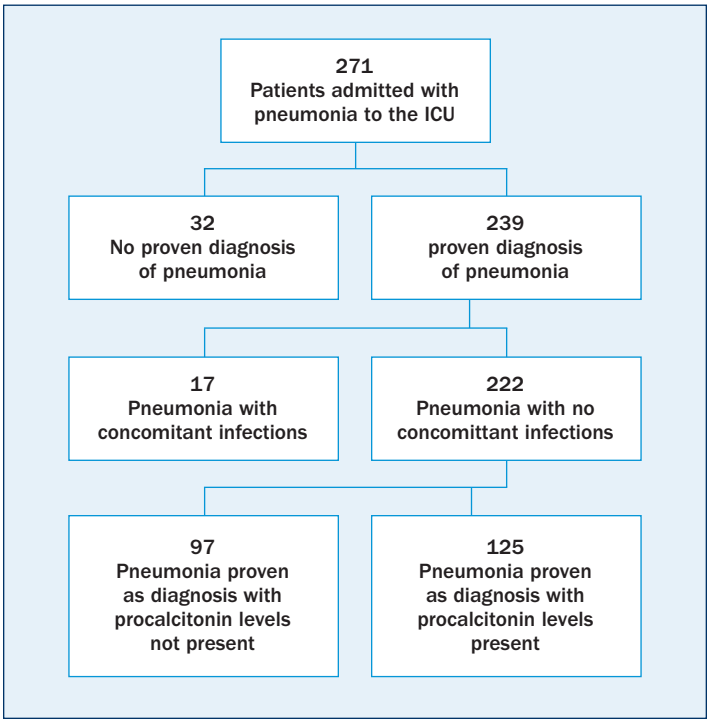
RESULTS

A total of 271 patient charts were reviewed, 49 patients were excluded because of either unproven diagnosis of pneumonia or presence of concomitant infections. We also excluded 97 due to the lack of PCT level at the time of diagnosis. PCT level and SOFA score had a mean of 11.8 and 7 respectively, and 93.6% of the patients had a SOFA score equal to or above 2. After measuring the correlation between PCT and SOFA score, we found that there was a statistically significant correlation between PCT and SOFA score ($p = 0.001$): $r = 0.286$ (95% confidence interval 0.116 – 0.440). We also found a statistically significant correlation between PCT and Glasgow Coma Score (GCS) ($p = 0.05$): $r = -0.199$ (95% confidence interval -0.362 – -0.024), and PCT and creatinine level ($p = 0.01$): $r = 0.414$ (95% confidence interval 0.257 – 0.550).

CONCLUSION

We found a statistically significant correlation between PCT and SOFA score which would suggest the utility of procalcitonin as a prognostic factor in addition to its diagnostic use. More in-depth investigations are needed to determine whether addition of PCT levels to SOFA score would complement and increase the SOFA score's predictive value.

Figure A



INTRODUCTION

Pneumonia is a common diagnosis in both the medical ward and the intensive care unit (ICU). Hospital-acquired pneumonia (HAP), ventilator-associated pneumonia (VAP), and health care-associated pneumonia (HCAP) were and still remain major causes of morbidity and mortality in the United States, despite the advances in diagnosis and treatment measures (1-5). It is of great importance to identify tools to aid in the diagnosis and management of such illnesses.

Several indicators of sepsis and septic shock have been shown to be useful in critically ill patients such as PCT and Interleukin 6 (IL-6). Also, the measured levels of PCT and IL-6 on intensive care unit admission were diagnostic of sepsis (6).

PCT is a prohormone that is normally secreted by the C-cells of the thyroid in response to hypercalcemia. In normal conditions, PCT levels are negligible, but in systemic infections, PCT levels are markedly elevated. The levels of serum PCT correlate positively with the severity of the illness and mortality (7). It has been shown that severe generalized bacterial infections are associated with higher levels of PCT than in instances of viral or noninfectious conditions where its level is low or moderately elevated. (8) (9).

Several scores, such as SOFA scores, have been suggested in the assessment of morbidity and mortality in critically ill and intensive care unit patients. The SOFA score is a multi-component tool that includes partial pressure of oxygen, fraction of inhaled O2, platelet count, Glasgow Coma Scale, Bilirubin levels, blood pressure and the use of vasopressors, and creatinine. The SOFA score was used to assess disease severity (10), and describe organ dysfunction/failure in critically-ill patients (11). The SOFA score was also found to be a useful predictor of outcome, where an increase in SOFA score during the first 48 hours in the ICU predicts a mortality rate of at least 50%. (12)

Although there have been multiple studies discussing the prognostic values of PCT and other inflammatory markers, such as C-reactive protein (CRP), in the prediction of mortality in Ventilator Associated Pneumonia (VAP), the results obtained from these studies have been contradictory (14) (15). To our knowledge, no study has yet compared the prognostic value of SOFA score to PCT levels in pneumonia in the critical care unit setting. Our aim was to investigate the presence of a correlation between SOFA score and PCT levels to identify a possible prognostic value of PCT given the proven prognostic value of the SOFA score.

Table 1: BASELINE CHARACTERISTICS OF PATIENTS

Characteristic		Number	Percentage
Age – Year	≤ 65	74	59.2 %
	> 65	51	40.8 %
Gender	Male	78	62.4 %
	Female	47	37.6 %
Race	African American	68	54.4 %
	White Caucasian	57	45.6%
Diagnosis of COPD	Yes	35	28 %
	No	90	72 %

Table 2: DEMOGRAPHICS

Variables	Maximum	Minimum	Mean	95% CI
Age (Year)	91	23	62.18	59.51 – 64.85
PCT (ng/mL)	192	0.05	11.8	7.37 – 16.27
PaO2 (mmHg)	389	26	96.8	87.38 – 106.32
FIO2 (%)	100	0	43	37.74 – 48.3
PLTs (K/uL)	670	52	209.7	191.55 – 227.85
GCS (points)	15	3	11.19	10.5 – 11.87
Bilirubin (mg/dL)	3.6	0.1	0.81	0.70 – 0.92
Creatinine (mg/dL)	15.5	0.15	2.6	2.19 – 3.04
SOFA (points)	16	0	7.03	6.33 – 7.73

METHOD

We reviewed 271 medical charts of patients who were diagnosed with pneumonia in the intensive care unit from January 2013 through December 2016. Then, we excluded all the charts that did not have an end diagnosis of pneumonia, did not have PCT values, had concomitant infections, or had missing data for the calculation of SOFA score (Figure A).

A diagnosis of pneumonia was made starting with clinical suspicion which included a history of one of the following: a cough, sputum production, fever, and chills with radiographic evidence of consolidations in the lung.

We collected age, gender, race, partial pressure of oxygen, fraction of inhaled O2, platelet count, Glasgow Coma Scale, Bilirubin levels and creatinine levels, as well as past medical history of Chronic Obstructive Pulmonary Disease (COPD). We calculated SOFA score for each patient based on the data collected.

The quantitative data were summarized by the sample mean and sample standard deviation (SD). The correlation between PCT and SOFA score, PCT and GCS, and PCT and creatinine level was measured by the Pearson product-moment correlation coefficient, r. The p-value cited is for rejecting the hypothesis of zero correlation in a two-tailed test. Also given is the 95% confidence interval for r. SPSS software package was used for the analysis.

RESULTS

Demographics

The mean age of patients in the study was 62. Of the 125 patients we reviewed, 62.4% were of male gender and 54.4% were of the African American race. Only 28% had been previously diagnosed with COPD (Table 1). Our data showed that the mean GCS was 11 (95% CI 10.5 - 11.9), while 26.4% had a GCS of 15 and 9.6% a score of 3. PCT had a mean of 11.8 and SOFA score had a mean of 7 and 93.6% of the patients had a SOFA score equal to or above 2 (Table

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Figure B

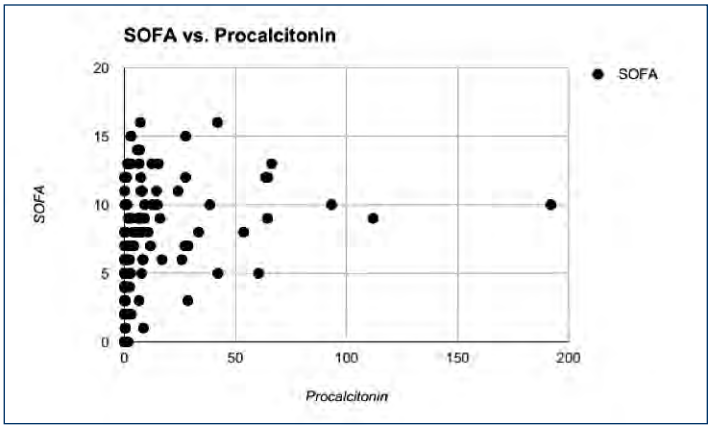
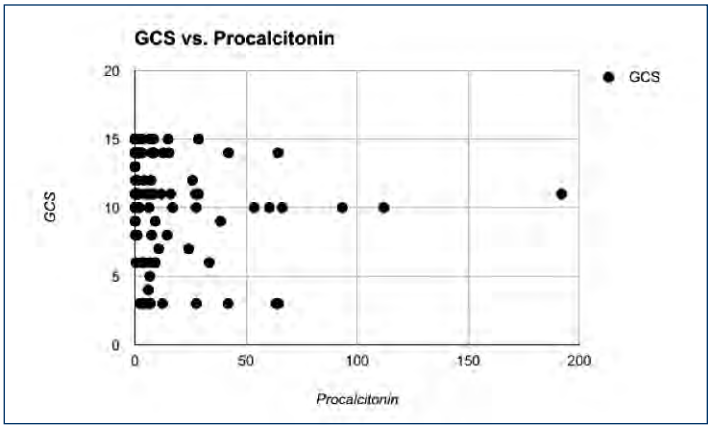


Figure C



2). Negative blood culture and sputum cultures were found in 78.4% and 64.8% of patients respectively.

The Correlation

Primary Outcome

After measuring the correlation between PCT and SOFA score by the Pearson product-moment correlation coefficient, we found that there was a statistically significant correlation between PCT and SOFA score ($p = 0.001$): $r = 0.286$ (95% confidence interval 0.116 – 0.440). Figure B.

Secondary Outcomes

The correlation between PCT and GCS by the Pearson product-moment correlation coefficient demo strated a statistically significant correlation between PCT and GCS ($p = 0.05$): $r = -0.199$ (95% confidence interval -0.362 – -0.024) (Figure C). Furthermore, the correlation between PCT and creatinine level by the Pearson product-moment correlation coefficient demonstrated a statistically significant correlation between PCT and creatinine level ($p = 0.01$): $r = 0.414$ (95% confidence interval 0.257 – 0.550) (Figure D).

DISCUSSION

This study was designed to investigate a correlation between SOFA score and PCT level in patients admitted to the ICU with a diagnosis of pneumonia in order to determine the possible prognostic value of PCT and the usefulness of adding PCT to SOFA score.

SOFA score is a dedicated numerical number which quantifies the severity of failed organs and therefore provides potentially valuable prognostic information on in-hospital survival when applied to patients with severe sepsis, with or without evidence of hypoperfusion. Numerous studies have identified a correlation between the number of failed organs and both short-term and long-term mortality among patients with infection (18). SOFA score objectively calculates the number and the severity of organ dysfunction in six organ systems (respiratory, coagulation, liver, cardiovascular, renal, and neurologic). The use of the SOFA score is considered an acceptable method for risk stratification and prognosis of patients with severe sepsis with fair to good accuracy for predicting in-hospital mortality. The increment in SOFA score was found to have a positive correlation with in-hospital mortality (19).

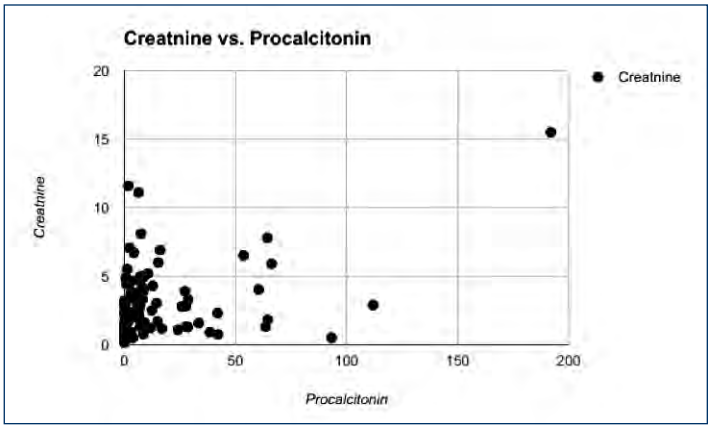
PCT is a biomarker used for the diagnosis of sepsis, severe sepsis, and septic shock, and additionally to guide antibiotic therapy. The classic indications for PCT measurement are: (i) confirmation or exclusion of the diagnosis of sepsis, severe sepsis, or septic shock, (ii) severity assessment and follow-up of systemic inflammation mainly induced by microbial infection, and (iii) individual, patient-adapted guide of antibiotic therapy and focused treatment. In critically-ill patients with sepsis, severe sepsis, or severe bacterial infections like pneumonia, the success of therapy and duration of antibiotic treatment can be evaluated and individually adapted by PCT measurement. High PCT levels indicate a high urgency for sepsis therapy. A PCT value greater than or equal to 7 ng/ml obtained at the time of admission to the ICU has been proven to be a predictor of short-term mortality and may be used to identify septic patients at increased mortality risk and help improve their treatment.

PCT was found to be a good predictor of severity of sepsis in peritonitis patients 48 hours after surgery (20). It was also found that SOFA score and PCT predict post-ICU mortality and survival days after ICU discharge and the inclusion of albumin level would provide an accurate prediction (21). Although PCT was a valuable prognostic factor and severity indicator for septic shock, it may not be a significant independent prognostic marker for 28-day survival in the patients with septic shock (22). PCT levels may be affected by an impairment of renal function (23). Also, a higher cutoff level for PCT was suggested for patients with end-stage renal disease (24).

Glasgow Coma Scale (GCS) was found to be a useful tool to stratify and predict mortality in non-traumatic intensive care unit admissions which were a finding from the acute physiology and chronic health evaluation III study although the lack of sensitivity in the intermediate range of GCS was noted (25).

We found a significant, but "weak", correlation between procalcitonin level and SOFA score, which was consistent with findings in prior studies. This appears to suggest that as the severity of sepsis caused by pneumonia wors-

Figure D



ens, which is objectively measured through SOFA score, procalcitonin level increased. There was also a significant, but weak inverse correlation between procalcitonin and Glasgow Coma Scale, which was in keeping with previous studies. The correlation between procalcitonin and creatinine was also significant, but weak, which was also described in multiple earlier publications.

These weak correlations could be amended by increasing the power of the study through increasing the number of patients studied. Further larger clinical trials might be needed.

The limitation of this study was related to studying the correlation of PCT and SOFA score in solely pneumonia patients. SOFA score has a strong prognostic value in all sepsis patients, regardless the cause of infection. It is well known that most of the critically ill septic patients present with infection from multiple sources.

Adding PCT level to SOFA score needs a more in-depth investigation to determine its effect on SOFA score's predictive value. In general, SOFA score's sensitivity is 86.7%, and specificity is 90.0%. The sensitivity and specificity to predict bacterial infection, using a PCT level threshold of 0.5 ng/mL, was 0.80 and 0.35 respectively (26).

In conclusion, PCT had a significant correlation to SOFA score in ICU-admitted pneumonia patients. We suggest the usage of PCT as a prognostic tool in addition to its diagnostic value.

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Decreased Pulmonary Arterial Proportional Pulse Pressure is Associated with Increased Mortality in Group 1 Pulmonary Hypertension

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BACKGROUND

This study evaluated the utility of a novel index pulmonary arterial proportional pulse pressure (PAPP, range 0-1, defined as [PA systolic pressure - PA diastolic pressure]/PA systolic pressure) in predicting mortality in patients with WHO group 1 pulmonary hypertension (PH).

HYPOTHESIS

Low PAPP is associated with increased 5-year mortality independent of the validated contemporary risk prediction equation [Pulmonary Hypertension Connection (PHC)].

METHODS AND RESULTS

262 patients in the NIH-PPH registry had a 5-year probability of mortality calculated using the PHC risk model, and the calculated model was compared with PAPP using a Cox proportional hazards model. Kaplan-Meier survival curves were used to compare mortality among PAPP quartiles, and significance was tested using the logrank test. Patients in the lowest quartile (PAPP ≤ 0.47) had a significantly higher 5-year mortality than patients in higher quartiles (logrank p = 0.016). In a Cox model adjusted for the PHC equation, PAPP remained significantly associated with 5-year mortality (HR 0.74 per 0.10 increase in PAPP, 95% CI [0.61 - 0.90]). The chi-square statistic for the single PAPP covariate in this model was 8.8 (p = 0.003), which compared favorably with the chi-square statistic of 15.2 (p < 0.0001) for the multivariable PHC equation.

CONCLUSIONS

PAPP, an index of ventricular-arterial (VA) coupling, is independently associated with survival in WHO group 1 PH. The use of this easily-measurable index for guiding risk stratification needs further investigation.

KEY WORDS

RV failure, VA coupling.

INTRODUCTION

Pulmonary arterial hypertension (PAH) is a progressive disease that leads to right ventricular (RV) failure and death. There are limited clinical metrics available to guide risk stratification for PAH patients. PAH is defined hemodynamically as mean pulmonary artery pressure (mPAP) ≥ 25 mmHg at rest measured by pulmonary artery catheter (5, 18) accompanied by pulmonary artery wedge pressure (PAWP) ≤15 mmHg and pulmonary vascular resistance (PVR) ≥ 3 Woods Units (W.U) in absence of other causes of pre-capillary PH (21). Outcomes in PAH are inextricably linked to RV function (1, 2). With progression of PH, RV function correspondingly declines leading to death. VA coupling describes the interaction between the ventricle and arterial conduits, and in the case of PH, the efficiency of RV contractility in overcoming afterload in the pulmonary artery. PAPP is a surrogate marker of the RV-arterial interaction. We have recently shown that a low PAPP is independently associated with poor prognosis in patients with advanced heart failure (3). PAPP is an integrated hemodynamic index of VA coupling that mirrors the RV adaptive response to increased afterload. The application of PAPP to patients with PH has to our knowledge never been evaluated. We, therefore, used data from the National Institutes of Health Primary Pulmonary Hypertension (NIH-PPH) database to test the aforementioned hypothesis. The PHC risk equation is a contemporary risk model incorporating mPAP, mean right atrial pressure (mRAP) and cardiac index (CI), and has been shown to accurately predict survival in patients with idiopathic, heritable, and anorexigen-associated PAH in large cohort studies (6).

METHODS

Primary Pulmonary Hypertension Registry

This study is a retrospective analysis of de-identified public release data of the NIH-PPH registry from the National Heart, Lung and Blood Institutes. The NIH-PPH registry was one of the first registries established to study the natural history of PAH. It included patients with idiopathic, familial and anorexigen-associated PAH, who by current nomenclature, fall under World Health Organization (WHO) group 1 PH. The methodology, enrollment and 5-year outcome determinants have been published (2). Briefly, the study included PAH patients; all but two patients had a PVR > 3 W.U. which is required to diagnose PAH per contemporary European Society of Cardiology PH guidelines (21). Patients were enrolled from 32 centres across the USA.

Study Cohort and Follow-up

We included all patients with complete variables for the calculation of PAPP and the PHC equation (N=262). The results were analyzed based on a 5-year follow-up time.

Statistical Analysis

The statistical analysis was performed using SAS 9.4 (Cary, NC).

Demographic variables were characterized as continuous (age, BMI) or categorical (sex, race). The hemodynamic continuous variables included PAPP, mPAP, PAWP, PA systolic pressure (PASP), PA diastolic pressure (PADP), mRAP, transpulmonary gradient (TPG), (PVR), PA pulse pressure (PPP), PA capacitance, RV stroke work index (RVSWI), and CI. Continuous variables were characterized using the median and interquartile range, while categorical variables were categorized based on the frequency in each group. Differences in continuous variables between groups were assessed using the Kruskal-Wallis test or, for normally distributed variables, analysis of variance. Differences in categorical variables between groups were assessed using a chi-square test or Fisher's exact test. In all cases, a p-value of 0.05 was considered significant.

Survival analysis using Kaplan-Meier curves was used to assess survival among the PAPP quartiles. In order to assess how PAPP can identify patients with the worst prognosis, survival in patients in the lowest quartile of PAPP was also compared with survival in the upper three quartiles of PAPP. The significance of the differences between groups was determined using the log rank statistic.

Bivariable Cox proportional hazards regression was used to evaluate the association between PAPP and survival, and the proportional hazards assumption was confirmed. The hazard ratio and 95% confidence intervals for death were determined. PAPP was evaluated both as a continuous variable (per 0.1 increase) and dichotomized based on the lowest quartile versus the remaining quartiles. For reference,

Table 1: DEMOGRAPHICS OF THE POPULATION COHORT BY QUARTILES (Q1-Q4) OF PAPP

Variables	PAPP Q1 (<0.47)	PAPP Q2 (0.48-0.53)	PAPP Q3 (0.54-0.59)	PAPP Q4 (>0.59)	P-Value
	n=63	n=68	n=64	n=67	
Age	31 (21-39)	36 (28-42)	40 (32-53)	43 (33-54)	< 0.0001
Female gender (n, %)	38 (60%)	39 (57%)	41 (64%)	45 (67%)	0.67
Race (%)					0.49
White	50 (79%)	48 (71%)	41 (64%)	49 (73%)	
AA	8 (13%)	7 (10%)	13(20%)	8 (12%)	
Other	5 (8%)	13 (19%)	10 (26%)	10 (15%)	
BMI (Kg/m^2)	22 (19-25)	24 (21-27)	22 (19-27)	23 (21-26)	0.037

AA=African American; BMI=body mass index; PAPP=pulmonary artery proportional pulse pressure.

Table 2: HEMODYNAMIC MEASUREMENTS AND CALCULATION BY QUARTILES (Q1-Q4) OF PAPP

Variables	PAPP Q1 (≤0.47)	PAPP Q2 (0.48-0.53)	PAPP Q3 (0.54-0.59)	PAPP Q4 (>0.59)	P-Value
Directly measured hemodynamics					
Mean PAP (mmHg)	62 (47-75)	56 (49-68)	56 (47-63)	54 (44-61)	0.06
PAWP (mmHg)	9 (6-12)	8 (6-10)	8 (6-11)	7 (5-10)	0.15
PASP (mmHg)	84 (65-102)	82 (72-100)	87 (75-98)	90 (75-106)	0.59
PADP (mmHg)	48 (39-66)	41 (35-50)	38 (33-44)	30 (26-40)	<0.0001
Mean RAP (mmHg)	10 (6-16)	9 (5-13)	8 (6-11)	6 (3-10)	0.018
Calculated hemodynamics					
TPG (mmHg)	51 (38-64)	47 (39-61)	47 (40-55)	45 (36-54)	0.13
PVR (Wood units)	16 (9-22)	14 (9-20)	13 (9-18)	11 (7-15)	0.03
PA pulse pressure (mmHg)	34 (26-46)	44 (37-51)	50 (43-55)	57 (48-70)	<0.0001
PA capacitance (ml/mmHg)	0.0008 (0.0005-0.0015)	0.0009 (0.0007-0.0013)	0.0009 (0.0007-0.0013)	0.0009 (0.0006-0.0015)	0.99
RVSWI (g/m^2)	14 (9-21)	15 (11-23)	18 (13-23)	19 (11-26)	0.095
CI (L/min/m^2)	1.9 (1-3)	2.1 (1-3)	2.2 (2-3)	2.3 (2-3)	0.018

CI=Cardiac Index; PA=pulmonary artery; PAP=pulmonary artery pressure; PAPP=Pulmonary Artery Proportional Pulse Pressure; PADP=pulmonary artery diastolic pressure; PASP=pulmonary artery systolic pressure; PCWP=pulmonary capillary wedge pressure; PVR=pulmonary vascular resistance; RAP=right atrial pressure; RVSWI=RV stroke work index; TPG=transpulmonary gradient.

Table 3: BIVARIABLE COX REGRESSION HAZARD RATIOS FOR THE OUTCOME OF DEATH

Covariate	HR	95% CI	Chi-Square	P-Value
PAPP (Q1 v. Q2-4)	1.58	1.09-2.31	5.74	0.016
PAPP (per 0.1 increase)	0.71	0.60-0.85	14.4	0.0001
PHC (per 0.01 increase)	0.96	0.93-0.98	18.04	<0.0001
RAP (per 1 mmHg increase)	1.07	1.04-1.09	22.1	<0.0001
Mean PAP (per 1 mmHg increase)	1.02	1.01-1.03	15.5	<0.0001
CI (per L/min/m2)	0.68	0.53-0.87	9.7	0.002

PAPP=Pulmonary Artery Proportional Pulse Pressure; PHC=Pulmonary Hypertension Connection; RAP=Right Atrial Pressure; PAP=Pulmonary Artery Pressure; CI=Cardiac Index.

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Table 4: MULTIVARIABLE COX REGRESSION HAZARD RATIOS FOR THE OUTCOME OF DEATH

Covariate	HR	95% CI	Chi-Square	P-Value
PAPP (per 0.1 increase)	0.74	0.61-0.90	8.8	0.003
PHC (per 0.01 increase)	0.96	0.93-0.98	15.2	<0.0001

Cox regression was also used to determine the corresponding hazard ratio for death and 95% confidence interval with the PHC risk score, based on weighting of mean PAP, RAP and CI. The associated chi-square statistic was used to evaluate the strength of these associations relative to each other.

A multivariable Cox proportional hazards regression model was then constructed based on covariates with significant association with the outcome of death on bivariable regression. In particular, we evaluated the multivariable model with PAPP (as a continuous variable) and the PHC risk score. An alternative multivariable model with PAPP and the individual components of the PHC risk score was also considered. Again, the chi-square statistic was used to evaluate the strength of association of each covariate in the adjusted model.

RESULTS

Baseline characteristics

The mean (± SD) age of patients was 37.5 ± 14.9 years old, 62% were female, and 28% had race reported as other than white. The distributions of baseline demographic and hemodynamic characteristics by quartile of PAPP are shown in Table 1 and 2 respectively. Patients in the higher PAPP quartiles were older, but age was not a significant predictor of survival in a bivariable Cox regression model for death (P=0.85). There were no significant differences in gender or race among PAPP quartiles. Table 2 demonstrates that the following hemodynamic variables were significantly different among the PAPP quartiles: PADP, RAP, PPP, PVR and CI. There was also a clinically meaningful trend in increasing concordant with the PAPP quartiles and RVSWI.

Survival Analysis Based on PAPP

With respect to the hypothesis that patients with the lowest PAPP would have greatest 5-year mortality, the Kaplan-Meier curves in Figure 1 show that 5-year survival in the lowest quartile of PAPP (Q1) was indeed lower than in the other quartiles combined (Q2-4) (P=0.016).

Bivariable Cox Proportional Hazards Regression

The results of bivariable Cox proportional hazards regression for the outcome of death are shown in Table 3. As a continuous variable, PAPP had a hazard ratio (HR) of 0.71 (95% CI 0.60-0.85; P=0.0001) for the outcome of death, indicating that increased PAPP was associated with a lower risk of death in group 1 PH. With PAPP as a categorical variable based on the lowest quartile versus the remaining patients, we found that patients in the lowest PAPP quartile (PAPP ≤ 0.47) had a HR of 1.58 for death (95% CI 1.09 - 2.31; P= 0.017); however, the chi- square statistic was greater for PAPP as a continuous parameter, indicating a stronger association with survival with PAPP categorized in this way. For reference, the PHC equation had a chi-square statistic of 18.0, which was only marginally greater than the chi-square statistic for PAPP as a continuous parameter (14.4), indicating that the strength of the continuous form of PAPP was only slightly less than the complex PHC risk score. In the multivariable models for the outcome of death, the Wald chi square statistic increased from 18.0 to 28.0 (an increase of 56%) when PAPP was added to the model with the PHC score alone. Constituent PHC equation variables and PAPP are compared in Table 3. However, in a multivariable Cox model adjusted for PAPP, only RAP had a significant association with survival, while the mean PAP and CI did not. In this multivariable Cox model for death with PAPP and RAP, PAPP had a HR of 0.75 (95% CI 0.63-0.90) per 0.1 unit increase (chi-square = 9.5, P =0.002), and RAP had a HR of 1.06 (95% CI 1.03-1.09) per mm Hg increase (chi-square = 16.8, P < 0.0001).

Multivariable Cox Proportional Hazards Regression

Multivariable Cox proportional hazards regression analysis (Table 4) shows that PAPP as a continuous measure was also independently associated with prognosis after adjustment for the PHC risk score. The chi-square statistic for PAPP in this model was 8.8 (P=0.003), which was less than the chi-square statistic of 15.2 (P < 0.0001) for the more complex PHC equation, but was of similar magnitude.

Sensitivity analysis

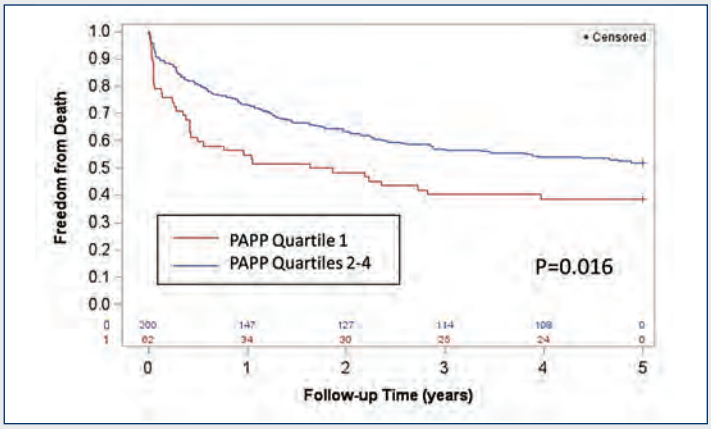
Of the 262 patients, only 2 patients had a PVR < 3 W.U. (2.13 and 2.43 W.U., respectively, while the rest had PVR > 3 W.U. (median 12.84 W.U., IQR 8.86-18.54 W.U.). A sensitivity analysis for the main findings in the Cox regression models excluding these two patients showed no significant change.

DISCUSSION

The present study investigated the prognostic implication of PAPP in PAH. We found that lower PAPP is strongly associated with 5-year mortality in WHO group 1 PH independent of the PHC risk equation. Patients in the lowest quartile of PAPP (PAPP ≤ 0.47) (Q1) had a significantly higher probability of mortality compared to patients in the higher quartiles of PAPP combined (Q2-4). Survival analysis demonstrated a significant difference in probability of mortality between the lowest quartile of PAPP (Q1) and the higher PAPP quartiles group (Q2-4). We further noted that patients in the lowest PAPP quartile showed significantly unfavourable hemodynamic variables (mRAP, mean PAP, PADP and PVR) compared to the higher PAPP quartiles.

PAH is a relentless disease that invariably leads to RV failure. The status of RV function is the primary determinant of overall prognosis (1, 4, 15, 16, and 17). Pathophysiologically, PAH is characterized by pulmonary vascular remodelling with increasing PVR that imposes an increased resistive and pulsatile load on the RV. With disease progression, this increased load impedes RV contractility leading to RV failure and death (1, 4, and 8). Under optimal conditions, the fluidic nexus between the RV and PA is facilitated by the RV-PA coupling. In essence, the RV augments contractility to offset the pulmonary arterial load while the PA dilates to accommodate the

Figure 1



stroke volume. With a sustained pressure load, the RV fails to generate sufficient contractility proportional to the increased arterial load thereby impairing optimal VA coupling (4, 5, and 8).

Physiologically, PAPP, is PA pulse pressure normalized to PASP. PA pulse pressure is an indirect measure of the combined effects of RV contractility and pulmonary vascular distensibility (pulmonary arterial capacitance) (5, 11, and 12). Taken in isolation, PA pulse pressure and PASP in prior studies have not shown linear correlation with mortality (20). PVR and pulmonary arterial compliance are inversely related and are both key markers of PAH disease progression. Decreases in pulmonary artery distensibility (compliance) are an early marker of increased PVR (8, 14). Worsening PAH leads to increased pulmonary vascular bed stiffness that hemodynamically manifests as increased PVR. In this analysis, we found these relationships (with other indices of RV failure) to be congruent to the polarity of PAPP and PAH severity. For instance, patients in the lowest PAPP quartile had significantly worse indices of RV function (elevated mRAP, higher PVR values and lower CI) compared to the rest of the PAPP quartiles, signalling advanced disease status in the respective strata. Elevated RAP has been shown to impact survival outcomes (2, 6, 8, 9, 13, and 19). As expected, patients in the lowest quartile of PAPP demonstrated elevated mRAP compared to the rest of the PAPP quartiles. CI values were lower among patients in the lowest quartile of PAPP. Both PASP and PADP were notably higher in the lowest quartile of PAPP versus higher PAPP quartiles. In summary, a lower PAPP (< 0.47) was associated with markers of severe disease status and was independently associated with increased 5-year mortality in NIH-PPH registry patients.

Our study extends the application of PAPP in guiding prognosis in WHO group 1 PH. PAPP was originally shown to inform prognosis in patients with advanced heart failure where a lower PAPP (< 0.5) was associated with increased adverse events such as death, heart transplant and LV assist devices during the 6-month follow-up of the study (3). The finding that PAPP adds significant predictive value to the PHC risk equation with an improvement in the model Wald chi-square statistic from 18.0 to 28.0 (an increase of 56%) warrants further investigation into the use of PAPP in a contemporary cohort of PAH patients. PAPP is a readily measurable index that may prove useful in risk stratification of PAH patients. Future studies should evaluate how PAPP varies with therapeutic interventions and whether this novel index can be used as a target to guide therapy.

Limitations

Our study was a retrospective analysis of NIH-PPH registry data, and therefore had weaknesses inherent to this type of study design. Foremost is that patient characteristics have changed remarkably in the current era. Newer therapies have resulted in an older patient population with multiple medical comorbidities. The changing patient demographics in terms of age, gender and comorbid medical conditions may limit the external validity of this study (1). The NIH-PPH registry had a relatively younger, predominantly female population compared to more contemporary PAH registries (5, 7). Furthermore, survival in the current era of pulmonary vasodilator therapies has modestly improved by about 10% in contrast to the era of our study (1, 7, 9, and 10). Finally, we had no echocardiographic images to correlate the hemodynamic data. These weaknesses are however offset by the strengths of the study which include a robust focus on objective hemodynamic measurements, use of a contemporary PHC equation and the multicentre enrollment of the study.

Conclusions

PAPP is independently associated with survival in WHO group 1 PH, and adds significant predictive power for all-cause mortality when used in combination with the PHC equation. These findings support further investigation into the use of this index in guiding risk stratification in WHO group 1 PH.

DISCLOSURES

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How Long Does it Take from Referral to Go Under the Knife? Process Mapping the Epilepsy Presurgical Evaluation

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OBJECTIVE

To identify barriers that might delay epilepsy surgery due to different investigations performed during epilepsy presurgical evaluation.

BACKGROUND

When medication fails to control seizures, epilepsy surgery is the next best recommended therapy. The outcome is better if surgery is performed early in the course of the disease, but the average duration to surgery is almost 18 years. To accelerate presurgical evaluation, we need to map the process and identify critical steps that can be improved. Process mapping is a technique to analyze a process or sequence of activities of a process and provide a compact picture to facilitate the improvement of a process.

DESIGN/METHODS

A single-center retrospective study, where we reviewed presurgical evaluation of patients who underwent temporal lobectomy between 2008 and 2012. This cohort was divided into 2 groups based on requirement of invasive Phase II monitoring (Group II) or surgery after Phase I only (Group I). The timing of all presurgical investigations performed after referral to the epileptologist to the day of epilepsy surgery was mapped. These investigations included Video EEG, WADA, MRI, PET, MEG, neuropsychological testing. We used SPSS software and did distribution analysis.

RESULTS

A total of 123 patients (Group I=71, Group II= 52) underwent epilepsy surgery in 5 years. The mean time from referral to epilepsy surgery was 10 months (group I) vs, 15 months (group II). In group I, the mean times were: MRI(3 mo), PET (4.5 mo), EEG(1.17 mo), Neuropsych (5 mo). In group II, mean times were: MRI(4 mo), PET (4.5 mo), icEEG(5 mo), and Neuropsych (5.5 mo). The neuropsychological testing had the longest waiting time.

CONCLUSIONS

By process mapping, we analyzed the duration of presurgical evaluations performed in adults with intractable temporal lobe epilepsy. Neuropsychological evaluation had the longest waiting time in our center. In the future, we should aim to have a "one stop shop" presurgical evaluation process.

DISCLOSURE

All authors involved have no conflict of interest, and have nothing to disclose.

Utility of Ankle-Brachial Index in Screening for Peripheral Arterial Disease in Rural India: A Cross Sectional Study and Review of Literature

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had CAD. [10] Khurana et al showed prevalence of PAD based on ABI in Punjab, India. Out of 200 diabetics with age > 45 years, 33% had abnormal ABI ≤ 0.9. Nag et al in 2012 published a study showing the association of chronic venous ulcer and peripheral arterial disease. They compared the ABI and Color Doppler study for PAD and found a strong correlation between them. [11]

LIMITATIONS

The cross sectional nature of this study was not designed to evaluate the accuracy of diagnostic methods of PAD. Sample size was relatively small and would not represent an accurate estimation of PAD prevalence. More studies with larger sample sizes are necessary. Recruiting patients from a medical camp possibly contributed to the high prevalence of PAD and its risk factors. We could not use gold standard color Doppler studies for diagnosing PAD due to lack of resources.

CONCLUSION

The prevalence of PAD in the Indian population is understudied. Defining the population at risk and using ABI as an early screening tool would help in prompt treatment and prevent further complications. ABI is a simple and low-cost tool to aid screening for the disease.

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