

**EVALUATION OF THE EFFECTIVENESS OF THE ROYAL HOSPITAL'S
ELECTRONIC REFERRAL SYSTEM**

by

Shihab Hamed Al Subhi

BS, Health Management Systems, Duquesne University, 2011

Submitted to the Graduate Faculty of

School of Health and Rehabilitation Sciences in partial fulfillment

of the requirements for the degree of

Master of Science

University of Pittsburgh

2012

UNIVERSITY OF PITTSBURGH

SCHOOL OF HEALTH AND REHABILITATION SCIENCES

This thesis was presented

by

Shihab Hamed Al Subhi

It was defended on

08/01/2012

and approved by

Valerie J.M. Watzlaf, PhD, Health Information Management

Suzanne Paone, DHA, Health Information Management

Patricia Anania Firouzan, M.S.I.S, Health Information Management

Thesis Director: Valerie J.M. Watzlaf, PhD, Health Information Management

EVALUATION OF THE EFFECTIVENESS OF THE ROYAL HOSPITAL'S ELECTRONIC REFERRAL SYSTEM

Shihab Hamed Al Subhi, M.S.

University of Pittsburgh, 2012

The study evaluates the effectiveness of the electronic referral system in reducing waiting time for patients who are referred to Royal Hospital for coronary angiography. The Study hypothesis is that with the current workflow, patients who are referred to Royal Hospital for coronary angiography using electronic referral system have relatively the same or higher waiting time when compared with patients who are referred with the fax referral system.

It is a comparative retrospective study that analyzes a random sample of 392 referral requests received from two secondary hospitals from January 1st, 2009 to June 30th, 2012. The study measures the waiting time for each referral request and calculates the median waiting time for the fax and electronic referral requests.

Waiting time for referrals received by fax are distributed according to the following: 1) 98 referral requests (50%) was 3 days or less; 2) 69 referral requests (35%) was 4 to 7 days; 3) 26 referral requests (13%) was 8 to 14 days; 4) 3 referral requests (2%) was 15 to 20 days; 5) 0 referral requests (0%) was over 20 days. The minimum waiting time was 0 days and the maximum was 16 days. The median waiting was 3.5 days. For the electronic referral requests, 1) 77 referral requests (39%) was 3 days or less; 2) 64 referral requests (33%) was 4 to 7 days; 3) 37 referral requests (19%) was 8 to 14 days; 4) 14 referral requests (7%) was 15 to 20 days; 5) 4 referral requests (2%) was over 20 days. The minimum waiting time was 1 day and the maximum was 21 days. The median waiting time was 5 days. The differences seen between the average wait time for electronic referrals and fax referrals was statistically significant ($p < 0.001$). Based on these results a new workflow model was developed and simulated within the Cardiology Department at Royal Hospital in Oman.

The current workflow increases the waiting time for electronic referral requests when compared with fax referral system. Changes to the current workflow are required to eliminate the inefficiencies that hinder the effectiveness of the system.

TABLE OF CONTENTS

PREFACE	ix
1.0 INTRODUCTION	1
1.1 OVERVIEW.....	1
1.2 SPECIFIC AIMS.....	3
1.3 HYPOTHESIS.....	5
1.4 SIGNIFICANCE	5
1.5 INNOVATION.....	7
2.0 LITERATURE REVIEW	9
2.1 THE DIFFUSION OF INNOVATION.....	9
2.2 ELECTRONIC REFERRAL PREVIOUS STUDIES	10
3.0 METHODS	15
3.1 INTRODUCTION.....	15
3.2 STUDY DESIGN	15
3.3 STUDY VARIABLES	16
3.4 INCLUSION CRITERIA	17
3.5 EXCLUSION CRITERIA.....	17
3.6 STUDY SAMPLE.....	18
3.7 DATA COLLECTION METHODS	19
3.8 DATA ANALYSIS	20
3.9 STUDY RECOMMENDATION	21
4.0 RESULTS	23
4.1 INTRODUCTION.....	23
4.2 STUDY HYPOTHESIS	23

4.2.1	Fax Referral System.....	24
4.2.2	Electronic Referral System	25
4.3	STATISTICAL SIGNIFICANCE OF THE RESULTS	26
4.4	PROPOSED ELECTRONIC REFERRAL WORKFLOW	26
4.5	PROPOSED WORKFLOW SIMULATION.....	28
4.5.1	Introduction.....	28
4.5.2	Physician’s Feedback.....	29
4.5.3	HIM Technician Feedback.....	30
5.0	DISCUSSION.....	32
5.1	INTRODUCTION.....	32
5.2	INTERPRETATION OF FAX AND ELECTRONIC REFERRAL REQUESTS FINDINGS.....	32
5.3	PROPOSED ELECTRONIC REFERRAL WORKFLOW SIMULATION	34
5.4	COST.....	37
5.5	LIMITATIONS	38
6.0	CONCLUSION.....	39
	BIBLOGRAPHY.....	51

LIST OF TABLES

Table 1. Referral Requests - By Waiting Time Category.....	40
Table 2. Fax Referral Waiting Time Frequency Distribution.....	41
Table 3. Electronic Referral Waiting Time Frequency Distribution.....	42
Table 4. Study Descriptive Statistics	43
Table 5. Statistical Significance – Paired t –Test	44

LIST OF FIGURES

Figure 1. Current Electronic and Fax Referral Systems Workflow	45
Figure 2. Fax Referral Requests – By Waiting time Category	46
Figure 3. Fax Referral Frequency Distribution Histogram.....	47
Figure 4. Electronic Referral Requests- By Waiting Time Category	48
Figure 5. Electronic Referral Frequency Distribution Histogram	49
Figure 6. Proposed Electronic Referral Workflow	50

PREFACE

I am extremely grateful to my advisor and M.S. thesis director Prof. Valerie Watzlaf for her guidance, support, and encouragement throughout the journey of my M.S. work. I am also thankful to my M.S. thesis committee members, Prof. Suzanne Paone and Prof. Patricia Anania Firouzan for their comments and suggestions which enriched the work.

The work in this thesis would not have been accomplished without the financial support of my sponsor, The Ministry of Health, Oman. I would like to thank Salim Al Salmi for his guidance, trust, and support during my study at The University of Pittsburgh.

Finally, I wish to acknowledge my family whose infinite patience and understanding are never taken for granted. My parents, my wife, and my kids; Nasra and Fatma are the motivation to do more.

1.0 INTRODUCTION

1.1 OVERVIEW

Effective communication is the key for any quality health care delivery. The communication between primary health care providers and specialists should be adequate to facilitate patients transfer between two levels of care. Innovations in health information technology promote better communication between providers.¹ Electronic Referrals is an effective way of utilizing health information technology to improve access to specialty care by making the referral process more efficient.²⁻⁶

Health care institutions that have adopted an electronic referral system have been able to make a simple and an efficient referral process, improve patient access, and have better coordination of patient care.² Also, Electronic Referral reduces the waiting time for a specialty appointment when compared with a manual referral process.⁶ This is because an electronic referral provides a

standardized referral process and iterative communication between the referring primary care providers and specialists.¹ Nevertheless, there are some coordination breakdowns that could prevent realization of all the benefits of electronic referral systems.^{3,7} To overcome those breakdowns, there should be a clear referral policy, well-defined roles and responsibilities of the users, standardized communication procedures, and adequate human resources.³

Electronic referral is a system that replaces the traditional way of referring patients from one provider to another. Some providers utilize fax to refer patients and some provide the patient with a hard copy of the referral records to submit to the specialist whom the patient was referred to. Electronic Referral sends the patient's health information electronically to eliminate inefficiencies associated with the traditional referrals methods.

This study evaluates the electronic referral system that was implemented by The Royal Hospital, the largest tertiary care institution in Oman. The health care system in Oman is socialized where the government regulates, provides, and pays for the health care services for its citizens. Health care services are delivered in

health care institutions that are located across the country. The healthcare system provides three levels of health care services; primary, secondary, and tertiary.

Primary health care institutions are health centers and poly clinics that are located in every community to provide general health care services. The primary health care is considered the gatekeeper of the system. A patient is not treated in secondary health care institutions unless evaluated and referred by a primary healthcare institution. The secondary health care level is the regional hospitals that cover a specific population in a specific geographic area. These regional hospitals provide specialized health care services. If patients require further consultations and services beyond secondary health care facility capabilities, they are referred to the tertiary health care institutions. Those institutions are located in Muscat, the capital city of Oman. They provide specialty and sub-specialty health care services for patients from different parts of the country.

1.2 SPECIFIC AIMS

The study evaluated the electronic referral system that is being implemented by the Ministry of Health of the Sultanate of Oman to facilitate the patient's referral process between the three health care levels. The study was conducted at the Royal

Hospital, the largest tertiary health care institution in Oman. The Royal hospital has already implemented the electronic referral system. The hospital receives referral requests using both the electronic referral and fax referral since not all the secondary level institutions implemented electronic referral yet. The study targeted referral requests for patients who are referred for coronary angiography. The study examined the effectiveness of the system in terms of reducing waiting time. The waiting time is the period from the time of request until the request is completed. The ultimate purpose of the study is to provide evidence that the current work flow of the electronic referral process is no more effective than the traditional fax referral system in terms of reducing the waiting time for those patients. Figure.1 illustrates the current workflow for both systems at The Royal Hospital; Electronic Referral and Fax Referral. The following is the specific aim of the study:

To determine the effectiveness of the electronic referral system in reducing waiting timeⁱ for patients who are referred to Royal Hospital for coronary angiography.

ⁱ Waiting time is defined as the period of response time from the date of receiving the referral request until the request is completed and sent to the referring institution

1.3 HYPOTHESIS

With the current workflow, patients who are referred to Royal Hospital for coronary angiography using an electronic referral system have relatively the same or higher waiting time when compared with patients who are referred using the fax referral system.

1.4 SIGNIFICANCE

As part of the eOman strategy that aims to automate the government services, Ministry of Health has developed a Health Information Management System called “Al Shifa”, an Arabic name for “Recovery”. Al Shifa was developed in-house by the Directorate General of Information Technology of the Ministry of Health. The System was awarded the first place in the ‘Advancing Knowledge Management in Government’ category at the 2010 United Nations Public Service Awards (UNPSA).⁸ Al Shifa is a comprehensive system that provides electronic modules including⁹ adult & pediatric emergency, anesthesia, dental, general medicine, general surgery, nephrology & renal dialysis, obstetrics & gynecology, child health, psychiatry, billing, stores management, pharmacy, electronic health record,

para medical services, laboratory, radiology, management information system, electronic referral, oncology, quality assurance, operation theatres, medical and non-medical purchase, engineering, and asset management system.

Electronic referral is a web-based application integrated with the electronic health record (EHR) that is used to refer patients from one institution to another. It has been implemented in all tertiary health care institutions. It is also implemented in some secondary and primary health care institutions. The Directorate General of Information Technology is in process to implement the Electronic Referral in every health care institution in the country by 2015ⁱⁱ. The purpose of implementing electronic referral is to make the patients' flow from one institution to another more efficient. This includes better communication between doctors, improve the continuum of care, provide faster interventions, reduce process time (waiting time), increase access to specialists when necessary, and provide reliable referral records. As the literature shows, that electronic referral has the potential to improve communication between primary care providers and specialists and increase the effectiveness of the referral process¹. This is true for electronic referral in Oman but there are some barriers that hinder the realization of all the benefits of the

ⁱⁱ Personal communication with the Deputy Director General, Directorate General of Information Technology, July 2012

systems. The system does not seem to work as it is intended to work. The process varies from institution to another for reason related to different institutional requirements, ownership of the process, and difficulties to standardize the electronic referral process among different institutions.

This study targets coronary artery disease patients who need angiography and are referred to the Royal hospital since it is one of only two institutions that perform the procedure in the country. More than 90% of the patients who need the procedure are referred to the Royal Hospital. The hospital receives patients from all across the Oman, which means there should be an efficient referral system that could handle the high demand of the service. This includes reducing waiting time to prevent problems like duplication of requests, lack of early intervention, and reduced patients' satisfaction.

1.5 INNOVATION

Health IT is evolving in Oman's health care system. The government is aiming to improve the health care delivery in the country by providing better health care with less cost. They realize that Health IT will reduce the inefficiencies in the health care system which will save them a lot of resources. Unfortunately, there are very

few research studies that investigate and evaluate this momentum. This includes looking at its history, development, implementation, impact, effectiveness, barriers, and solutions. These kinds of studies are needed to facilitate successful adoption of those technologies by providing evidence based information.

This study is the first that will specifically evaluate an electronic referral system in Oman. Even though the system is being implemented and used in some institutions, there are controversial perspectives about the effectiveness of the system in the current health care system. There are some benefits that the health care system has gained from implementing an electronic referral but many issues must be considered and addressed in order to fully realize the electronic referral's benefits. The system does not have a standard to follow in every institution. There are some barriers that prevent the appropriate adoption of the system which need to be identified and addressed with the possible solutions. The system needs to be evaluated to investigate its impact, effectiveness, barriers, and to discover how to make it work better.

2.0 LITERATURE REVIEW

2.1 THE DIFFUSION OF INNOVATION

The diffusion of innovations depends on three primary factors¹¹; the perception of the innovation, the characteristics of the people, and the contextual factors. According to Rogers¹² the perception of the innovation is responsible for 49 - 87% of the difference in the rate of the spread of the new change. There are 5 attributes that mostly influence the rate of diffusion. First, adopters should perceive the benefits of the innovation or the change as they only will adopt if they feel the innovation will help them to do their work.

Second, the innovation or the change should not conflict with the adopters' needs, values, and beliefs. Third, the complexity of the innovation affects the diffusion of the innovation as simple innovations spread quicker than complex ones. Fourth, the innovation or the new change should have the ability to be tested in units instead of implementing the innovation in all the organization's units.

Fifth, the innovation or the new change should be easy to observe by the potential adopters so that they can see it work for others before adopting the changes.

The second factor that affects the diffusion of the innovation is the characteristics of the people or the potential adopters. According to Rogers¹², the adopters are categorized into 5 categories; innovators, early adopter, early majority, late majority, and laggards. Innovators and early adopters are the fastest to adopt the change whereas the laggards are the traditional group that usually refuses the change. The third factor to influence the diffusion of the innovation or the new change is the contextual factors. This is related to the organizational environment where the innovation is implemented. The nature of the environment can play a vital role in the diffusion of the innovation. The organization's environment can support the change by encouraging the innovation and can impede the innovation by discouraging the innovation.

2.2 ELECTRONIC REFERRAL PREVIOUS STUDIES

In the literature, there was no work done on the electronic referral system in Oman. In general, there is a significant amount of literature that looked at different aspects of the electronic referral at different settings. Most of the literature indicates that

the electronic referral has an impact on the efficiency and the effectiveness of the referral process between different health care settings. Some literature shows that the electronic referral is still prone to breakdowns that hinder the realization of its full benefits. It suggests that there is much work to be done to make it work effectively.³

At San Francisco's public safety-net system, they integrated a web based electronic referral system called eReferral system into their electronic health record. They found that wait time for non-urgent referrals declined by 90% in the first six months of use for seven of eight medical specialties. The median wait time dropped dramatically from 126 days to 29 days. The surveyed specialists and found that the eReferral system helped clarify the reasons for referral. The number of referrals that specialist were unsure about the reason for referral declined by 50% in medical specialties and 75% in surgical specialties. They also survey primary care clinicians. 72% of them reported that eReferral improved care, 71% reported that it provided better guidance to pre-visit evaluations, and 89% reported that it makes it easier to track referrals. However, among the clinicians, 42% reported that they found eReferral process is more time consuming than paper based referral system especially for those with limited access to electronic health records.⁶

Boston Medical Center, a private non - profit, 626 academic medical centers implemented the Carfax eReferral system to replace the paper based referral system. The automated system has given them the ability to simplify and optimize the referral process, enhance the provider's collaboration, improve patient access, and provide efficient care. The percentage of scheduled referrals increased from 30% to 80%. They have decreased the waiting time from an average of 33 days to 5 days and the no show rate from 25% to 23%. They also have gained a 10% increase in the number of incoming referrals.²

In United Kingdom, Margaret hospital of Scotland conducted a study to assess the feasibility, safety, and effectiveness of the electronic referral (with and without images) of patients referred from primary care optometrists to hospital eye service as compared with the traditional paper based referrals(without images). For the intervention group (electronic referrals), they received 346 referrals over 18 months. They found that 218 (63%) of the referrals were classified as requiring and 128 (37%) were classified as not requiring and appointment. For the control group (paper based referrals), out of 309 referrals of which 283 (85%) classified as requiring appointment. They concluded that electronic referral is safe, speedy, efficient, and effective in avoiding unnecessary consultations.⁴

In a study that evaluated the impact of the electronic referral for specialty care at public hospital as compared with the paper based referrals, a visit based questionnaire was conducted to new patient charts before and after implementation of the electronic referral. The questionnaire identified the referral question, referral appropriateness, and the need and availability of follow up visits. They found that out of 505 questionnaires from specialty clinicians. It was difficult to identify the reason for referral in 19.8% of medical and 38.0% of surgical visits using paper-based methods. For electronic referral, they found that it is difficult to identify the reason for referral for 11.0% of medical and 9.5% of surgical visits. In the appropriateness of the referrals, they found that 6.4% and 9.8% of medical and surgical referrals using paper methods vs. 2.6% and 2.1% using electronic referral were not completely appropriate. For paper based referrals, 82.4% and 76.2% of medical and surgical patients compared with 90.1% and 58.1% of electronic referrals were found that the follow-up was requested. Follow-up was considered avoidable for 32.4% and 44.7% of medical and surgical follow-ups with paper-based methods compared to 27.5% and 13.5% with electronic referral.¹

In a qualitative study to understand the coordination breakdowns related to electronic referral, interviews with experts and focus groups were conducted at 2 tertiary care hospitals at the Veterans Affairs medical services. The researchers used techniques from grounded theory and content analysis to identify organizational themes that affected the referral process. They found that there are some breakdowns that are considered challenges to the success of electronic referral. First, the lack of the referral policy should be resolved with a clear institutional policy. Second, the lack of standardized referral procedures should be addressed with standardized procedures and communication protocols. Third, the ambiguity in roles and responsibilities should require well defined roles and responsibilities of the key personnel. Fourth, adequate human resource should be available for the electronic referral to function efficiently.³

3.0 METHODS

3.1 INTRODUCTION

This section focuses on the methodology used in this study of evaluation of the electronic referral. The section includes a description of the research design, study sample, measurement procedures, and statistical analysis.

3.2 STUDY DESIGN

This is a demonstrationⁱⁱⁱ comparative study that use comparison based approach of evaluation to determine the effectiveness of the electronic referral by comparing it with the traditional referral system that utilizes fax to communicate between primary, secondary, and tertiary health care institutions. It is a retrospective study that was held at the largest tertiary hospital in Oman, The Royal Hospital. It

ⁱⁱⁱ Demonstration studies answer questions about an information system (resource), exploring such issues as the resource's value to a certain professional group or its impact on the processes and outcomes of health care.

targeted referrals from two secondary health care institutions, Nizwa Hospital (electronic referral system) and Sohar Hospital (fax referral system). The Study was submitted to the University Of Pittsburgh Institutional Review Board (IRB) and received approval at the exempt level.

The study included only referrals of coronary artery disease that were referred for coronary angiography procedure since the hope was to use this department as a model for future departments. The study determined the effectiveness of the electronic referral system on reducing the waiting time as compared with the traditional referral system that uses fax.

3.3 STUDY VARIABLES

The study has two levels of independent variables. The first level is referrals received by electronic referral system. These are referrals received from Nizwa Hospital since the hospital has already implemented the Electronic Referral system.

The second level is referrals received from Sohar Hospital which are received by fax. The hospital did not implement an electronic referral system yet and uses a fax referral system to refer patients. The dependent (outcome) variable is the waiting time. Waiting time is defined as the period of response time from the date of receiving the referral request until the request is completed and sent back to the referring institution.

3.4 INCLUSION CRITERIA

This study included only coronary angiography referral requests with scheduled angiography appointment. It included requests received from Nizwa hospital for electronic referral system and requests received from Sohar Hospital for fax referral system. Due to the availability of the data and the change of the system over time, the study included only referral requests received from January 1st, 2009 to June 30th, 2012. The study included referrals that are in complete status which means that the request must be responded with an appointment and fulfilled.

3.5 EXCLUSION CRITERIA

The study excluded referral requests that are not in complete status and referral request from any other institution except Nizwa Hospital and Sohar Hospital. The

emergency referral requests were excluded to avoid the skewing effect of those cases since they have special handling procedure that usually expedites the handling process of the requests. Also, the pediatrics referral requests for coronary angiography were excluded since they are handled by another department.

3.6 STUDY SAMPLE

To determine the sample for the study, the number of coronary angiography referral requests was considered. The Royal Hospital receives about 2500 coronary angiography referral requests annually. The total number of coronary angiography referrals requests received since the electronic referral was implemented is estimated to be 18,800 requests. As many other studies the bound for error estimate (B) set to 0.05. The (p) value is set to 0.5 for the purpose of sample size determination. The above mentioned values was used in the following formula and resulted in a sample of 392 coronary angiography referral requests.

$$n = \frac{Npq}{(N-1)D+pq} \quad D = \frac{B^2}{4} \quad \text{Where } B=0.05^2/4 = 0.000625$$

$$n = \frac{(18800)(0.5)(0.5)}{(18800-1)(0.000625)+(0.5)(0.5)} \quad n = \frac{4700}{11.999375}$$

$$n = 391.687067 \quad n = \mathbf{392}$$

The sample size was divided between referral requests received from Nizwa Hospital and Sohar Hospital. So, the sample size will be 196 referrals requests from Nizwa Hospital and 196 referral requests from Sohar Hospital. Systematic randomization is utilized to select 196 cases from list of referral requests of each hospital with random starting point and fixed interval.

3.7 DATA COLLECTION METHODS

The study is retrospective. Referral data from January 1st, 2009 to June 30th 2012 were collected to investigate the effectiveness of the electronic referral system as compared with the fax referral system. The study neither had direct interaction with patients nor their identifiable health information. The data were retrieved from the Royal Hospital's databases.

“Sql” queries were used to generate referral requests list that does not include patient's identifiable information such as patient name or medical record number. The list included data that help to analyze the waiting time of each referral request. Two separate reports were retrieved for the fax registration system database and

electronic referral system database. The reports included data according to the inclusion criteria including referral request number, referring institution, department, procedure type, receive date, response date, and appointment date.

3.8 DATA ANALYSIS

After the collection of the data from the referral lists, the waiting time was measured. The calculations included every case in the sample that meets the inclusion and exclusion criteria during the predetermined study period i.e. January 1st 2009 to June 30th, 2012 (The waiting time was measured in days according to the following formula:

Waiting time = "response" date minus "receive" date.

Median waiting time instead of average waiting time (mean) was calculated using the individual waiting time durations. Median wait time is the point at which half the referrals were responded and the other half are still not responded. For instance if the median wait time is 4 days, it means that half of the referrals waited for response less than 4 days and half waited for response more than 5 days. The

median is steadier over time as it shows what the typical referral's waiting time. Unlike the average wait time (mean), the median wait time is not affected by rare cases that might be very short or long due to potential confounding variables. Those unusual cases skew the average waiting time and therefore the median waiting time especially with small number of cases, median waiting time will control the skewing effect.¹⁰ However, the mean waiting time was collected and used in the statistical analysis (paired t test) of the differences seen between the electronic referral and the fax referral.

3.9 STUDY RECOMMENDATION

The results of the study were utilized to make recommendations to improve the electronic referral system process. The recommendation focused on the workflow of the process and was supported by a simple simulation. The simulation involved a physician and HIM technician who are involved and the key users of the referral process. The physician and HIM technician walked through both the current electronic referral workflow and the one proposed by the study. The purpose of the simulation is to seek the support of the key users of the system. The simulation also provides the opportunity to get a qualitative feedback from the key users about the proposed workflow. There are two HIM staff currently working in the

electronic referral, one of them was selected randomly. The same applied to the physicians. One of the cardiologists was selected randomly to do the simulation.

4.0 RESULTS

4.1 INTRODUCTION

This section presents the results of the study of the evaluation of the effectiveness of electronic referral system. It includes: 1) the results of the fax system data analysis; 2) the results of the electronic referral system data analysis; 3) the proposed workflow to improve the effectiveness of the electronic referral; and 4) a qualitative feedback from the key users of the proposed workflow of electronic referral.

4.2 STUDY HYPOTHESIS

The hypothesis of the study states that with the current work flow, patients who are referred to Royal Hospital for coronary angiography using electronic referral system have relatively the same or higher waiting time when compared with patients who are referred with the fax referral system. The following results show

that hypothesis is true in term of the negative impact of the electronic referral system in reducing waiting time for coronary angiography referral requests.

4.2.1 Fax Referral System

The study investigated a sample of 196 coronary angiography referral requests received from Sohar Hospital between January 1st, 2009 and June 30th, 2012. The waiting time for each request was calculated. The waiting time period was categorized into five categories: 1) 3 days and less; 2) 4 to 7 days; 3) 8 to 14 days; 4) 15 to 20 days; and 5) 20 days and above.

The results presented in Table.1and Figure.2 show that waiting time for referrals received from Sohar Hospital (by fax referral system) distributed according to the following: 1) 98 referral requests (50%) was 3 days or less; 2) 69 referral requests (35%) was 4 to 7 days; 3) 26 referral requests (13%) was 8 to 14 days; 4) 3 referral requests (2%) was 15 to 20 days; 5) 0 referral requests (0%) was 20 days and above. The minimum waiting time was 0 days (26 faxed referral requests) and the maximum waiting time was 16 days (1 faxed referral request).

The median waiting time for the sample of the fax referral system requests was 3.5 days and the mean waiting time 4.3 days. See Table.4 for descriptive statistics.

4.2.2 Electronic Referral System

The study investigated a sample of 196 coronary angiography referral requests received from Nizwa Hospital between January 1st, 2009 and June 30th, 2012. The waiting time for each request was calculated. The waiting time period was categorized into five categories: 1) 3 days and less; 2) 4 to 7 days; 3) 8 to 14 days; 4) 15 to 20 days; and 5) 20 days and above.

The results presented in Table.1and Figure.4. It showed that waiting time for referrals received from Nizwa Hospital (by electronic referral system) are distributed according to the following: 1) 77 referral requests (39%) was 3 days or less; 2) 64 referral requests (33%) was 4 to 7 days; 3) 37 referral requests (19%) was 8 to 14 days; 4) 14 referral requests (7%) was 15 to 20 days; 5) 4 referral requests (2%) was above 20 days. The minimum waiting time was 1 day (17 referral requests) and the maximum waiting time was 21 days (4 referral request).

The median waiting time for the electronic referral system requests sample was 5 days and the mean waiting time 6.4 days. See Table.4 for descriptive statistics.

4.3 STATISTICAL SIGNIFICANCE OF THE RESULTS

The median waiting time was 3.5 days and the mean was 4.3 days compared with median waiting time of 5 days and mean of 6.4 days for electronic referrals (Table.4). To test if the study results of the two samples is statistically significant with the difference in mean; a paired t-test was done using the SPSS tool. The test showed that the results are statistically significant. It was found that the differences seen between the average waiting time for electronic referrals and fax referrals was statistically significant ($p < 0.001$). Based on these results a new workflow model was developed and simulated within the Cardiology Department at Royal Hospital in Oman. See Table.5

4.4 PROPOSED ELECTRONIC REFERRAL WORKFLOW

The results of the study show that the current workflow (Figure.1) is not efficient enough to facilitate an effective electronic referral system work process. The study recommends that the electronic referral process should be modified to eliminate

inefficiencies in the system. The modified workflow in Figure.6 is a collaborative process between physicians and health information management (HIM) staff. The electronic referral requests will no more be printed for the physicians to comment on them and no messengers and medical coordinators will be involved.

The physicians will access the referral requests electronically and will provide their orders as comments on each referral request. HIM technician reviews the commented referral requests and complete it based on the physician's orders which usually is scheduling patients in the appointment system and sending the information to the referring institution electronically. The proposed workflow will eliminate one channel of communication from the current workflow (Figure.1& Figure.6) which is the medical coordinator. They will not be involved in the proposed workflow which will make the process more efficient due to less communication channels. The new work flow will relieve the physicians from doing clerical jobs and give the opportunity to focus more on the clinical side of patient care.

4.5 PROPOSED WORKFLOW SIMULATION

4.5.1 Introduction

The study did a simple simulation to the proposed workflow (Figure.6). The purpose of the simulation is to seek the support of the key users of the system. The simulation also provides the opportunity to get a qualitative feedback from the key users about the proposed work flow. Most importantly, it will be utilized as an evidence to persuade the administration to modify the current electronic referral system workflow.

The simulation included a cardiologist and an HIM technician. They went through the proposed workflow to fulfill five referral requests. Both the physician and the HIM technician were introduced to the workflow and their roles were identified. The physician role is to login into the electronic referral system and check the cardiology department list for new referral request. The physician role is to review the referral requests and provide an electronic comment for each referral request. The electronic comment is considered the physician order for that patient

referral request. After commenting the referral request, the status changes from “new” to “commented” and appears in the HIM technician electronic referral system screen. The role of the HIM technician is to go over the commented referral requests and complete each referral request based on the physician’s order.

4.5.2 Physician’s Feedback

After the simulation, the physician provided a qualitative feedback about the experience with the new electronic referral workflow. The physician was satisfied with the experience for three main reasons; convenience, ease of use, and relief from non-clinical work. The system is convenient as the physician can access it from any workstation at their free time without the need to carry printed referral requests in hand. The system is easy to use as the physician can comment or reject the referral request with one click in the same screen. They can monitor the new referral request momentarily without the need to wait for the printed referral request from HIM department. The workflow relieves the physician from non-clinical work that the administration is asking the physician to do where the physician is responsible for the whole electronic referral process from monitoring new referral requests to sending them back to the referring institution.

4.5.3 HIM Technician Feedback

After the simulation, the HIM technician provided a qualitative feedback about the experience with the new electronic referral workflow. The HIM technician was satisfied with the workflow. The new process eliminates inefficiencies that existed in the current workflow. The new workflow reduces the waiting time of the referral request. The workflow provides a shortcut by stopping print outs of referral requests sent to the physicians. It eliminates the missing of referral request due to different channels of communication that the referral request goes through in the current workflow.

The proposed workflow requires no referral requests paper archival. In the current workflow all the printed referral requests that were completed are stored in for at least 1 year to save the physicians comments. The proposed workflow eliminate this process since the referral request, physician comment, and the appointment given are computerized and stored in the system's database. It provides a tracking capability of the referral request progress which is helpful in answering patients and sending institutions inquiries. Also, in the current workflow

the HIM technician retypes comments of the physicians into the electronic referral. The simulated workflow ends this hassle as the comments are entered electronically by the physician instead of handwritten comments.

5.0 DISCUSSION

5.1 INTRODUCTION

This section includes an interpretation of study's primary findings. It includes interpretation of the fax and electronic referral systems findings. It discusses the recommended electronic referral workflow and the feedback from its simulation.

5.2 INTERPRETATION OF FAX AND ELECTRONIC REFERRAL REQUESTS FINDINGS

The results show that the fax referral system has less waiting time than the electronic referral. The median waiting time is 3.5 days compared with 5 days median waiting time for the electronic referral system (Table.4). The fax referral requests are usually sent to the physicians for review the same day whereas the electronic referrals are not sent at the same day of receiving the referral requests. This is because the electronic referrals need to be printed before sending to the physicians for review. The HIM technician prints the electronic referral requests

once a day to avoid duplication of printed referral requests. This makes the electronic referral requests delayed for at least one day compared with the fax referral requests that are sent to the physicians immediately when they are received.

The findings on Figure 2 and Figure 4 show that 61% of the electronic referral requests take 4 to 21 days to be completed compared with 50% of fax referral request completed between 4 and 16 days. The other 50% of fax referral requests are completed in 3 days or less compared with only 39% of electronic referral requests completed in 3 days and less. This is because when the commented electronic referral requests are returned from the physicians to the HIM department, the HIM technician has to retype the handwritten comments into the electronic referral system so that the comments can be viewed by the referring institution. The commented fax referral requests are faxed immediately to the referring institution without the need to retype the physician comments by the HIM technician. This makes the fax referral request sent to the referring institution faster than the electronic referral requests.

The frequency distribution of the waiting time for the fax referrals is significantly clustered between 0 and 7 days (Table.2 & Figure. 3) with total

percentage of 85% and an average of 3 days. The Electronic referrals waiting time frequency distribution shows a clustering between 1 and 7 days (Table.3 & Figure.5) with a total percentage of 72% with an average of 3.6 days. The waiting time frequency distribution (Table.2 & Table.3) also shows that 7% of the electronic referrals' waiting time exceeds the maximum waiting time period of 16 days for the fax referrals with an average of 19 days.

5.3 PROPOSED ELECTRONIC REFERRAL WORKFLOW SIMULATION

The proposed workflow is designed to eliminate the inefficiencies in the current workflow. It defines the roles for the primary users of the system to produce clear and standardized electronic referral system. The proposed workflow focused on reducing the channels of communication to avoid prolonged waiting time period. It eliminates printing the electronic referral requests to make the system fully computerized process.

The results of the study were used to show the physicians how the current workflow is not an effective referral system. The physicians are not willing to adopt the electronic referral system because the administration is insisting in making the physicians responsible for the whole process. This includes monitoring

new referrals requests, reviewing referral requests, commenting on them, and booking appointments when needed. Physicians argue that this process is time consuming and that it keeps the clinician busy with clerical work. They prefer to spend the time on providing clinical care to the patients instead.

After simulating the proposed referral workflow, the cardiologist gave a positive impression about the proposed changes. The Cardiology Department is one of the departments that refuse to implement full electronic referral. The department insists in continuing the current system where the referral request are printed and sent to the department for review. The department justifies the refusal from adopting the system due to the high volume of referrals received daily and the limited resources available.

With the study results and the feedback of simulation of the proposed workflow, the Head of the Cardiology Department met to show how the current workflow is not effective and how the proposed changes help to improve the effectiveness of the system and relieves the physicians from clerical work. He supported the new changes and agreed to pilot the proposed workflow in

September 2012. The Cardiology Department will be used as a model for other departments to show how other department could benefit from the changes.

The HIM technician who simulated the proposed workflow gave a positive impression about the changes in the process. He believes that the workflow will have a positive impact on the electronic system. He says that the changes will help decrease the waiting time period for referral requests. It will eliminate many challenges that they experience in the current system. The proposed changes will eliminate missing printed referral requests that they do not get back from the physicians which means that they have to reprint the missing referral request and send them again to the physicians. The proposed change solves the issue of feeding the physicians' comments into the system by HIM technicians. They face difficulties in reading the handwriting of the physicians which delays the completions of the referral requests. Also, the proposed changes eliminate the need for the paper archival of the completed referral requests since everything is available electronically.

5.4 COST

The proposed workflow saves the cost associated with printing electronic referral requests. Printing involves the operating and the supplying cost of printing machines, ink cartridges, and papers. If the hospital receives 150 referral requests per day and each referral printed in two papers, the hospital will save the cost associated with printing 72,000 papers annually. In addition, the proposed workflow will save the cost and space for archiving those referral requests.

In terms of human resources, the proposed workflow eliminates two channels of communication. The messenger and the medical coordinators will not be involved in the process. The process will save the working hours that was assigned to for the messengers and medical coordinators to keep the referral system process flowing.

5.5 LIMITATIONS

This study did not collect any patient identifiable information. This limits the ability to collect patient's demographics and other medical information like the severity of illness. Collecting this type of information could help to control for other variables that may affect the waiting time for the referral requests.

6.0 CONCLUSION

This study was an attempt to evaluate the effectiveness of the electronic referral system compared with the fax referral system in reducing the waiting time for coronary angiography referral requests. The results of this study demonstrated that the current workflow increases the waiting time for electronic referral requests when compared with the traditional fax referral system. Changes to current workflow are required to eliminate the inefficiencies that hinder the effectiveness of the system.

Table 1. Referral Requests - By Waiting Time Category

Waiting Time Category	Fax Referral Requests Count (%)	Electronic Referral Request Count (%)
3 days and less	98 (50%)	77 (39%)
4 to 7 days	69 (35%)	64 (33%)
8 to 14 days	26 (13%)	37 (19%)
15 to 20 days	3 (2%)	14 (7%)
over 20 days	0 (0%)	4 (2%)
Total Sample	196	196

Table 2. Fax Referral Waiting Time Frequency Distribution

Waiting Time	Frequency	Percentage (%)
0	26	13.3 %
1	27	13.8 %
2	24	12.2 %
3	21	10.7 %
4	14	7.1 %
5	23	11.7 %
6	19	9.7 %
7	13	6.6 %
8	3	1.5 %
9	5	2.6 %
10	5	2.6 %
11	5	2.6 %
12	2	1 %
13	4	2 %
14	2	1 %
15	2	1 %
16	1	0.5 %
Total	196	100 %

Table 3. Electronic Referral Waiting Time Frequency Distribution

Waiting Time	Frequency	Percentage (%)
1	17	8.7 %
2	29	14.8 %
3	31	15.8 %
4	19	9.7 %
5	18	9.2 %
6	13	6.6 %
7	14	7.1 %
8	4	2.0 %
9	7	3.6 %
10	6	3.1 %
11	4	2.0 %
12	7	3.6 %
13	5	2.6 %
14	4	2 %
15	3	1.5 %
16	1	0.5 %
17	3	1.5 %
19	4	2 %
20	3	1.5 %
21	4	2 %
Total	196	100.0 %

Table 4. Study Descriptive Statistics

	Electronic Referrals	Fax Referrals
N	196	196
Mean	6.36	4.28
Std. Error of Mean	0.37	0.26
Median	5	3.5
Std. Deviation	5.14	3.67
Variance	26.41	13.40
Skewness	1.28	1.02
Std. Error of Skewness	0.17	0.17
Range	20	16
Minimum Waiting Time	1	0
Maximum Waiting Time	21	16
	10	0
	20	1
	25	1
	30	2
	40	3
Percentiles	50	3.5
	60	5
	70	6
	75	6
	80	7
	90	10

Table 5. Statistical Significance – Paired t –Test

Paired T- Test	Mean	Std. Deviation	Std. Error Mean	t	df	Significance (2 tailed)
Electronic referral & Fax Referral (Paired)	2.08	6.09	0.44	4.78	195	0.00

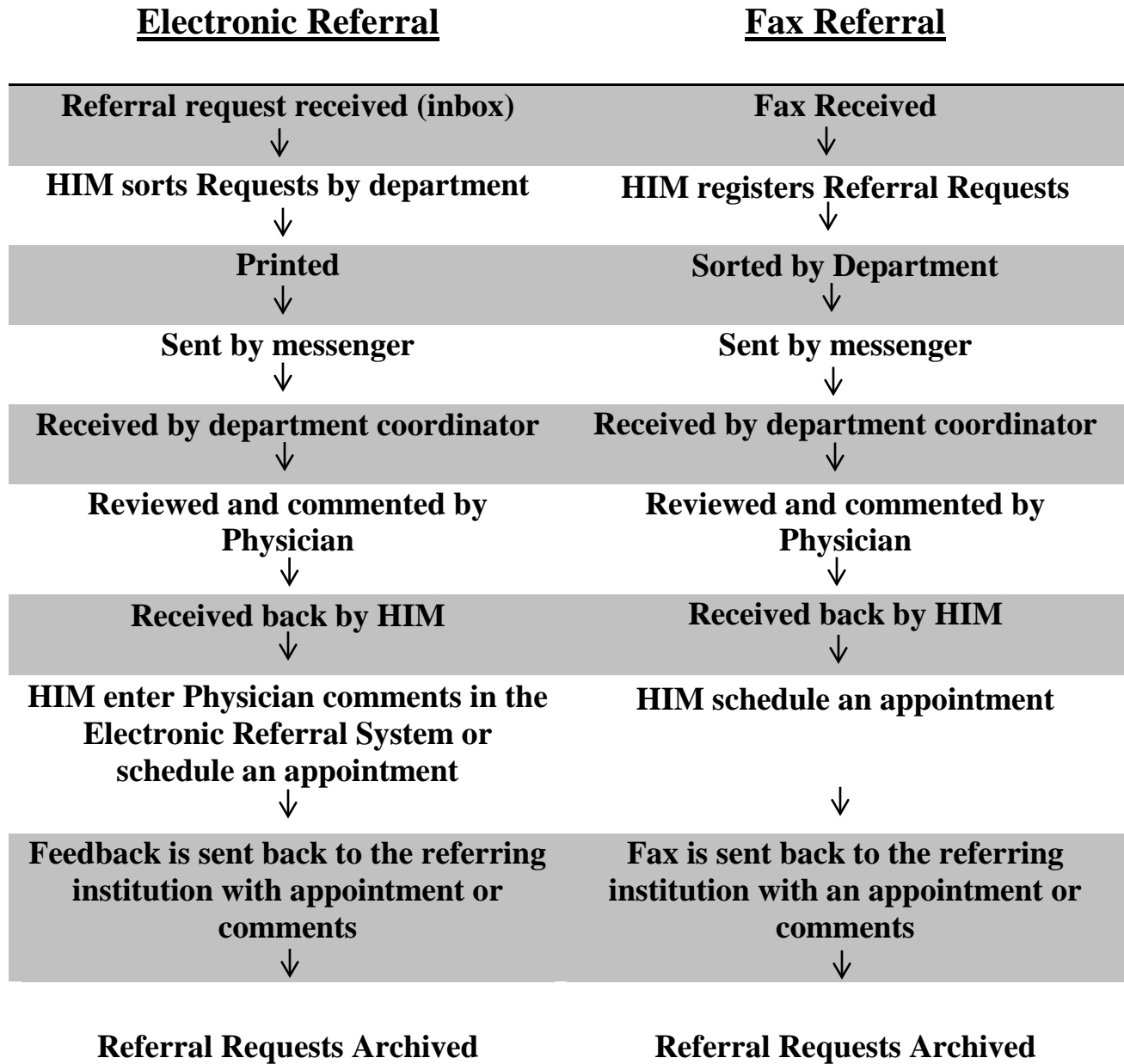


Figure 1. Current Electronic and Fax Referral Systems Workflow

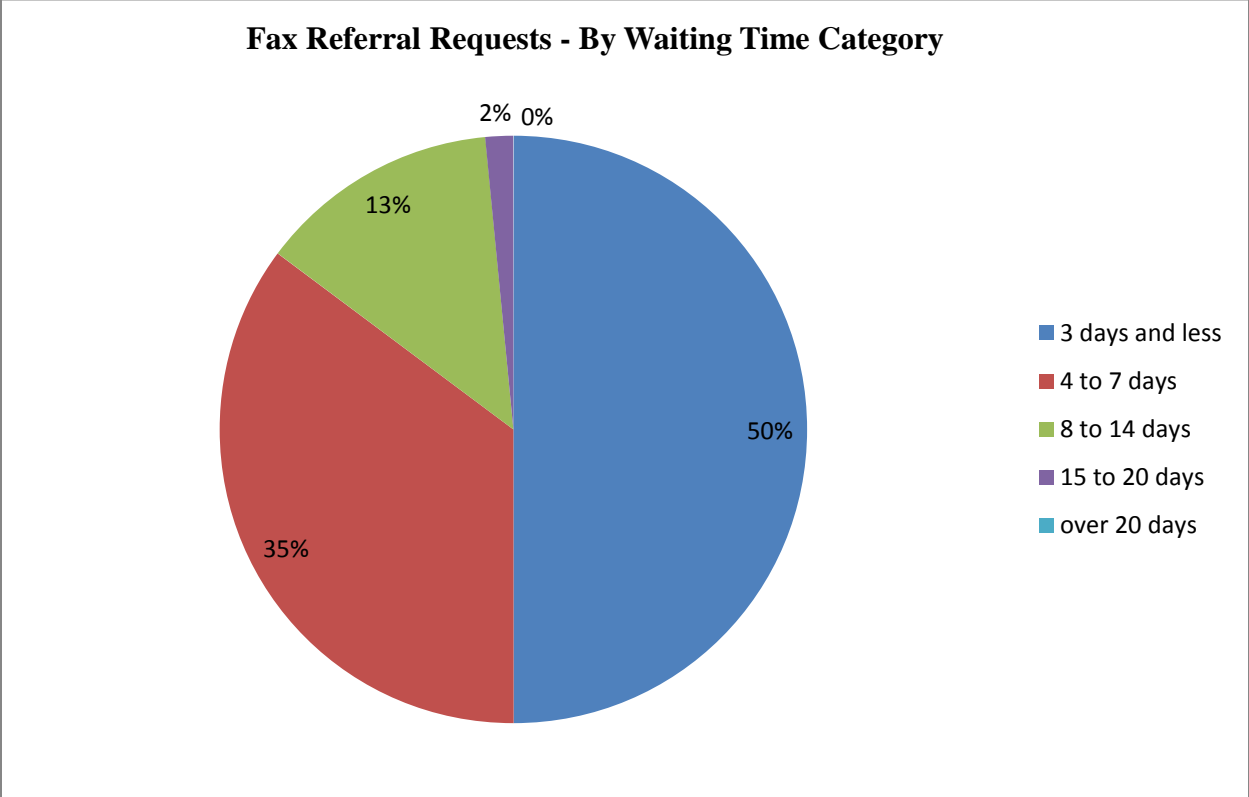


Figure 2. Fax Referral Requests – By Waiting time Category

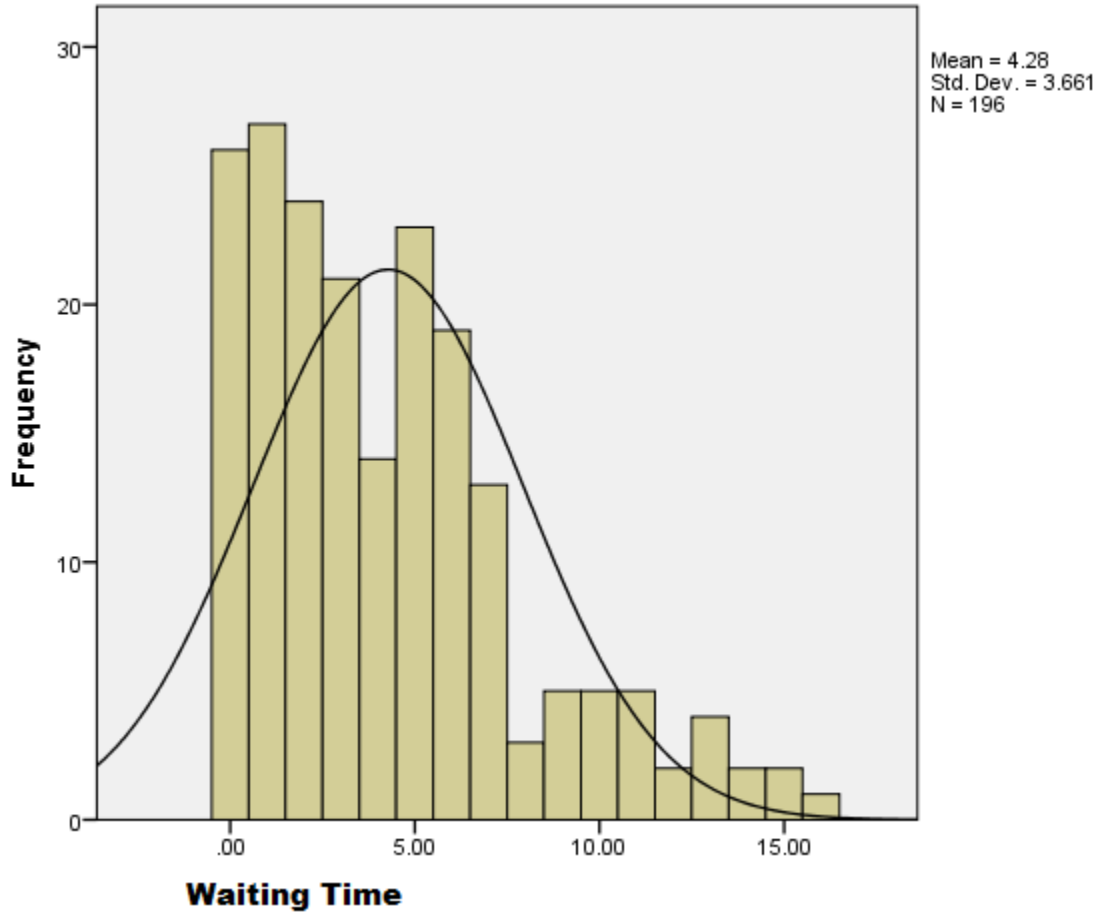


Figure 3. Fax Referral Frequency Distribution Histogram

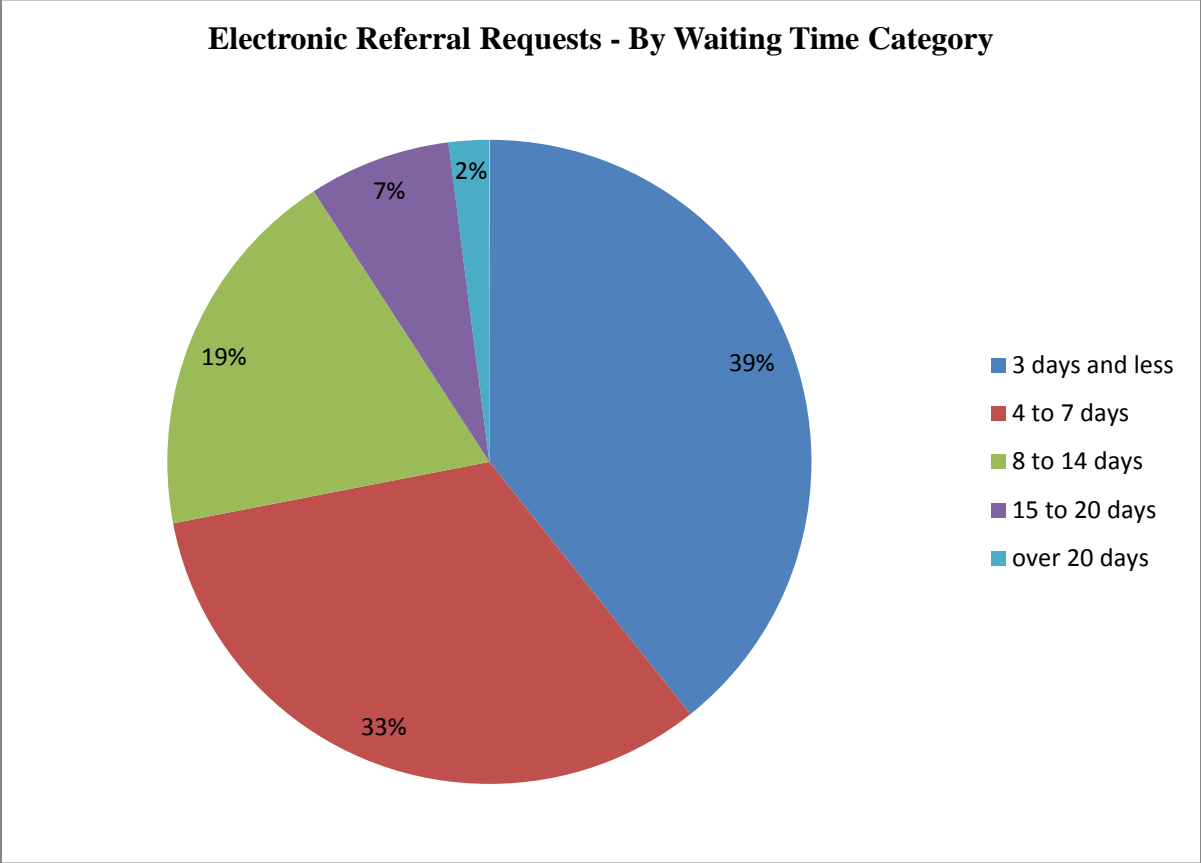


Figure 4. Electronic Referral Requests- By Waiting Time Category

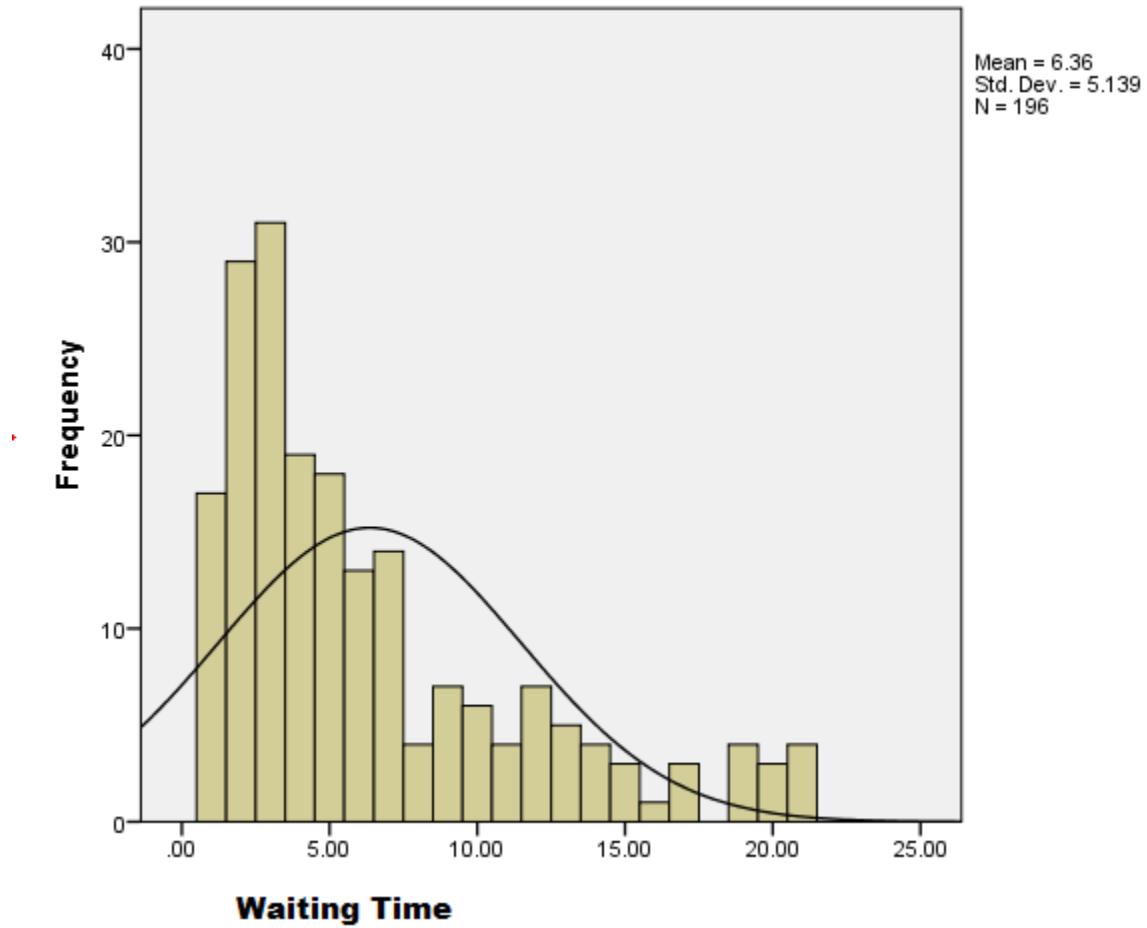


Figure 5. Electronic Referral Frequency Distribution Histogram

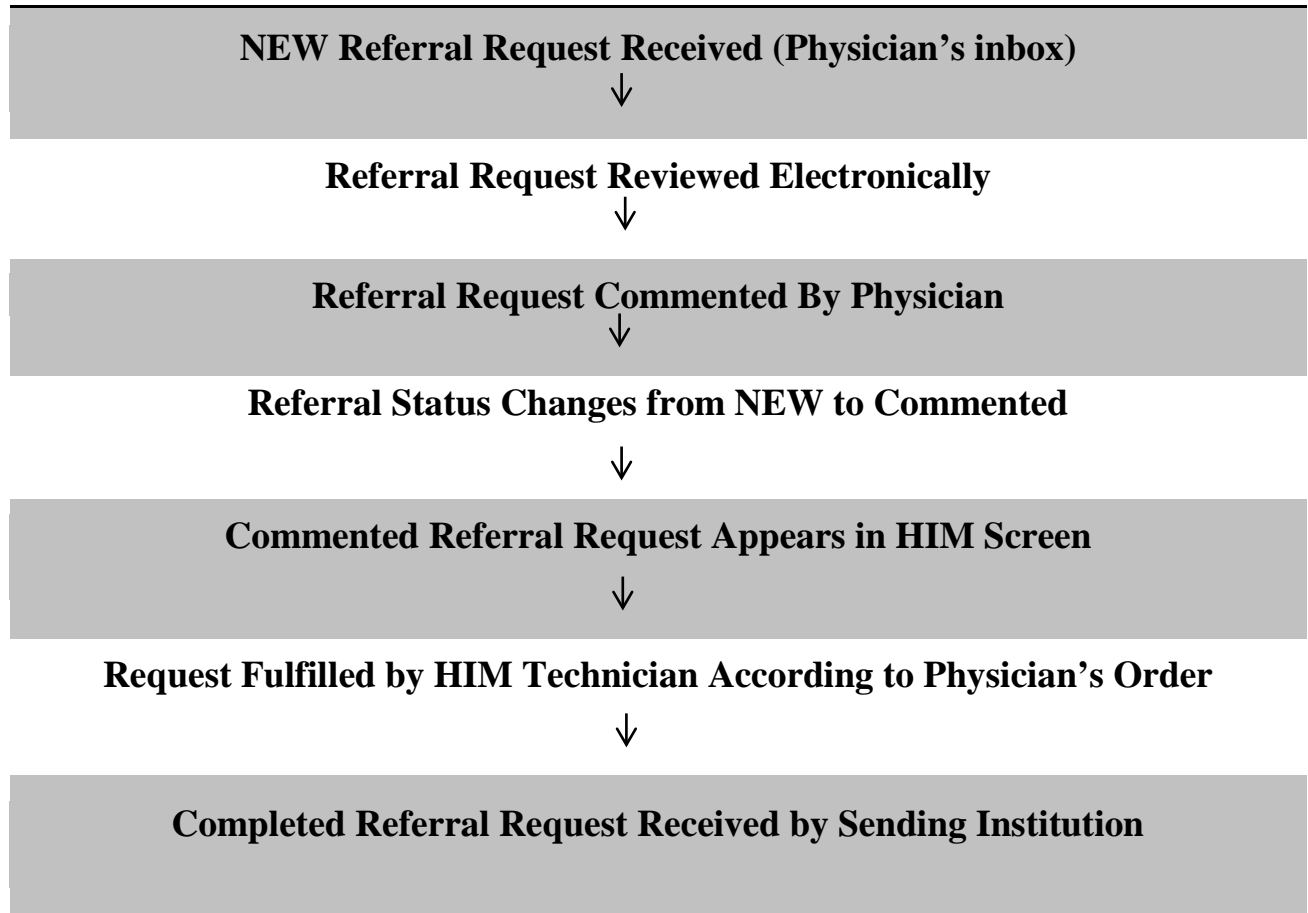


Figure 6. Proposed Electronic Referral Workflow

BIBLIOGRAPHY

1. Kim-Hwang JE, C. A. (2010). Evaluating electronic referrals for specialty care at a public hospital. *J Gen Intern Med.*, 1123-1128.
2. Vengco, J. (2010). Automated Referrals Close The Communications Loop. *Health Management Technology*, 18-19.
3. Sylvia J Hysong, A. E. (2011). Towards successful coordination of electronic health record based-referrals: a qualitative analysis. *Implementation Science*, 6:84
4. Cameron JR, A. S. (2009). Impact of direct electronic optometric referral with ocular imaging to a hospital eye service. *Nature - Eye*, 1134-1140.
5. Yeuen Kim, M. M. (2009). Not Perfect, but Better: Primary Care Providers' Experiences with Electronic Referrals in a Safety Net Health System. *J Gen Intern Med.*, 614–619.
6. Alice Hm Chen, M. B. (2010). A Safety-Net System Gains Efficiencies Through 'eReferrals' To Specialists. *Health Affairs*, 969-971.
7. Singh H, E. A. (2011). Follow-up actions on electronic referral communication in a multispecialty outpatient setting. *J Gen Intern Med.*, 64-69.
8. (2012, April 14). *UNPSA 2010 WINNERS*. Retrieved from United Nations: <http://unpan1.un.org/intradoc/groups/public/documents/un-dpadm/unpan039440.pdf>
9. (2012, April 14). *Computers & Health Information*. Retrieved from Royal Hospital: http://www.royalhospital.med.om/computers_health_information.htm#A1%20Shifa
10. *Ontario Wait Time*. (2012, 4 18). Retrieved from Ministry of Health and Long Term Care: <http://www.health.gov.on.ca/en/pro/programs/waittimes/surgery/data.aspx>
11. Berwick, D. M. (2003). Disseminating Innovations in Health Care. *JAMA*, 1969-1975.
12. Rogers, E. M. (1995). *Diffusion of Innovations*. New York: Free Press.