Telemedicine's use in the emergency department:

Does telemedicine improve patient outcomes?

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Summary

The impact of the type of care on outcomes was reviewed for patients seen in rural, critical access hospitals. The purpose of this study was to compare telemedicine with traditional emergency medical care delivery. A randomized retrospective chart review was conducted to identify whether patient outcomes improve with use of telemedicine in the emergency department. Four hundred charts for admission diagnoses of pneumonia, sepsis, myocardial infarction and stroke were reviewed. Outcomes compared were: time until provider interaction with patient, time until diagnostic implementation, time until treatment, time until transfer, length of hospitalization and incidence of mortality. The central finding concluded that telemedicine, used in critical access emergency departments, demonstrated a statistically significant difference when compared to traditional emergency medical care delivery for decreasing care times, length of hospitalization and mortality for all diagnoses. In contrast, for the diagnosis of pneumonia, the results show that time until transport was shorter with traditional emergency medical care delivery. The main benefits of this study were to show that telemedicine, when utilized in critical access emergency departments, can improve patient's time until care implementation and decrease their risk of mortality with the diagnoses of pneumonia, sepsis, myocardial infarction and stroke.

Keywords:

Telemedicine, Telehealth, eHealth, and TELEMED

Introduction

Rural communities face difficulties in obtaining appropriate care secondary to geographic isolation, cost, limited treatment services and lack of medical specialties [1]. In response to some of these issues, the Affordable Care Act (ACA) was implemented to increase the quality of care for all, decrease costs by $200 billion and invest the savings into forward-thinking forms of care. One example of this is telemedicine [2].

Telemedicine, which is defined as health care at a distance, allows for the integration of specialty services, including dermatology, ophthalmology, critical care, cardiology, emergency medicine, radiology, neurology and dentistry [3]. Examples of types of telemedicine include store forward, home-based and office- or hospital-based telemedicine. These types of telemedicine can be used for acute or chronic disease states, physical and occupational therapy, disease prevention and end-of-life care [4]. Office- and hospital-based telemedicine offer biometrics tracking and live videoconferencing. This is also known as teleconsulting [5]. Teleconsulting allows for an open and live communication link between the local provider, patient and distant provider [6]. This type of telemedicine is seen in the emergency department for complaints ranging from minor issues of skin lacerations, burns and musculoskeletal injuries to complex scenarios of sepsis, stroke, myocardial infarction and trauma [7,8,9]. Research on the effectiveness of telemedicine has demonstrated improved access to care, improved care delivery and improved professional education; however, research to demonstrate whether telemedicine has an impact on patient outcomes is still lacking [10,11,12].

The goal of this project was to determine via a retrospective chart review whether telemedicine use in the emergency department improves patient outcomes through early problem identification, treatment implementation and timely transfer for core-measure diagnoses: pneumonia, myocardial infarction, sepsis and stroke in emergency departments.

Methods

Four hundred charts from small, rural critical access community hospitals were retrospectively reviewed. Inclusion criteria included patients: a) age 19 or older, seen in the critical access emergency departments in a Midwestern network and b) diagnosed with stroke, myocardial infarction, pneumonia, or sepsis. Patient exclusion criteria included 1) any incarcerated person, 2) younger than 19 years of age, 3) patient outside the Midwestern network and 4) pregnant women.

A sample of 50 charts per diagnosis (acute myocardial infarction, stroke, sepsis, pneumonia) per care group (traditional and telemedicine) were randomly selected from the database to explore time differences in emergency department care milestones (N=400). All charts were randomly selected and data were collected from Meditech, using de-identified electronic medical records. Additionally, Institutional Review Board (IRB) approval was obtained and institutional policies and procedures were followed during data collection. The following data were collected from both the traditional group and telemedicine groups: age, sex, ethnicity, diagnosis, time until provider interaction from arrival, time until diagnostic testing from arrival, time until treatment initiation from arrival, time until transfer from arrival, length of hospitalization and mortality in both the emergency department and during hospitalization. Comparisons were done using two-sample t-tests, Wilcoxon’s sum rank test, generalized linear model ANOVA and Fisher’s exact test as dictated by the nature of the data. All analyses were conducted using SAS 9.3 (SAS Institute, Cary NC) using the GLIMMIX, NPAR1WAY and FREQ procedures.

Results

The demographic summary of the sample is as follows: patients ranged in age from 19 to 101 years; the average age was 74.3 +/- 0.74 years. The sample was primarily white (389) and male (215).

First, comparing time to patient-provider interaction for rural facilities with and without telemedicine interventions, the data did not support analysis by linear model ANOVA due to lack of fit. The difference in mean and type of care for time to patient-provider interaction was explored using a two-sample t-test and Wilcoxon's sum rank test, respectively. On average, a patient who received telemedicine had a 6.43-minute ($P=0.0001$) shorter time to patient-provider interaction, and the locations of the two distribution curves find the time to patient-provider interaction for telemedicine patients was below that of non-telemedicine patients ($P=0.0005$); see Table 1.

Next, comparing time until diagnostic testing implementation, a generalized linear model ANOVA was used, assuming a negative binomial distribution for the response variable time (measured in minutes). In this case, the fit was reasonable: the Pearson chi-square statistic divided by degrees of freedom was 1.52. The model was first fitted with the main effects of telemedicine and diagnosis, as well as the interaction term telemedicine*diagnosis. The interaction term was not significant and dropped from the model. The resulting model found both telemedicine ($P=0.0001$) and diagnosis ($P<0.0001$) to be significant in explaining the variation in time until diagnostic testing implementation. Post-hoc t-tests showed that, on average, those receiving telemedicine underwent their diagnostic testing 10.4 minutes (p value=0.0001) sooner than the non-telemedicine group; see Table 2.

Comparing time until treatment initiation with and without telemedicine was analyzed. The fit was good: the Pearson chi-square statistic divided by degrees of freedom was 1.20. Again, the interaction term was not significant and dropped from the model. The resulting model found both telemedicine (P=0.0006) and diagnosis (P<0.0001) to be significant in explaining the variation in time until treatment initiation. Post-hoc t-tests showed that, on average, those receiving telemedicine began their treatment 24.6 minutes (p value=0.0006) sooner than the non-telemedicine group. All post-hoc comparisons for diagnosis were conducted using the Tukey-Kramer adjustment to maintain the overall study error rate at 0.05; see Table 3.

Comparing time until transportation with and without telemedicine was analyzed. The fit was reasonable: the Pearson chi-square statistic divided by degrees of freedom was 1.48. The interaction term was significant (P=0.0036) and retained in the model, restricting any comparisons to simple effects. A simple effect is where comparisons are made across one factor while holding the other factor constant. Post-hoc t-tests showed that, on average, acute myocardial infarction, stroke and sepsis patients receiving telemedicine were transported 34.94 (P=0.0224), 28.24 (P=0.0403) and 39.59 (P=0.0160) minutes sooner than those not receiving telemedicine, respectively; see Table 4.

Comparing length of stay with and without telemedicine was analyzed. The fit was good when comparing length of stay: the Pearson chi-square statistic divided by degrees of freedom was 1.29. The interaction term was not significant and dropped from the model. The resulting model found only telemedicine (P<0.0001) to be significant in explaining the variation for length of stay. A post-hoc t-test showed that, on average, those receiving telemedicine stayed in the hospital one day less than those not receiving telemedicine; see Table 5.

Lastly, the Fischer's exact test was used in identifying and comparing patient mortality rates during hospitalization. Mortality was looked at in three ways: first, mortality in the emergency department; second, mortality during the length of stay in the hospital; and third, overall mortality without regard to when death occurred. In the first and third cases, there was no evidence of an association between mortality and receiving or not receiving telemedicine. However, when comparing mortality during length of stay, there is evidence of an association between telemedicine and mortality. Specifically, the odds that a patient who did not receive telemedicine died while in the hospital are 4.2 times greater than the odds a patient who did receive telemedicine died while in the hospital. This odds ratio is significant with a p-value=0.0318; alternatively one can look at the 95% confidence bound for the true odds ratio (1.1592 to 15.0376). Since the interval does not include 1, there is evidence of an association; see Table 6.

Discussion

The use of telemedicine in the emergency department is increasing. In the research study described, telemedicine was analyzed to determine whether times improved and length of hospitalization and mortality incidence decreased. The major findings of the study supported that telemedicine with the diagnoses of pneumonia, sepsis, myocardial infarction and stroke does decrease time until provider contact, diagnostics, treatment implementation and transfer. Also, telemedicine was found to decrease length of hospitalization and mortality rates while hospitalized. The exception was the diagnosis of pneumonia, in which traditional medical care was demonstrated to be superior to telemedicine in the category of time until transfer.

These findings suggest that patients treated with telemedicine, especially in the rural community, will have improved outcomes compared to those treated without telemedicine.

Also, patients treated with telemedicine may have a decrease in costs, decreased time away from work and decreased unnecessary travel. Telemedicine offers rural communities equal, possibly improved care compared with those who live in the urban community; therefore improving their outcomes. No other studies were found that compared telemedicine to improved patient outcomes.

The study of telemedicine's use in the emergency department was conducted to determine whether it improves patient outcomes; however this study had several limitations. First, the telemedicine program from which data was collected was established in 2008. Another limitation of the study is the absence of diversity in diagnoses and ethnicity. The only diagnoses examined were pneumonia, sepsis, myocardial infarction and stroke, and white, Native American and other were the only ethnic backgrounds noted. More diagnoses and ethnicities would lead to a greater application of telemedicine and stronger validity of the findings. Finally, there are few or no prior research studies based on telemedicine and improved patient outcomes. Future research should focus on diversity of diagnoses and diversity of ethnicity in telemedicine in comparison to patient outcomes. Future studies should also be collected over a longer period of time to determine whether the findings remain true. Additional research needs to explore the finding related to mortality risk to determine the nature of this finding by exploring age, acuity of illness, and other relevant factors. Also, future research should examine the role of nurse practitioners in telemedicine in comparison to patient outcomes.

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Declaration of Conflicting Interests

The Authors declare that there is no conflict of interest.

Resources

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Table 1

Telemedicine	Q1 (25th Percentile)	Median (50th Percentile)	Q3 (75th Percentile)	Mean	Std Error	Wilcoxon	t-test
Yes	1	1	5	3.92	0.353	0.0005	0.0001
No	1	3	10	10.345	1.516		

Table 2

Table 2: Telemedicine Least Squares Means for Time until Diagnostic Testing							
Telemedicine	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Mean**	**Standard Error Mean**
Yes	3.3619	0.05623	371	59.79	<.0001	28.8436	1.6218
No	3.6700	0.05744	371	63.90	<.0001	39.2504	2.2544

Table 3

Table 3: Telemedicine Least Squares Means for Time until Treatment Initiation							
Telemedicine	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Mean (minutes)**	**Standard Error Mean**
Yes	4.5221	0.04739	371	95.41	<.0001	92.02	4.36
No	4.7589	0.04888	371	97.35	<.0001	116.62	5.70

Table 4

Table 4: Telemedicine*Diagnosis Least Squares Means for Time until Transportation								
Tele	**Diagnosis**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Mean Time to XFER**	**Standard Error Mean**
1	1	4.7264	0.08376	368	56.43	<.0001	112.88	9.4554
1	2	4.7021	0.07771	368	60.51	<.0001	110.18	8.5616
1	3	4.7277	0.07768	368	60.86	<.0001	113.04	8.7805
1	4	4.8034	0.07838	368	61.28	<.0001	121.92	9.5563

2	1	4.9960	0.08252	368	60.54	<.0001	147.82	12.1977
2	2	4.9303	0.07907	368	62.36	<.0001	138.42	10.9440
2	3	5.0280	0.09673	368	51.98	<.0001	152.63	14.7630
2	4	4.6037	0.07105	368	64.80	<.0001	99.8483	7.0937

Table 5

Table 5: Telemedicine Least Squares Means for Length of Stay							
Tele	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Mean**	**Standard Error Mean**
1	1.1674	0.04963	374	23.52	<.0001	3.2135	0.1595
2	1.4469	0.04646	374	31.15	<.0001	4.2500	0.1974

Table 6

Table 6: of Mortality in the Hospital Only by Telemedicine			
Telemedicine	**Mortality**		
Frequency	**Yes**	**No**	**Total**
No	12	184	196
Yes	3	192	195
Total	15	376	391