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Factors Influencing Delayed Hospital Presentation in Patients with Appendicitis: The APPE Survey

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Abstract

Background—Among patients with acute appendicitis (AA), perforation is thought to be associated with symptom duration before treatment. Perforation rates vary between hospitals raising the possibility that some perforations are preventable. The factors that compel patients to present earlier or later are unknown, but are critical in developing quality improvement interventions aimed at reducing perforation rates.

Materials and Methods—The Appendicitis Patient Pre-Hospital Experience (APPE) Survey is a prospective study of adults and parents of children with AA in 6 hospitals participating in Washington State's Comparative Effectiveness Research Translation Network (CERTAIN). The

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AUTHOR CONTRIBUTIONS:

Dr. Drake, Dr. Kotagal, Dr. Agrawal, Dr. Joslyn, and Dr. Flum were responsible for study design. Dr. Ehlers, Dr. Drake, Dr. Kotagal, Dr. Simianu, and Dr. Flum participated in data acquisition from patients. Dr. Ehlers and Ms. Achar were responsible for data analysis. All authors contributed to data interpretation, manuscript drafting, and final editing.

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APPE survey includes questions about symptom duration before presentation (late defined as >24 hours), predisposing characteristics, enabling factors, and need.

Results—Among 80 patients, perforation occurred more frequently in late presenters (44% vs. 11%, $p<0.01$). Late presenters more frequently drove themselves to the hospital (64% vs. 52%, $p=0.05$) as opposed to relying on friends/family members, and described their health behavior as “waiting it out” when something is wrong (71% vs. 46%, $p=0.03$). We found similar sociodemographics, clinical characteristics, healthcare utilization, optimism, healthcare trust, and risk-taking between the two cohorts.

Conclusions—Late presenters described reduced social support and a tendency to “wait it out,” and had higher rates of perforation than early presenters. These characteristics have not been well studied conditions but are important to understand to identify patients at high-risk for delayed presentation. Future interventions might target those with low social support, or those who are reluctant to seek care early to decrease rates of perforation.

Introduction

Acute appendicitis (AA) is one of the most common indications for urgent surgery worldwide,⁽¹⁾ and more than 300,000 appendectomies are performed annually in the United States.⁽²⁾ One clinical factor that often complicates care is the presence of appendiceal perforation. Published rates of perforation vary, but may be as high as 30%.⁽³⁻⁵⁾ While the factors that lead to perforation are not known, the traditional model of AA identifies time as a critical component where longer time-to-treatment leads to higher rates of perforation. In this model, most cases of AA proceed to perforation unless timely intervention occurs. Previous studies have investigated the association between time to treatment and perforation rates, but the results vary among studies.^(3, 6-10) One important consideration is that most previous studies have investigated time-to-treatment only after a patient has presented for care at a hospital, and it may be that there are important factors occurring in the pre-hospital setting that lead to delayed presentation and subsequent perforation.

Washington State's learning healthcare system, the Comparative Effectiveness Research Translation Network (CERTAIN), is a collaboration of healthcare providers and systems that works to provide real world assessments of care within the community to develop quality improvement initiatives.⁽¹¹⁾ Previous studies in Washington State performed by the CERTAIN collaborative indicate that the perforation rate is approximately 15%,⁽³⁾ but unpublished data indicate that this rate varies significantly among hospitals. This variation raises the question of whether some cases of perforation are preventable. Beyond time to presentation, few factors have been definitively identified to explain the variability in perforation rates, but understanding these factors is critical for developing quality improvement interventions aimed at reducing perforation rates.

The Appendicitis Patient Pre-Hospital Experience (APPE) Survey is a 53-item survey designed to prospectively evaluate factors that are associated with time-to-presentation among patients in Washington State. The purpose of the survey is to identify patient-level characteristics that may explain differences in time to presentation and *possibly* rates of perforation. Our objective was to describe the population of patients who delay seeking care

for appendicitis with the goal of developing future quality improvement and patient safety interventions. Understanding why some patients delay seeking care is important knowledge in and of itself because it may help us identify potential barriers that prevent patients from coming to the hospital early.

Methods

Study Design and Population

We conducted a prospective survey of adult patients with AA or parents of children with AA at six hospitals within CERTAIN from February 2014 to October 2015. Providers at each hospital identified eligible study participants based on a diagnosis of AA through any mechanism (i.e. ultrasound, computerized tomography scan, clinical diagnosis). Consenting adult patients and parents of pediatric patients completed a paper-based survey in either English or Spanish. Study data were collected and managed using REDCap electronic data capture tools hosted at the University of Washington.(12) REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources. A complete copy of the survey can be found in the **Appendix**. The University of Washington Institutional Review Board (IRB) and the Multicare IRB approved this study. The Seattle Children's Hospital IRB granted authorization and review for this study to the University of Washington IRB.

Conceptual Model

We used the Andersen model of healthcare utilization as the conceptual model to explain the relationship between patient characteristics (or characteristics of parents of pediatric patients) as measured by the APPE survey and time-to-presentation. In the Andersen model, healthcare utilization (in this case, time-to-presentation) can be explained by differences in predisposing characteristics, enabling resources, and need.(13) A modified version of the conceptual model is shown in **Figure 1**.

Predisposing Characteristics

Within the Andersen model, predisposing characteristics include demographics and health beliefs that are not typically modifiable. To identify these characteristics within our patient population, we measured sociodemographic characteristics (i.e. age, sex, self-identified race, pre-existing comorbidities); health behaviors (i.e. whether or not someone had a flu shot in the previous year, number of times per week that one flosses his/her teeth); whether or not the individual generally trusts doctors and a measure of baseline optimism as described by the Revised Life Orientation Test (LOT-R).(13) In the LOT-R, patients are asked ten questions regarding expectations and optimism. A standardized scoring system is used to calculate an overall score from 0-24, with higher scores indicating higher level of optimism. Scores of 0-13 are associated with low optimism, 14-18 with moderate optimism, and 19-24 with high optimism.(14)

As an additional indicator of predisposing characteristics that might influence one's health behaviors, we assessed risk preferences using a modified version of the Nightingale risk preference instrument, a two item survey.(14-16) At two separate points in the survey, we provided a scenario where patients or parents of pediatric patients were allocated a hypothetical sum of money and were then asked if wanted to gamble with their money by flipping a coin. In the first scenario, flipping the coin could potentially result in significant financial gain, while in the second scenario it was associated with a potential loss of money. **(Figure 2)** According to prospect theory as described by Kahneman and Tversky, people tend to take the sure thing in the gain scenario (i.e., avoid the gamble), but prefer to gamble against a sure loss.(17, 18) We categorized patients into four categories based on their answers to the two questions: risk averse (never coin flip), risk seeking (always coin flip), prospect theory concordant (choose to gamble only in second scenario), or prospect theory discordant (choose to gamble only in the first scenario).

Enabling Resources

Enabling resources refer to items that facilitate access to the healthcare system. We assessed enabling resources by measuring household income level based on a median income level of approximately \$55,000 in Washington State at the time of survey development (19); whether the adult patient or parent of pediatric patients had a primary care physician; and whether or not they had health insurance. To assess social support, we asked survey respondents whether they lived with their spouse or significant other; whether they had a source of guidance that they turned to when they were concerned about their symptoms; whether that person encouraged them to seek care; if they identified any barriers to treatment; and how they were transported to the hospital once they decided to seek care for either themselves or their child.

Need

Need focuses on items related to the perceived need for care. We asked each survey respondent whether they considered themselves to be the type of person who seeks help early or waits it out as long as possible. We then asked about the current episode of appendicitis including the level of pain, the type and location of pain, and whether they thought they had appendicitis versus a different diagnosis. Finally, we asked survey respondents about their level of anxiety (range 0-6 with higher scores indicating higher anxiety) regarding the symptoms they or their child were experiencing, as well as the level of optimism (separate from the LOT-R, range 0-6 with higher scores indicating higher optimism) that they or their child would get better at the time when they had symptoms of appendicitis

Outcome Variables

The primary outcome of interest was time from onset of symptoms to hospital presentation (time-to-presentation). We measured time-to-presentation by asking survey respondents to write down the time at which they or their child first had symptoms and the time at which they sought care for the symptoms and then calculated the difference. We then classified patients into two cohorts based on whether they presented “early” or “late.” We defined

early presentation as that occurring within 24 hours of symptom onset and late as occurring after 24 hours. We chose this time point as it is easily interpretable as being less than or greater than one day.

The secondary outcome was perforation rate as it related to time-to-presentation. All patients were asked whether their/their child's appendix was perforated and could response “yes,” “no,” or “do not know.” We selected this method because we did not have access to medical records for all patients. To validate this measure, we compared self-reported perforation rates to pathological perforation information (among those whose medical records we could access) and found 100% concordance. Within this analysis, we also investigated patient-level factors that were independently associated with perforation among those patients who knew whether or not their appendix was perforated.

Analysis

In the primary analysis, categorical variables were compared using frequency distributions and the Pearson χ^2 test. We compared continuous variables using medians and the non-parametric equality of means test. A p-value of 0.05 was considered statistically significant. All analyses were conducted using STATA® 13 (StataCorp LP, Texas).

To further explore the relationship between patient characteristics and time-to-presentation, we performed two *post hoc* analyses. In the first, we treated time-to-presentation as a continuous outcome variable rather than a binary variable as described above. In this analysis, we examined the interaction between a patient's risk preference as demonstrated by Scenario 1 (**Figure 2**) and other baseline characteristics relative to time-to-presentation. We tested interactions using ANOVA, which allowed us to identify the interaction effect of patient risk profile and another categorical predictor variable on time-to-presentation. This set of analyses were conducted using Statistical Package for the Social Sciences (SPSS®) 21 (IBM, New York) and a p-value of 0.05 was considered statistically significant.

In the second *post hoc* analysis, we stratified the cohort into two patient groups: one of adult patients answering the survey for themselves, and the second comprised of parents of children with appendicitis who were completing the survey on their behalf. The purpose of this analysis was to identify any potential differences between the way that individuals make decisions about their own health compared to how they may make decisions about the health of their child.

Results

Of the 153 patients who agreed to participate, 93 (61%) returned a survey. Time-to-presentation data was missing or obviously inaccurate (e.g. time of presentation occurred prior to symptom onset) in 13 patients; thus, these patients were not included. Among the 80 remaining patients, the median time to presentation was 20 hours. We identified 44 patients who presented within 24 hours and 36 who presented after 24 hours. The majority of patients (n=51, 64%) were adult patients rather than parents of pediatric patients. We had access to the medical records of 38 adult patients with appendicitis (median age 30.5 years, range 18-71, 50% female).

Time to Presentation

Predisposing characteristics associated with time-to-presentation are shown in **Table 1**. We found no significant differences with regard to sociodemographic characteristics, baseline health behaviors, presence of comorbid conditions, measurements of trust in doctors, score of optimism (using LOT-R score), and education level. We also found no significant difference in health maintenance behaviors such as flu shot receipt or frequency of flossing. Using the modified Nightingale instrument, we did not find any significant differences in baseline risk tolerance between early and late presenters, with about half of both early and late presenters categorized as risk averse. While not statistically significant, there were more prospect theory concordant people in the early group (15% vs. 3%, $p=0.26$).

Enabling resources associated with time-to-presentation are represented in **Table 2**. Patients who presented early were more often driven to the hospital by a friend or family member (38% vs. 22%, $p=0.05$) as opposed to another mode of transportation. Although it was not statistically significant, patients who presented early more frequently reported that someone encouraged them to seek care for their symptoms (88% vs. 70%, $p=0.07$). We otherwise found no differences in household income level, access to a primary care provider, whether or not the patient had medical insurance, and whom the patient sought guidance from in response to their level of pain.

Need factors are reported in **Table 3**. Patients who presented early more frequently stated that they were the type who “seeks help early” rather than “waiting it out” when they think that something is wrong (54% vs. 29%, $p=0.03$). Although it appears that early presenters used the internet more, this difference was not statistically significant (54% vs. 34%, $p=0.09$). We found no differences with regard to patients’ knowledge and beliefs pertaining to appendicitis and whether or not they thought their symptoms were due to appendicitis. Optimism and anxiety scores at the time of illness did not differ significantly.

Perforation

Time-to-presentation was strongly associated with patient-reported rates of perforation: patients who presented late had a rate of perforation nearly four times higher than who presented early (44% vs. 12%, $p<0.01$). Among those with perforated appendicitis ($n=20$, 26%), the median time to presentation was 49 hours, compared to 16 hours among those who did not have perforated appendicitis ($n=45$, 58%) and 24 hours among those who did not know if their appendix was perforated ($n=12$, 16%). Among the 65 survey respondents who knew whether their appendix was perforated or not, the only significant difference between those with perforated and non-perforated appendicitis was education level: patients or parents of children with perforated appendicitis more frequently reported that they had a high school degree or less (30% vs. 9.1%, $p=0.03$). We found no other significant differences with regard to predisposing characteristics, enabling resources, or need factors.

Factors Associated with Time-to-Presentation

In the first *post-hoc* analysis, we found three significant interactions between risk preference and other patient characteristics that were associated with time-to-presentation. Among risk seeking patients, patients who had previously undergone surgery had a significantly longer

time-to-presentation compared to those who had not had surgery before (14.8 hours vs. 3.4 hours, $p<0.01$). Risk seeking patients who used the internet to research their symptoms also had a longer time-to-presentation, compared to those who did not research their symptoms, although this was not statistically significant (10.8 hours vs. 4.9 hours, $p=0.06$). Among risk seekers, those who knew a friend or family member who had been treated for appendicitis had a significantly shorter time-to-presentation compared to those who had never known anyone with appendicitis (3.2 hours vs. 12.4 hours, $p=0.05$).

Adult Patients vs. Parents of Pediatric Patients

In the second *post hoc* analysis, there were 51 adult patients and 29 parents of pediatric patients. Among the adult patients, 32 (63%) presented within 24 hours, while 19 (37%) presented after 24 hours. Within the adult population, we found no statistically significant differences between the two groups on any predisposing characteristic, enabling resource, or need factor. Among the pediatric population, 12 patients (41%) presented within 24 hours, while the remaining 17 (59%) presented after 24 hours. Within this cohort, we found that parents of pediatric patients who presented late were less likely to say that they were encouraged to seek care for their child (54% vs 100%, $p=0.02$) compared to parents of pediatric patients who presented early. Parents of late presenters less frequently suspected that their child had appendicitis (37.5% vs 75%, $p=0.05$), and less frequently described their health behaviors as “seeking help early” when they think that something is wrong (35.3% vs 80%, $p=0.03$). There were no other significant differences between early and late presenters among the parents of early and late presenters.

Discussion

We performed a prospective study of adult patients with AA and parents of children with AA to describe pre-hospital factors that are associated with delayed hospital presentation. Patients who presented to the hospital more than 24 hours after the onset of symptoms more frequently drove themselves to the hospital, as opposed to having someone from their social support network drive them, and more often described themselves as the type of person who “waits it out” when they think that something is wrong. Patients who presented late were diagnosed with perforated appendicitis nearly four times as often as those who presented before 24 hours, which suggests that pre-hospital delay is an important factor in the incidence of perforated appendicitis. We also found several interactions between risk preference and time-to-presentation: among risk-seeking patients it appears that knowledge about appendicitis and overall health may influence the time period between symptom onset and when the patient decides to seek care. Personal experience with surgery or information gleaned from the internet was associated with a longer time-to-presentation among risk-seekers, whereas knowledge about another individual's experience was associated with a shorter time-to-presentation.

While delay of treatment is frequently cited as an important factor in the development of perforated appendicitis,(6, 8, 10) several studies investigating this have found no association between time-to-treatment and perforation rates.(3, 7, 9) However, most of these studies have relied upon the use of clinical registries, large claims databases, or retrospective chart

abstraction to describe time-to-treatment once the patient has arrived at the hospital and do not consider pre-hospital events. This is an important omission in the literature on appendicitis since some hypothesize that health behavior may differ between those who seek care early vs. later in acute conditions (21) and these factors are not usually measured in large databases. Indeed, we found that patients who presented to the hospital more than 24 hours after the onset of symptoms described themselves as the type of person who “waits it out” rather than “seeks help early” when they sense that something is wrong; asking this question may be a simple but effective tool for evaluating health behaviors. It is important to note that these individuals were not necessarily those who avoid healthcare in general since we found no association between health promoting behaviors such as receipt of a flu shot and frequency of flossing.

Delay of treatment was also significantly associated with mode of transportation: we found that patients who presented after 24 hours of symptoms more frequently drove themselves to the hospital rather than relying on other sources of transportation. This difference may be an indicator of the level of social support available to patients: if someone has a friend or family member who can drive them, perhaps this person is also encouraging the patient to seek care for their symptoms. This may also indicate that they have social support available to help with other potential barriers such as need for child care. We know that in other disease processes, such as acute myocardial infarction, patients frequently cite reluctance to call emergency services as a reason to delay seeking care.(21, 22) As far back as the 1960s it was recognized that encouragement from another individual was associated with less time delay among patients with acute myocardial infarction.(23) In this study, we noted a similar trend, although this did not reach statistical significance: those who presented early more frequently reported that they were encouraged to seek care.

There are limitations to this study that should be considered. This survey is a convenience sample of individuals who were willing to complete the survey; thus, the results may not be generalizable to all patients with AA. We do not know how many patients were potentially eligible for the survey and whether we have information from a representative sample because we did not have approval to review admission records for all patients with appendicitis. While we were primarily focused on understanding factors that were related to time-to-presentation, we were limited by the fact that we did not have information about perforation status in all patients. Finally, because this survey asked about past events, the information is subject to recall bias on the part of the patient where the outcome of their care influenced their memory of events prior to their illness. For example, the severity of a patient's disease may have affected their ability to recall the time at which they initially had symptoms and when they chose to seek care. One of the most important limitations is the small sample size of this study, which likely prevented us from ascribing significance to certain survey questions such as whether or not an individual was encouraged to seek care for their symptoms. For example, we found that early presenters more often were encouraged to seek care compared to late presenters (88% vs. 70%). This likely represents a type 2 error, as we would need more than 200 individuals in order to truly detect the significance of this result (alpha 0.05, power=0.90).

Despite asking patients about a broad range of topics, we found only two significant associations between patient factors and time-to-presentation. While these factors may provide some insight into patient decision making, we also recognize that this highlights the fact that the medical community does not understand what drives patient behavior. As noted above, this may be due to the fact that we were underpowered. Alternatively, it may indicate that we either did not ask patients about the domains that are most influential for decision-making or that decision-making for non-healthcare decisions is not reflective of decision-making in healthcare. For example, we ascertained risk preference using standardized questions related to financial gain or loss, but this construct may not necessarily apply for decisions in healthcare. An additional consideration is that for the 29 pediatric patients in this study, surveys were completed by their parents. It may be that parents make different choices for their children than they would for themselves but the extent to which this limits the findings from this study are not clear. However, in the subgroup analysis of parents of pediatric patients, we again found that parents of kids who presented after 24 hours described their health behavior as “waiting it out” when they think that something is wrong. Future work should focus on understanding how individuals make decisions for their own health versus the health of their child.

We performed a prospective evaluation of adult patients and parents of pediatric patients with AA. We found that delayed presentation to the hospital was significantly associated with higher rates of perforation and that there were several patient-level factors that might be associated with delays in treatment. These differences are important because certain personality traits, such as a health behavior of “waiting it out” could be assessed in the primary care setting to identify patients who might be at risk for delaying treatment for symptoms. However, the work we present here is exploratory in nature and is likely not ready for clinical application. More work should be done to target at-risk individuals to alert them to warning signs, such as has been done in the stroke campaigns to alert patients to the signs and symptoms of acute stroke. We also found potentially important interactions between risk preferences and disease knowledge that may influence time-to-presentation. However, there remain many unanswered questions regarding patient decision-making that are important for us to understand. At a population level, identifying high-risk individuals could have a major impact not only on patients with appendicitis but also with other acute conditions such as myocardial infarction. Another important consideration is the identification of patients who lack social support. Providing resources for these individuals, whether through the medical system or through more community based services such as discounted services on transportation to the hospital, may provide a mechanism to prevent individuals from delaying treatment in the setting of acute illness.

In summary, we present results from the APPE Survey which sought to evaluate patient characteristics that might be associated with pre-hospital patient-decision making. These characteristics have not been well studied in acute surgical conditions but are important to understand in order to identify patients at high-risk for delayed presentation. This is true not only for appendicitis, but other non-surgical conditions such as stroke or acute coronary syndrome where a delay in presentation may have significant consequences for their treatment options and outcomes. Despite the small size of this study, we demonstrated that

practical evidence can be gleaned from focusing inquiry on aspects of the pre-hospital segment of acute surgical disease.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

References

1. Stewart B, Khanduri P, McCord C, Ohene-Yeboah M, Uranues S, Vega Rivera F, et al. Global disease burden of conditions requiring emergency surgery. *Br J Surg*. Jan; 2014 101(1):e9–22. [PubMed: 24272924]
2. Weiss, AJ.; Elixhauser, A.; Andrews, RM. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs. Rockville (MD): 2006. Characteristics of Operating Room Procedures in U.S. Hospitals, 2011: Statistical Brief #170..
3. Drake FT, Mottey NE, Farrokhi ET, Florence MG, Johnson MG, Mock C, et al. Time to appendectomy and risk of perforation in acute appendicitis. *JAMA Surg*. Aug; 2014 149(8):837–44. [PubMed: 24990687]
4. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol*. Nov; 1990 132(5):910–25. [PubMed: 2239906]
5. Braveman P, Schaaf VM, Egerter S, Bennett T, Schechter W. Insurance-related differences in the risk of ruptured appendix. *N Engl J Med*. Aug 18; 1994 331(7):444–9. [PubMed: 7880234]
6. Ditillo MF, Dziura JD, Rabinovici R. Is it safe to delay appendectomy in adults with acute appendicitis? *Ann Surg*. Nov; 2006 244(5):656–60. [PubMed: 17060754]
7. Kearney D, Cahill RA, O'Brien E, Kirwan WO, Redmond HP. Influence of delays on perforation risk in adults with acute appendicitis. *Dis Colon Rectum*. Dec; 2008 51(12):1823–7. [PubMed: 18584252]
8. Omundsen M, Dennett E. Delay to appendectomy and associated morbidity: a retrospective review. *ANZ J Surg*. Mar; 2006 76(3):153–5. [PubMed: 16626357]
9. Teixeira PG, Sivrikoz E, Inaba K, Talving P, Lam L, Demetriades D. Appendectomy timing: waiting until the next morning increases the risk of surgical site infections. *Ann Surg*. Sep; 2012 256(3):538–43. [PubMed: 22842128]
10. Busch M, Gutzwiller FS, Aellig S, Kuettel R, Metzger U, Zingg U. In-hospital delay increases the risk of perforation in adults with appendicitis. *World J Surg*. Jul; 2011 35(7):1626–33. [PubMed: 21562871]
11. Devine EB, Alfonso-Cristancho R, Devlin A, Edwards TC, Farrokhi ET, Kessler L, et al. A model for incorporating patient and stakeholder voices in a learning health care network: Washington State's Comparative Effectiveness Research Translation Network. *J Clin Epidemiol*. Aug; 2013 66(8 Suppl):S122–9. [PubMed: 23849146]
12. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. Apr; 2009 42(2):377–81. [PubMed: 18929686]
13. Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? *J Health Soc Behav*. Mar; 1995 36(1):1–10. [PubMed: 7738325]
14. Scheier MF, Carver CS, Bridges MW. Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the Life Orientation Test. *J Pers Soc Psychol*. Dec; 1994 67(6):1063–78. [PubMed: 7815302]
15. Nightingale SD. Risk preference and admitting rates of emergency room physicians. *Med Care*. Jan; 1988 26(1):84–7. [PubMed: 3336247]
16. Nightingale SD. Risk preference and laboratory use. *Med Decis Making*. Jul-Sep; 1987 7(3):168–72. [PubMed: 3613916]
17. Nightingale SD, Grant M. Risk preference and decision making in critical care situations. *Chest*. Apr; 1988 93(4):684–7. [PubMed: 3349824]

18. Kahneman D TA. The psychology of preference. *Sci Am.* 1982; 246(161)
19. Kahneman D TA. Prospect theory: An analysis of decision under risk. *Econometrica.* 1979; 47(2): 263–291.
20. Median Household Income Estimates by County. 1989 to 2014 and Projection for 2015 [Internet]. 2016. Available from: <http://www.ofm.wa.gov/economy/hhinc/medinc.pdf>
21. Bickell NA, Siu AL. Why do delays in treatment occur? Lessons learned from ruptured appendicitis. *Health Serv Res.* Apr; 2001 36(1 Pt 1):1–5. [PubMed: 11324738]
22. Meischke H, Ho MT, Eisenberg MS, Schaeffer SM, Larsen MP. Reasons patients with chest pain delay or do not call 911. *Ann Emerg Med.* Feb; 1995 25(2):193–7. [PubMed: 7832346]
23. Hackett TP, Cassem NH. Factors contributing to delay in responding to the signs and symptoms of acute myocardial infarction. *Am J Cardiol.* Nov; 1969 24(5):651–8. [PubMed: 5347938]

Figure 1. Conceptual model to describe healthcare utilization, adapted from the Andersen Model of Health Care Utilization. Modified and reproduced with permission from the American Sociological Association.

Scenario 1:

Imagine you start with \$100 to play a choice game. Please pick one of the following choices:

- Choice A: You flip a coin. If it's "heads" you win another \$100 and keep \$200. If it's "tails" you don't win anything but keep the original \$100.
- Choice B: You don't bother with the coin flip. You get another \$50 and keep \$150.

Scenario 2: Imagine you start with \$200 to play a choice game. Please pick one of the following choices:

- Choice A: You flip a coin. If it's "heads" you lose \$100, but if it's "tails" you don't lose anything and keep all \$200.
- Choice B: You don't bother with the coin flip. You lose \$50 and get to keep \$150.

Figure 2.

Risk preference scenarios presented to patients in the APPE Survey. According to prospect theory, most people would NOT gamble in Scenario 1 (certain gain), but would choose to gamble in Scenario 2 to avoid a certain loss.

Table 1

Predisposing factors associated with early versus delayed presentation to the hospital for acute appendicitis.
Due to rounding values may not always add to 100%.

Predisposing Factor	Early (<24hours)	Delayed (24 hours)	P-Value
	N=44	N=36	
Median age (range) ¹	28 (20-71)	44.5 (18-63)	0.50
Female sex (%) ¹	12 (50)	7 (50)	1.00
Self-identified racial identity			
White (%)	34 (79)	25 (69)	0.33
Non-white (%)	9 (21)	11 (31)	
Primary English speaker (%)	36 (82)	31 (86)	0.61
Flu Shot (%)	24 (57)	18 (53)	0.71
Floss (%)			
2 times per week (%)	7 (16)	6 (17)	0.93
3 times per week (%)	37 (84)	30 (83)	
1 pre-existing condition (%)	12 (27)	10 (28)	0.96
Generally trust doctors (%)	38 (95)	33 (94)	0.89
Median LOT-R Score (range) ²	16 (5-24)	18 (9-23)	0.81
Education level			
High school or Less	6 (14)	7 (19)	0.54
More than high school	36 (86)	29 (81)	
Risk Tolerance			
Risk averse	19 (49)	17 (50)	0.26
Risk seeking	8 (21)	7 (21)	
Prospect Theory Concordant	6 (15)	1 (3)	
Prospect Theory Discordant	6 (15)	9 (26)	

¹ Age and sex data was available for 38 adult patients with appendicitis (19 female, 19 male).

² Based on the revised life orientation test. (14)

Table 2

Enabling factors associated with early versus delayed presentation to the hospital for acute appendicitis. Due to rounding values may not always add to 100%.

Enabling Factor	Early	Delayed	P-Value
	(<24hours)	(24 hours)	
	N=44	N=36	
Annual Household Income			
<\$55,000 (%)	21 (49)	15 (42)	0.52
\$55,000 (%)	22 (52)	21 (58)	
Live with spouse or significant other (%)	29 (67)	25 (71)	0.70
Has a regular PCP (%) ¹	28 (67)	27 (77)	0.31
Medically insured (%)	37 (86)	34 (94)	0.22
Concern about the hospital bill			
No (%)	25 (60)	25 (74)	0.20
Yes (%)	17 (40)	9 (26)	
Source of Guidance in Response to Pain²			
Family/Significant Other (%)	21 (50)	13 (36)	0.28
Friend (%)	1 (2)	1 (3)	
Medical Professional (%)	7 (17)	14 (39)	
Other (%)	6 (14)	3 (8)	
No One (%)	7 (17)	5 (14)	
Were you encouraged to seek care? (%)	30 (88)	21 (70)	0.07
Any reported barrier to care (%)	24 (55)	26 (72)	0.10
Mode of Transportation			
Personally Owned Vehicle (%)	22 (52)	23 (64)	0.05
Friend/Family Member (%)	16 (38)	8 (22)	
Taxi (%)	2 (5)	0 (0)	
Ambulance (%)	0 (0)	4 (11)	
Walk (%)	2 (5)	0 (0)	
Other (%)	0 (0)	1 (3)	

¹ Refers to whether the patient or the parent of the pediatric patient has a regular PCP.

² This question is asking the parent whether they sought advice for care regarding their child's condition.

Table 3

Need factors associated with early versus delayed presentation to the hospital for acute appendicitis. Due to rounding values may not always add to 100%.

Need Factors	Early	Delayed	P-Value
	(<24 hours)	(≥ 24 hours)	
	N=44	N=36	
Did you think you/your child had appendicitis?			
No (%)	19 (43)	18 (51)	0.47
Yes (%)	25 (57)	17 (49)	
Had you ever heard that an appendix might perforate?			
No (%)	2 (5)	3 (8)	0.49
Yes (%)	42 (95)	33 (92)	
Were you concerned that your/your child's appendix might perforate?			
No (%)	24 (57)	20 (61)	0.76
Yes (%)	18 (43)	13 (39)	
Did you use the internet to find information about symptoms?			
No (%)	19 (46)	23 (66)	0.09
Yes (%)	22 (54)	12 (34)	
When you think something is wrong, do you tend to:			
Seek help early (%)	22 (54)	10 (29)	0.03
Wait it out (%)	19 (46)	25 (71)	
Median anxiety (range) ^I	6 (2-7)	5 (2-7)	0.18
Median optimism (range) ^I	4 (1-7)	4 (1-7)	0.47

^I Scored on a modified Likert scale from 0=not at all anxious/optimistic, 6=very anxious/optimistic.