Sizing the health system outpatient capacity problem and simulating the value of A.I. triage

Bilal A. Naved, Ph.D[1,2], Adeel Malik[2], B.S, Quintan M. Slott[2], B.S, Yuan Luo, Ph.D[1*]

1. Northwestern University Feinberg School of Medicine, Department of Preventive Medicine, Chicago, IL, USA
2. Clearstep Health, Chicago, IL, USA

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Corresponding author's contact information: yuan.luo@northwestern.edu

Abstract

Importance

Many United States (US) health systems face increasing financial strain and provider shortages, potentially driving long wait times. Aligning ambulatory appointments with true patient needs could improve access and sustainability.

Objective

To quantify unnecessary in-person visits across service lines and determine how self-triage might redirect scheduling toward more appropriate care.

Design

This cross-sectional study combined (1) retrospective billing data from 2 US health systems (2022–2023) and (2) prospective self-triage data from randomly sampled users across all 50 states.

Setting

Two US regional health systems of varying sizes, plus a nationally adopted self-triage platform integrated into multiple health system websites.

Participants

Retrospective data included 2,789,780 ambulatory visits from 685,982 patients and 1,880 providers. Prospective data comprised 4,789 digital care seekers who reported “pre-intent” before receiving automated triage results.

Exposures

(1) Visits were categorized by whether diagnostics or physical exam maneuvers were billed.
(2) Self-triage recommendations were compared with participants’ pre-intent to assess validation or redirection.

Main Outcomes and Measures

Primary outcomes: proportion of visits with no diagnostics or exams (indicating potential for virtual care), and the degree to which self-triage redirected care intentions. Secondary outcomes: simulated revenue impacts if underutilized slots were replaced with higher-acuity appointments.

Results

Overall, 27% (746,129/2,789,780) of visits had no billed diagnostics or exams. Among 4,402 users with clear pre-intent, 73% were redirected (67% de-escalated to less acute care; 33% escalated). Engagement with recommended booking was 54% for those validated vs 27–37% for those redirected. Replacing these “unnecessary” visits with higher-acuity appointments could yield a 5.33% (+/- 4.52%) gross revenue increase. Applying observed redirection behavior suggests a 34% realization (about 1.29% (+/- 1.09%) net revenue gain).

Conclusions and Relevance

A substantial portion of ambulatory visits may not require in-person care suggesting significant hidden capacity. Automated self-triage systems can help redirect patients to more appropriate sites of care, potentially improving patient access, use of capacity and financial outcomes.

Introduction

By 2030 it is estimated that the US will be short >100,000 physicians.[1-3] This shortage may help explain why wait times to be seen by a provider can range up to 89 days (depending on the specialty and geographic area).[4,5,6] There is a lack of peer-reviewed studies examining how effectively US health systems and medical groups are able to make use of their employed and contracted providers' time. Inefficiencies that exist within the system may impact more than just the patient experience.[6] Financial performance at US health systems may also be impacted.[6] The percentage of health systems that have a negative outlook more than doubled in 2023, now encompassing one-in-five rated systems.[7,8] The share of hospitals with negative margins could rise from 25% to 41% in a decade.[8,9] Cash on hand of US health systems dropped to a ten year low this year, suggesting shrinking margins.[7]

With a provider shortage, optimizing the efficiency of provider time across health system ambulatory groups is of increasing importance. Aside from the visit itself, providers administer care for patients in the form of what they tell the patient,[8] physical exam maneuvers performed,[8,10] the diagnostics[11] and therapeutics[12,13] ordered for the patients, and any referrals they provide the patient to follow-on care.[14-18] Four of these five items are directly quantifiable (i.e. the type of visit, the diagnostics ordered, the therapeutics ordered, and the referrals provided).[19-26] Yet, no studies to date have comprehensively quantified these components to assess how effectively patient scheduling intent aligns with healthcare system resources and capacity.

The question stands of how efficiently is in-person time of providers across ambulatory service lines used by health systems today? To address this critical gap in knowledge, this study aims to be the first to (a) quantify the extent of the access and capacity challenges faced by multiple regional U.S. health systems, (b) characterize patient intent when initially seeking care and measure how effectively this intent can be redirected or managed through interactions with a A.I. self-triage system, and (c) integrate these measurements to estimate the potential value derived from optimizing ambulatory outpatient capacity across various medical service lines by more accurately qualifying incoming patient scheduling intent.

By clearly addressing these objectives, this research provides novel insights into potential strategies for improving healthcare access, patient experience, and the economic sustainability of health systems amid ongoing provider shortages.

Methods

Study design

To address the study objectives, this cross-sectional study examined (1) retrospective billing data from 2 US health systems (2022–2023) to understand the efficiency of outpatient provider time across ambulatory service lines and (2) prospective self-triage data from randomly sampled users across all 50 states to measure how effective self-triage may be at facilitating more efficient scheduling of provider time. Retrospective visits were categorized by whether diagnostics or physical exam maneuvers were billed with the assumption that any visit that had neither a physical exam maneuver nor a diagnostic ordered implied that the visit was merely a conversation and could have happened virtually. Self-triage recommendations and the post-triage

care seeking actions taken by participants were compared with those participants' pre-intent to assess the extent to which participants were booking appropriate care or should have been redirected to more clinically appropriate care. Retrospective data included 2,789,780 ambulatory visits from 685,982 patients and 1,880 providers. Prospective data comprised 4,789 digital care seekers who reported "pre-intent" before receiving automated triage results. To evaluate the financial impact of better optimizing the use of provider time a comparison of baseline revenue generated versus optimized revenue was calculated by applying average wRVU figures of visits that did "require" in-person care (i.e. had physical exam or diagnostic codes on the visit) to calculate replacement revenue and compare it to the actual revenue realized.

Ambulatory outpatient visit data across all service lines of two US health systems

Via Business Associates Agreement (BAA) with two health systems, a year of outpatient visit data was acquired from their databases for the year 2022-2023. The two health systems featured (a) one 10+ hospital, multi-regional system on the east coast, and (b) one <5 hospital system in the south. To avoid violating terms of the BAAs, data from the two systems was aggregated together and reported as one cumulative number for each measurement. Overall, 2,789,780 outpatient visits across 685,982 patients seen by 1880 providers were analyzed in this study.

Analysis of ambulatory outpatient visit data

Evaluation & Management (E&M) codes for every visit were extracted and aggregated across all new and existing patients. The visits were measured for the presence of codes suggesting diagnostics or physical exam maneuvers. These were used as a proxy for the "need" for in-person care. The total number of visits that didn't "need" in-person care was summed and reported by tallying the number of visits with no diagnostic nor physical exam codes.

Measuring digital care-seeking intents of patients across health systems in all 50 states

Before users received their self-triage results from using the USA's most prevalently adopted self-triage solution for health systems, a randomly selected set of users were asked what they were planning on doing for their care (**Supplemental Material**). We called this their "pre-intent". 4,789 pieces of user data were included in this analysis. This analysis only looked at users that answered the pre-intent question with a clear intent or "unsure" remark. Additionally, any users who were calculated to require a "911" or "Emergency Room" (ER) recommendation were not shown the additional pre-intent question and were immediately recommended to call an ambulance or go to the ER respectively.

Calculating the self-triage of the same patients whose care-seeking intents were measured

The model to calculate patient self-triage was chosen for the following reasons: (1) it is the most widely implemented model by US health systems[27,28], (2) it is based on clinical best practice guidelines that are trusted by 95% of US health system call centers in the country, (3) it is the only agentic model built in partnership with the co-author of the same clinical best practice protocols (built in partnership with Dr. Barton Schmitt, co-author of the Schmitt-Thompson Triage Protocols), and (4) it has been evaluated to be the most accurate virtual triage engine

available via a head-to-head analysis conducted using a set of standardized patient vignettes utilized to evaluate symptom checker accuracy in a seminal work[29] (**Supplemental Material**) boasting an 84 – 95% triage accuracy with the next closest competitor demonstrating a 74-88% triage accuracy. Therefore, the model is one of the closest available A.I. triage proxies to what patients calling into a call center would receive by way of triage and matching to clinically appropriate care. Using the USA's most prevalently adopted self-triage[27], a triage recommendation for each of the 4,789 users with collected pre-intent was calculated. The users engaged with the self-triage system via the websites or patient portals of the US health systems in which the solution was implemented nationally and in full scale use. The 4,789 users were randomly selected from across the breadth of the A.I. triage system's national adoption.

Comparing the calculated self-triage and the measured care-seeking intents

For the study population, the collected pre-intent was compared to the calculated A.I. triage. If the pre-intent matched the A.I. triage then the individual was classified as having their pre-intent validated. If the pre-intent mismatched the A.I. triage then the individual was classified as having their pre-intent re-directed. Of the re-directed individuals, those whose pre-intent was to a site of care that was less emergent than the calculated A.I. triage were sub-classified as having their pre-intent escalated. Those whose pre-intent was to a site of care that was more emergent than the calculated A.I. triage were sub-classified as having their pre-intent de-escalated. In sum, individuals could be classified into any one of three groups: "validated", "escalated", or "de-escalated". The latter two being sub-classifications of "re-directed".

Measuring the proportion of individuals that engaged with calculated options for care

As individuals in the study population complete the triage questionnaire, they were met with a results page that clearly stated the triage at the top (topline triage). Then, below the topline triage, the individuals would find options for booking or initiating the desired care (fulfillment options). Any individual that interacted to book, call, or initiate was classified as having engaged with the calculated option for care. Ultimately, the proportion of individuals who interacted with the calculated option for care was calculated in aggregate across the study population. Thereby measuring post-triage care seeking actions.

Using the measurements to simulate the number of visits that may be deflected across the two health systems

The measured number of in-person visits that didn't "need" to happen (as calculated described above) was used to represent the total potential of visits that could be deflected (deflectable visits). To simulate the proportion of deflectable visits that would realistically be deflected by an automated, self-triage system a simulation was run. In this simulation, the measurements of the self-triage system's effects on driving patient behavior as described above were used. In more detail, the proportion of re-directed patients that chose to engage with the presented options was applied to the overall number of deflectable visits. This simulation assumed that (a) all scheduled in-person visits were qualified by self-triage and (b) of the patients that use the self-triage to qualify their booking intent only a measured proportion of them proceed to engage with and follow the recommended care. This proportion is referred to as the "simulated deflections."

Translating the simulated deflections to financial metrics

To simulate the financial value to the health system of (a) deflecting patients without a "need" for in-person visits and (b) filling those slots with patients that do have a "need", average work relative value units (wRVUs) for each service line were calculated of all visits that had neither (a) an E&M code for a physical exam nor (b) an E&M code for a diagnostic order. This was done for the simulated deflections as calculated above. Using the total number of "replacement wRVUs" an "overall replacement revenue" was calculated. Finally, to calculate a "net replacement revenue" the total amount of lost revenue generated by deflecting visits to a virtual visit was calculated and subtracted from the overall replacement revenue. This calculation was done using an average revenue figure for each hypothetical virtual visit.[30,31] A detailed health economic analysis plan is included in the **Supplemental Material.**

Results

27% of visits across service lines did not have any physical exam nor diagnostic tests

Out of 2,789,780 visits analyzed, 746,129 visits had no E&M codes suggestive of a physical exam maneuver nor a diagnostic order. Thus, suggesting that 27% of visits across all service lines did not "require" a physical exam nor any diagnostic tests and may have been manageable via virtual care (**Table 1**).

92% of self-triage users have a clear intent with a distribution of intents across the spectrum

Of the 4,789 randomly selected study individuals 91.9% of them had a clear care seeking intent. 8.1% of them were unsure what type of care would be optimal. In descending order, 18.1% intended to seek Urgent Care, 17.7% Self-Care, 15.4% a PCP, 14.5% a Retail Clinic, 11.4% an Emergency Room, 10.0% a Specialist, 4.6% Telemedicine, 0.1% to call 911, and no one intended to seek Labor & Delivery nor a Dentist **(Table 2)**.

73% of care seeking intents are incorrect with 2/3 needing de-escalation and 1/3 escalation

Of the 4,402 patients with clear intent (i.e. not "unsure"), 27% had an accurate intent and were validated by the self-triage system (**Figure 1**). This meant that their indicated pre-intent was the same as the calculated self-triage. 73% of them had an inaccurate intent (i.e. one that differed from the calculated self-triage) (**Figure 1**). These patients with inaccurate intent represent the group that is eligible to be re-directed to a more appropriate site of care. 67% of the redirected patients had a care-seeking intent that was of a higher level than what was ultimately recommended (**Figure 1**). These patients were appropriate for de-escalation to less acute types of care. 33% of the redirected patients had a care-seeking intent that was of a lower level than what was ultimately recommended (**Figure 1**). These patients were appropriate for escalation to a more acute type of care.

Validating care seeking intents led to ~2x higher booking engagements than re-directing them

Study participant clicks on calls to action (CTAs) for booking care were measured. Thus, engagement with the calculated care and how it compared to the participants' pre-intent could also be measured. Participants whose pre-intent was validated by the self-triage were found to engage with CTAs 54% of the time (**Figure 1**). In contrast, participants whose pre-intent was re-directed engaged 37% of the time (when being de-escalated) and 27% of the time (when being escalated) (**Figure 1**). More broadly, participants who marked "unsure" in the pre-intent survey engaged with CTAs 27% of the time. While participants who had a clear pre-intent of any form engaged with CTAs 40% of the time on average.

Deflecting unnecessary in-person care and filling it with needed care represented a 5.33% gross revenue opportunity for the two systems

Based on the averaged payer mix of the two health systems (Commercial vs. Medicare vs. Medicaid) the weighted average reimbursement rate across payers per RVU was calculated to be $39.60 (+/- $17.50) (**Supplemental Table 1**). Then, if all 746,129 visits that didn't "need" in-person care were shifted to virtual care a net loss of $85,685,454.40 +/- $39,302,345.1 would be realized when applying the average wRVUs generated by each visit (2.9 +/- 0.11). Then, using the weighted average reimbursement rate across payers per RVU $39.60 (+/- $17.50) and the average number of wRVUs generated by visits that did indicate a "need" for in-person care (9.8 +/- 0.46), it was calculated that filling all 746,129 visits with those that do have a "need" would generate net new replacement revenue of $289,557,742 +/- $133,967,462. Subtracting the net loss brings the gross incremental revenue to $203,872,288 (+/- $173,269,807). With the two systems representing roughly $4.75B in total revenue in 2024, this represents a 5.33% (+/- 4.52%) gross revenue opportunity across the two systems (**Table 3**).

Simulating the proportion of the gross revenue opportunity realizable by self-triage (34%) revealed a $121M opportunity

The measured re-direction performance of the national application of self-triage reveals that of patients with an incorrect booking intent (73%), 2/3 engage with booking the calculated option 37% of the time and 1/3 engage with booking the calculated option 27% of the time. Using these metrics, the total proportion of patients with inaccurate care seeking intent that may be deflected via self-triage was estimated as (0.67 * 0.37) + (0.33 * 0.27) = 34%. This means that for the two health systems, the realizable value of using digital self-triage to qualify appointment booking intents is estimated to be $203,872,288 (+/- $173,269,807)×0.34=$69,316,577.90 (+/- $8,911,734.4), which corresponds to approximately a 1.29% (+/- 1.09%) net revenue increase across the two systems (**Table 4**).

Discussion

Many health systems spend tens to hundreds of millions of dollars to enable online scheduling for their patient populations.[32] This study is the first to quantify the size of inaccurate scheduling across two US health systems spanning numerous geographic regions. We report that 27% of all in-person appointments across a retrospective year indicated no "need" for an in-person visit as indicated by a lack of E&M codes for physical exams or diagnostic tests. If all 27% of those visits were re-directed to virtual care and replaced with the average RVU generating visit, the

systems would gain 5.33% more gross revenue. One limitation of this estimation is that it uses a simple average to calculate potential replacement revenue opportunity. A more sophisticated statistical model may be able to better simulate the opportunity. The simulated financial opportunity is a focus merely for (a) its ease in quantification and (b) its appeal to health system executives as a potential impetus for progress. The ultimate value to patients is in the broader implications of 27% greater access to in-person care and the ensuing benefit to patient outcomes of almost a third of patients receiving more appropriate care, which is more difficult to quantify and simulate.

To study the proportion of the 27% that may be realized we studied digital patient care seeking and booking behavior. Users of the USA's most prevalently adopted self-triage system[27] were randomly asked "what care [they] were thinking of seeking" prior to viewing the results of the self-triage. The vast majority of users had a clear intent (~92%) with only 8% indicating they were "unsure". Despite the fact that >90% of digital care seekers on health system websites have a clear intent, when comparing those intents with what would be clinically ideal for the patients (according to the self-triage) almost ¾ of those intents were inaccurate / inappropriate.

This suggests that people seeking care on health system websites may know what they want but that most often the intended level of care is incorrect. Of those with inaccurate intent 2/3 intended to seek a higher level of care than necessary and 1/3 intended to seek not enough care. Furthermore, care seekers with correct intent engaged almost 2x more often with the recommended care than care seekers with incorrect intent (54% vs. 27-37%). This suggests that validating a care seekers intent is about twice as likely to lead them to book the recommended care in contrast to re-directing it. This is the first reported study in the literature to examine prospective patient booking behaviors in response to intelligent recommendations provided to them on the websites of US health systems (i.e. large integrated delivery networks) at a national scale[33-37]. Thereby opening a field of inquiry into patient digital booking behavior.

Applying the rates of re-direction and engagement in this study revealed that of the 27% deflection opportunity, 34% might be realized if all bookings had been qualified through digital self-triage, amounting to a $69,316,577.90 (+/- $8,911,734.4) revenue gain (1.29% (+/- 1.09%)). Of course, a major limitation of this is that most patient bookings today across US health systems occur via call / access centers and not digital channels (e.g. website, patient portal).[38]

Considering that most patient bookings come in via call centers. Realizing the gains of better qualifying patient appointment bookings will require implementation of triage and routing intelligence across more than just digital channels of access. Inserting intelligent qualification into all channels of access will likely require significant resources. Framing the financial opportunity and case for doing so is likely to aid health system executives to advocate for it. With the growing provider shortage, unlocking hidden capacity by better matching patients to visits is a potentially valuable mechanism to consider. Especially to health systems operating on thin margins. For dozens of systems a 1-5% increase in margin could have existential implications to the system and to the availability of care to more individuals.[9,39,40]

And while call centers are staffed with agents that are trained in clinical triage, they are also replete with problems related to standardization of routing and with human error. Moreover, one

health system, staffing 2000 call center agents, may be paying upwards of $100 million a year on staffing costs.[41] We hypothesize that automated, digital, self-triage that can also be transformed into a voice automated agent with advances in generative and conversational artificial intelligence (e.g. large language models) serves as a first step to simultaneously saving tens to hundreds of millions in call center automation and also gaining in tens to hundreds of millions in optimizing provider capacity. A future prospective, randomized controlled trial employing self-triage for the purposes of capacity optimization and measuring its corresponding financial impact can further explore this hypothesis.

Conclusion

This study is the first to quantify unnecessary visits in the US ambulatory healthcare system, highlighting that approximately 27% of in-person outpatient visits of two health systems may be unnecessary based on the absence of physical exams and diagnostics. It is the first to simulate the value of self-triage systems to address this issue revealing their potential to accurately redirect approximately 73% of patients towards more appropriate care, with two-thirds requiring less acute care and one-third requiring escalation. Our analysis suggests that fully leveraging digital self-triage could realize up to 34% of the identified unnecessary visits, translating into a meaningful improvement in healthcare capacity, access, and financial outcomes. Furthermore, validating rather than redirecting patient intent nearly doubles patient engagement with recommended care, underscoring the importance of aligning patient expectations with clinical necessity. Given ongoing physician shortages and financial pressures on US health systems, implementing intelligent triage across multiple patient-access channels—including digital and call center environments—could yield substantial operational and financial benefits. Future research should focus on randomized controlled trials evaluating comprehensive triage implementations to further validate these findings and quantify associated improvements in patient outcomes, system efficiency, and economic performance.

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Author Contributions

- **BAN:** Conceptualization, data curation, formal analysis, investigation, methodology, securing funds, project administration, validation, writing – original draft; writing – review & editing.
- **AM:** Conceptualization, data curation, formal analysis, investigation, methodology, securing funds, project administration.
- **QMS:** Conceptualization, formal analysis, investigation, methodology.
- **YL:** Conceptualization, investigation, methodology, project administration, supervision, validation, participated in research design. writing – original draft; writing – review & editing.

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References

1. Zhang X, Lin D, Pforsich H, Lin VW. Physician workforce in the United States of America: forecasting nationwide shortages. *Hum Resour Health* 2020; **18**(1): 8.
2. Walensky RP, McCann NC. Challenges to the Future of a Robust Physician Workforce in the United States. *N Engl J Med* 2025; **392**(3): 286-95.
3. McClellan CB. Health care Utilization and Expenditures in Health Professional Shortage Areas. *Med Care Res Rev* 2024; **81**(4): 335-45.
4. Washington State Hospital A. MHA 2022 Wait Times Survey Final. 2022.
5. Bleustein C, Rothschild DB, Valen A, Valatis E, Schweitzer L, Jones R. Wait times, patient satisfaction scores, and the perception of care. *Am J Manag Care* 2014; **20**(5): 393-400.
6. Spencer S, Stephens K, Swanson-Biearman B, Whiteman K. Health Care Provider in Triage to Improve Outcomes. *J Emerg Nurs* 2019; **45**(5): 561-6.
7. Ratings PG. U.S. not-for-profit health care system median financial ratios: 2022. 2023.
8. Marrotte A, Calvo RY, Capacio B, et al. Financial vulnerability of trauma centers: A national analysis. *J Trauma Acute Care Surg* 2023; **94**(5): 637-42.
9. Hayford T, Nelson L, Diorio A. Projecting hospitals\'92 profit margins under several illustrative scenarios. 2016.
10. Fuller T, Newberry Z, Nasir M, Tondt J. Obesity. *Prim Care* 2024; **51**(3): 511-22.
11. Schiavoni KH, Lehmann LS, Guan W, Rosenthal M, Sequist TD, Chien AT. How Primary Care Physicians Integrate Price Information into Clinical Decision-Making. *J Gen Intern Med* 2017; **32**(1): 81-7.
12. Shively NR, Buehrle DJ, Clancy CJ, Decker BK. Prevalence of Inappropriate Antibiotic Prescribing in Primary Care Clinics within a Veterans Affairs Health Care System. *Antimicrob Agents Chemother* 2018; **62**(8).
13. Roblin DW, Liu H, Cromwell LF, et al. Provider type and management of common visits in primary care. *Am J Manag Care* 2017; **23**(4): 225-31.
14. Vimalananda VG, Meterko M, Waring ME, et al. Tools to improve referrals from primary care to specialty care. *Am J Manag Care* 2019; **25**(8): e237-e42.
15. Akbari A, Mayhew A, Al-Alawi MA, et al. Interventions to improve outpatient referrals from primary care to secondary care. *Cochrane Database Syst Rev* 2008; **2008**(4): CD005471.
16. Grimshaw JM, Winkens RA, Shirran L, et al. Interventions to improve outpatient referrals from primary care to secondary care. *Cochrane Database Syst Rev* 2005; (3): CD005471.
17. Blank L, Baxter S, Woods HB, et al. Referral interventions from primary to specialist care: a systematic review of international evidence. *Br J Gen Pract* 2014; **64**(629): e765-74.

18. Patel MP, Schettini P, O'Leary CP, Bosworth HB, Anderson JB, Shah KP. Closing the Referral Loop: an Analysis of Primary Care Referrals to Specialists in a Large Health System. *J Gen Intern Med* 2018; **33**(5): 715-21.
19. Dash D, Moser A, Feldman S, et al. Focusing on Provider Quality Measurement: Continued Consensus and Feasibility Testing of Practice-Based Quality Measures for Primary Care Providers in Long-Term Care. *J Am Med Dir Assoc* 2024; **25**(2): 189-94.
20. Mencke NM, Alley LG, Etchason J. Application of HEDIS measures within a Veterans Affairs medical center. *Am J Manag Care* 2000; **6**(6): 661-8.
21. Ryan GW, Goulding M, Beeler AL, et al. Trends in COVID-19 vaccine administration across visit types in a safety net pediatric practice during the first year of authorization. *Front Pediatr* 2023; **11**: 1227115.
22. Li RC, Wang JK, Sharp C, Chen JH. When order sets do not align with clinician workflow: assessing practice patterns in the electronic health record. *BMJ Qual Saf* 2019; **28**(12): 987-96.
23. McGreevey JD, 3rd. Order sets in electronic health records: principles of good practice. *Chest* 2013; **143**(1): 228-35.
24. Hulse NC, Lee J, Benuzillo J. Exploring Different Approaches in Measuring EHR-based Adherence to Best Practice - A Case Study with Order Sets and Associated Outcomes. *AMIA Annu Symp Proc* 2019; **2019**: 477-86.
25. Zhang Y, Trepp R, Wang W, Luna J, Vawdrey DK, Tiase V. Developing and maintaining clinical decision support using clinical knowledge and machine learning: the case of order sets. *J Am Med Inform Assoc* 2018; **25**(11): 1547-51.
26. van den Broek-Altenburg E, Atherly A, Cheney N, Fama T. Understanding the factors that affect the appropriateness of rheumatology referrals. *BMC Health Serv Res* 2021; **21**(1): 1124.
27. Naved BA, Luo Y. Contrasting rule and machine learning based digital self triage systems in the USA. *NPJ Digit Med* 2024; **7**(1): 381.
28. Naved BA, Ravishankar S, Colbert GE, Johnston A, Slott QM, Luo Y. LLM enabled classification of patient self-reported symptoms and needs in health systems across the USA. *NPJ Digit Med* 2025; **8**(1): 390.
29. Semigran HL, Linder JA, Gidengil C, Mehrotra A. Evaluation of symptom checkers for self diagnosis and triage: audit study. *BMJ* 2015; **351**: h3480.
30. Bajowala SS, Milosch J, Bansal C. Telemedicine pays: billing and coding update. *Current Allergy and Asthma Reports* 2020; **20**(10): 60.
31. RelyMd. Using a telemedicine platform for revenue generation.
32. Becker\'92s Hospital R. 10 most expensive Epic EHRs of \'9224.
33. Cotte F, Mueller T, Gilbert S, et al. Safety of Triage Self-assessment Using a Symptom Assessment App for Walk-in Patients in the Emergency Care Setting: Observational Prospective Cross-sectional Study. *JMIR Mhealth Uhealth* 2022; **10**(3): e32340.
34. Gellert GA, Kuszczynski K, Gellert GL, Kabat-Karabon A, Nowicka A, Price T. AI-Based Virtual Triage and Telemedical Health Care for Ukrainian War Refugees and Displaced Persons. *JAMA Netw Open* 2025; **8**(5): e258839.
35. Morse KE, Ostberg NP, Jones VG, Chan AS. Use Characteristics and Triage Acuity of a Digital Symptom Checker in a Large Integrated Health System: Population-Based Descriptive Study. *J Med Internet Res* 2020; **22**(11): e20549.

36. Gellert GA, Paula Galvão, Sandra Maria Gomes, Diogo Almeida Carvalho, Tim Price, Aleksandra Kabat-Karabon, Gabriel L. Gellert, and Piotr M. Orzechowski. Impact of integrated virtual and live nurse triage on patient care seeking and health care delivery effectiveness and efficiency. *Telemedicine Reports* 2024; **5**(1): 330-8.
37. Miller S, Gilbert S, Virani V, Wicks P. Patients' Utilization and Perception of an Artificial Intelligence-Based Symptom Assessment and Advice Technology in a British Primary Care Waiting Room: Exploratory Pilot Study. *JMIR Hum Factors* 2020; **7**(3): e19713.
38. Rohleder T, Bailey B, Crum B, et al. Improving a patient appointment call center at Mayo Clinic. *International Journal of Health Care Quality Assurance* 2013; **26**(8): 714-28.
39. Becker\'92s Hospital R. From -10.2% to 21.3%: 41 health systems ranked by operating margins.
40. Fierce H. Approximately half of US hospitals end 2022 with a negative operating margin.
41. Glassdoor. Call center representative salaries.

Tables

Number of visits analyzed	2,789,780
Number of patients represented by analyzed visits	685,982
# of Providers	1,880
Visits without any physical exam or diagnostic E&M codes	746,129

Table 1. Measuring the proportion of visits that didn't "need" in-person care

User selected Pre-Intent	# of Users Selected	% of Users Selected
Unsure where to get care	387	8.1%
Self-care	849	17.7%
Urgent Care	866	18.1%
PCP	739	15.4%
Retail Clinic	693	14.5%
Specialist	481	10.0%
ED	547	11.4%
Telemedicine	220	4.6%
Labor and Delivery	0	0.0%
Dentist	0	0.0%
911	7	0.1%
Total	4,789	100.0%

Table 2. Measuring the distribution of digital care-seeking pre-intents in a national population of self-triage users on health system websites.

Final revenue opportunity	
Total available visit capacity	746,129
Average RVUs generated by "necessary" in-person visits	9.8 (+/- 0.46)
Average weighted reimbursement rate across payers	$39.60 (+/- $17.50)
Net new "replacement" revenue	$289,557,742 +/- $133,967,462
Cost of shifting visits to virtual	-$85,685,454.40 +/- $39,302,345.1
Gross revenue from better capacity management	**$203,872,288 (+/- $173,269,807)**

Table 3. Simulating the revenue opportunity of replacing all "unnecessary" in-person, outpatient visits with "necessary" ones.

Simulating the impact of self-triage on the total revenue opportunity	
Total available visit capacity	746,129
% of inappropriately booked visits that should've been escalated	33%
% of inappropriately booked visits that should've been de-escalated	67%
% of attempted escalations that patients engage with	27%
% of attempted de-escalations that patients engage with	37%
Overall attempted re-directions likely to be engaged with	34%
Total re-directions via digital self-triage	251,445
Value of filling all available visit capacity with the average RVU generating visit	$289,557,742 +/- $133,967,462
Simulated value of re-directions if all bookings were qualified via digital self-triage	**$69,316,577.90 (+/- $8,911,734.4)**

Table 4. Simulating the proportion of total revenue replacement opportunity realizable by self-triage.

Figures

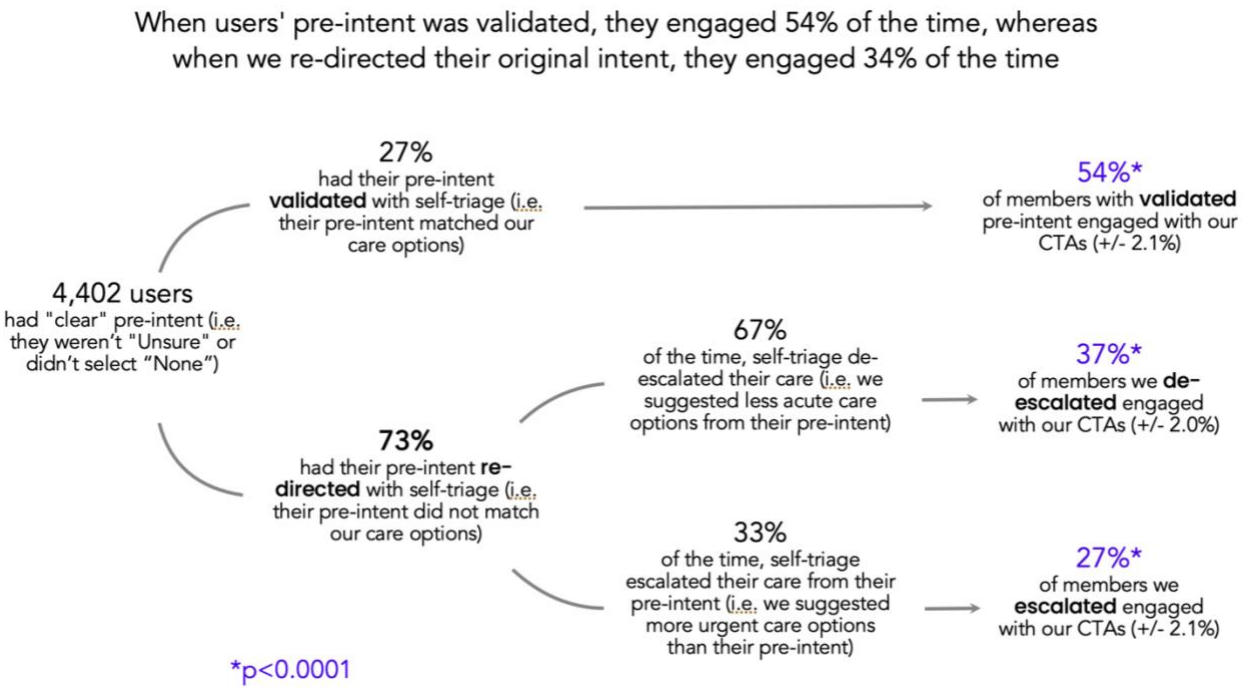

Figure 1. Accuracy of digital care-seeking intents from a population of national self-triage users alongside their engagement with CTAs. CTA engagement varied depending on whether users were validated or re-directed. Re-directed care seekers were either de-escalated or escalated.