ORIGINAL ARTICLE

Impact of virtual triage and care referral on patient care seeking intent and clinical acuity alignment in an Australian health plan: A cross-sectional study

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ABSTRACT

Objective: Evaluate if artificial intelligence (AI)-based virtual triage and care referral (VTCR) improved care acuity alignment and has the potential to reduce unwarranted, avoidable care costs when integrated into the patient engagement capabilities of an Australian private health insurance company.
Methods: A cross-sectional study compared patient pre- and post-VTCR care intent across 4,471 encounters to evaluate the degree of clinical care acuity re-alignment (or divergence) which occurred and potential associated cost savings.
Results: Overall compliance or alignment with triage recommendations was high (74.0%), and VTCR was effective in educating patients about the most appropriate care to meet their actual clinical needs. One-half of patients (50.5%) changed their care intent. Following VTCR there was a 91.3% reduction of patients with uncertain care intent (39.8 percentage points [PP]); a 56.5% (6.2 PP) increase in intent to engage self-care, and a 35.7% (0.5 PP) decrease in emergency care intent (all $p < .05$). This yielded a potential $4.27 (8.6%) overall net savings per completed VTCR encounter, with potential savings of $284.55 (72.2%) per completed encounter among patients initially intending to seek emergency care, and 35 unnecessary outpatient visits potentially avoided per 1,000 encounters producing potential savings of $3.39 (6.5%) per completed encounter among patients initially intending to seek outpatient care. Almost 10% of patients intended to book a clinically appropriate telemedicine consultation following VTCR.
Conclusions: VTCR was found to be potentially clinically and cost-effective in re-directing patients who had an initial care intent not supported by their actual clinical acuity, reducing patient care uncertainty and potentially avoidable care utilization. Future research should include clinical validation of patient diagnosis and care services delivered as a primary outcome in order to confirm the potential savings identified in this study.

Key Words: Virtual triage and care referral, Symptom checker, Artificial intelligence, Care acuity alignment, Telemedicine

1. INTRODUCTION

Virtual triage and care referral (VTCR), or artificial intelligence-based symptom checkers, are a relatively new form of online healthcare technology aimed at offering around the clock and accessible health advice to patient users via the internet. The COVID-19 pandemic saw a large surge in the usage and implementation of virtual and remote healthcare services, such as VTCR, in light of infectious

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risk, government lockdowns, overcrowded hospitals and clinics, and reduced general healthcare accessibility across the globe).[1] Australia was particularly successful in controlling the COVID-19 pandemic, in large part due to the extensive adoption of telehealth and remote healthcare services for the management of patients outside hospital settings.[2] Australia has continued to rapidly adopt and deploy digital healthcare technologies and services post COVID-19, with goals of improving healthcare equity and accessibility to supplement in-person care facilities.[3,4]

While online symptom checkers have been shown to improve communication between patient users and clinicians, as well as producing high patient satisfaction rates, organizational challenges in adopting and integrating VTCR within healthcare systems remain.[3,5] The addition of artificial intelligence (AI) to these technologies introduces new opportunities and challenges.[6,7] Multiple reports in the literature convey the impact of self-triage using automated AI-based and other virtual triage platforms (so-called "symptom checkers"). These studies were published on data extracted from virtual triage and care referral engines available to the general public or patients within a particular health plan or healthcare delivery system.[8–13] AI-based VTCR has demonstrated an ability to improve the clinical appropriateness of acuity-level care intent after patients were triaged, with 35% of patients altering their care plans to match the VTCR care recommendation.[8] VTCR has also demonstrated effectiveness in the early detection of common life-threatening conditions, suggesting a potential to decrease diagnostic and treatment delays which often impact clinical outcomes negatively.[10]

We evaluated if AI-based VTCR can improve care acuity alignment, patient experience, and improve plan financial performance by reducing unwarranted and avoidable clinical care and costs.

2. METHODS

2.1 Study objectives

To evaluate if AI-based VTCR can improve care acuity alignment and patient experience while potentially reducing unwarranted clinical care services and avoidable care costs when implemented by a large Australian private health insurance company, Newcastle Industrial Benefits (NIB).

2.2 Study design and setting

A cross-sectional study compared patient care intent before and following VTCR. NIB is a leading Australian private health insurance company insurance plans for Australian residents and international students and workers. An estimated 55% of Australian residents are covered by private health insurance plans, due to taxation benefits, reduced wait times for treatment, and access to ancillary healthcare services. As of 2024, NIB held an 9.8% share of the Australian private health insurance market.[14]

2.3 Description of virtual triage and care referral engine

The Infermedica VTCR engine conducts evidence-driven analyses spanning 800 illnesses, 1,500 symptoms, and 300 risk factors. VTCR can be accessed 24/7/365 in 24 different languages from any internet connected device. Using AI, machine learning, and natural language processing, the virtual triage engine assesses patient-users' reported symptoms and medical history, and then identifies the most likely ailment and recommends the most suitable care setting based on clinical acuity or urgency. No predetermined protocols or decision trees are employed. With new information, the VTCR engine iteratively evaluates varied clinical hypotheses, just as a live clinician does. The data used in this analysis was extracted from VTCR encounters with patients using the Infermedica VTCR engine.

2.4 VTCR engine clinical validity

To ensure patient safety and minimize potential mistriage, AI-based VTCR engines require validation. The Infermedica VTCR engine will, by design, err on the side of over-triage to higher acuity care, rather than possibly mis-triage or under-triage a patient whose clinical presentation warrants higher acuity care. Across clinical specialties VTCR accuracy varies as a result of the differing depth and breadth of disease-specific data used to train the engine's AI. Thus far, no instances of patient harm occurring as a result of virtual triage and care referral to an inappropriate level of care acuity have been documented. Clinical vignettes prepared by physicians in various clinical settings have evaluated the clinical validity and accuracy of VTCR.[15–17] Prior research demonstrated that the Infermedica VTCR engine provides safe recommendations in 97.8% of cases and is equal to or superior in accuracy to rules-based triage protocols.[15,17]

2.5 Respondent selection and data captured

Analyses focused on international plan members (students and workers) resident in Australia, with data collected from March 1st to October 31st, 2024. During this period, 8,195 encounters were completed, of which care seeking intent was determined for 4,471 encounters. Post-VTCR intent was inferred from a combination of intent survey patient response and patients engaging the call-to-action to book an appointment within the application. Patients also reported on the quality of their VTCR user experience. Patients provided explicit consent prior to the virtual triage encounter for their data to be analyzed in a fully de-identified manner and presented in the aggregate.

2.6 Measures used and analyses completed

Patient-user data was examined to determine the level of clinical care acuity alignment or divergence between patient post-triage care intent and that recommended by VTCR. The care intent survey provided the following care options: (1) self-care for symptoms not requiring professional medical care, managed by patients at home; (2) outpatient medical consultation, where symptoms warranted medical evaluation by scheduling a routine in-person visit with a healthcare provider; (3) outpatient consultation within 24 hours, where symptoms indicated a more urgent need for consultation with a healthcare professional; (4) emergency department (ED) care, where symptoms were sufficiently serious that patients were recommended to proceed immediately to the nearest ED or to call an ambulance; and (5) patient did not know or were uncertain about what level of care to seek. Patient care intentions before and after virtual triage were analyzed and differences were tested for statistical significance.

The findings are presented by identifying the volume of patients per 1,000 completed encounters at each of the five levels of clinical acuity. Potential financial return on investment (ROI) was estimated per completed interview, based on the following mean claims costs per visit: ED visit cost of $394; outpatient primary care general practitioner visit cost of $52; and $49 for a telemedicine consultation. Estimated potential savings are presented using three measures: (1) potential net cost savings per VTCR encounter across all levels of care acuity post-triage; (2) potential net cost savings per encounter involving a de-escalation of care acuity from pre-triage emergency care intent to a lower acuity level; and (3) potential net savings per interview based on de-escalation from pre-triage outpatient care intent to self-care.

Patient self-reported disease risk factors, relevant for engagement of health promotion and risk reduction programs offered by the health insurer, were collected during VTCR encounters and reported.

2.7 Ethics statement

As all information collected for these analyses was de-identified and anonymized, and all patient information is reported only in the aggregate, there is no requirement in Australia for consent as there is no personal information involved or risk of patient informational harm. Based on this, NIB was comfortable with the use of the de-identified data for research purposes as low risk and ethics review board approval was not sought.

3. Results

3.1 Patient profile and satisfaction with VTCR

There were 8,195 completed VTCR encounters between March 1 and December 31, 2024, and in 4,471 of encounters the pre- and post-triage intent surveys or call-to-action were completed by patients. Regarding cohort demographics, 64.5% of patients were female and 97.2% were aged 18-44; 65.8% were 18-29 years old and 31.4% were 30-44 years old. Almost all patients chose to complete the VTCR encounter in English.

There were 353 actionable risk factors reported per 1,000 encounters, including individuals with obesity/overweight status, diagnosed hypertension and hypercholesterolemia, and/or who used tobacco products, highlighting the opportunity to recruit patients for health promotion and disease risk reduction programs through VTCR.

Patients reported high satisfaction with the VTCR experience, conveying a mean rating score of 4.2 on a 5-point scale, with 39.8% evidencing uncertainty in healthcare seeking which decreased following use of VTCR.

3.2 Impact of VTCR on initial patient care intent

As seen in Table 1, the overall level of compliance or alignment with triage recommendations, as indicated by reported care intent, was high (74.0%), demonstrating that VTCR was effective in educating patients about the most clinically appropriate care to meet their needs. One-half of members (50.5%) changed their reported care seeking intent as a result of the triage recommendation. Among those who changed care seeking intent, 7.3% (or 3.7% of all members) de-escalated their intent to lower acuity care, compared with 11.6% (or 5.8% of all members) who escalated their intent to higher acuity care.

As can be seen in Table 2, following the VTCR encounter, there was a 91.3% decrease in patients with uncertain care seeking intent, a reduction of 39.8 percentage points (PP) from an absolute value of 43.6% of patients pre-triage to 3.8% of patients post-triage. There was a 56.5% (6.2 PP) increase intent to engage self-care following VTCR, benefiting the patient, health system and health insurer alike by reducing unnecessary and avoidable care visits. A 35.7% (0.5 PP) decrease in emergency care occurred following virtual triage, from 1.3% to 0.8% of patients. All of these post-VTCR changes in patient care intent were statistically significant ($p < .05$), and can achieve potential reductions in avoidable care and associated costs across the patient population.

Table 1. Impact of virtual triage care recommendation on patient care seeking intent

Alignment of Patient Care Intent and VTCR Recommendation	Impact of VTCR Recommendation on Patient Care Intent (%)	Change in Patient Care Intent (%)
Patient changed pre-triage care intent from as a result of triage recommendation	2,257 (50.5%)	–
Patient intent changed to engage lower acuity care as a result of triage recommendation (de-escalated acuity)	–	166 (7.3% of those who changed care intent and 3.7% of all patients)
Patient intent changed to engage higher acuity care as a result triage recommendation (escalated acuity)	–	261 (11.6% of those who changed care intent and 5.8% of all patients)
Patient intent changed from uncertainty to a specified acuity level from triage (reducing uncertainty)	–	1,830 (81.1% of those who changed care intent and 40.9% of all patients)
Patient pre-triage intent and triage recommendation were aligned/identical	1,053 (23.5%)	–
Patient did not change care intent as a result of triage recommendation when not aligned	1,161 (26.0%)	–
Total	4,471 (100%)	2,257 (50.5%)

Table 2. Impact of virtual triage and care referral on initial patient care intent

	Pre-VTCR[1] Patient Care Intent (%)	Post-VTCR Patient Care Intent (%)	Absolute (Relative) Magnitude of Change in Care Intent	Statistical Significance
Self-care	485 (10.8%)	759 (17.0%)	+ 56.5% (+ 6.2 PP[2])	$p < .05$
Outpatient care	1,805 (40.4%)	3,469 (77.6%)	+ 92.2% (+ 37.2 PP)	$p < .05$
Outpatient care < 24 h	177 (4.0%)	37 (0.8%)	- 79.1% (- 3.2 PP)	$p < .05$
Emergency care	56 (1.3%)	36 (0.8%)	- 35.7% (- 0.5 PP)	$p < .05$
Unsure of care need	1,948 (43.6%)	170 (3.8%)	- 91.3% (-39.8 PP)	$p < .05$
Total	4,471 (100.0%)	4,471 (100.0%)	-	-

Note. [1]VTCR: Virtual triage and care referral; [2]PP: percentage points

Table 3. Estimated potential financial value of overall patient care intent changes following virtual triage and care referral

Estimated Potential Financial Value							
Pre-Virtual Triage				Post-Virtual Triage			
Care Intent	Per 1,000 Encounters	Cost per Outcome	Total Cost	Care Intent	Per 1,000 Encounters	Cost per Outcome	Total Cost
Self-care	108	$0	$0	Self-care	170	$0	$0
Outpatient care	404	$52	$21,008	Outpatient care	776	$52	$40,352
Outpatient care < 24 h	40	$52	$2,080	Outpatient care < 24 h	8	$52	$416
Emergency care	13	$394	$5,122	Emergency care	8	$394	$3,152
		Total cost	$28,210			Total cost	$43,920
		Cost per encounter	$49.93			Cost per encounter	$45.65
						Potential net saving per encounter	$4.27 (8.6%)

Note. Data are based on all VTCR encounters with known pre-triage care seeking intent, with $N = 4,471$.

3.3 Estimated value of patient care intent changes following VTCR

As shown in Table 3, the volume of patients selecting routine outpatient care increased substantially following virtual triage and automated care referral. Based on the change in patient pre- and post-virtual triage care intent, there was a potential $4.27 (8.6%) total net saving per completed VTCR encounter.

3.4 Estimated savings from emergency care de-escalation following VTCR

Table 4 shows that nine unnecessary ED visits were avoided per 1,000 VTCR encounters, yielding estimated potential net savings of $284.55 (72.2%) per completed encounter among patients with an initial intent to seek emergency care.

Table 4. Estimated potential savings from emergency care de-escalation following virtual triage and care referral

Pre-Virtual Triage				Post-Virtual Triage			
Intent	**Per 1,000 Encounters**	**Cost per Outcome**	**Total Cost**	**Intent**	**Per 1,000 Encounters**	**Cost per Outcome**	**Total Cost**
Emergency care	13	$394	$5,122	Self-care	1	$0	$0
				Outpatient care	8	$52	$416
				Outpatient care < 24 h	0	$52	$0
				Emergency care	2	$394	$788
		Total cost	$5,122			Total cost	$1,204
		Cost per encounter	$394			Cost per encounter	$109.45
						Potential net saving per encounter	$284.55

Note. Data derived from the cohort of patients whose pre-virtual triage intent was to pursue emergency care.

Table 5. Estimated potential savings from outpatient care de-escalation following virtual trial and care referral

Pre-Virtual Triage				Post-Virtual Triage			
Intent	**Per 1,000 Encounters**	**Cost per Outcome**	**Total Cost**	**Intent**	**Per 1,000 Encounters**	**Cost per Outcome**	**Total Cost**
Outpatient care	404	$52	$21,008	Self-care	1	$0	$0
				Outpatient care	395	$52	$20,540
Outpatient care < 24 h	40	$52	$2,080	Outpatient care < 24 h	5	$52	$260
				Emergency care	1	$394	$394
		Total cost	$23,088			Total cost	$21,194
		Cost per encounter	$52			Cost per encounter	$48.61
						Potential saving per encounter	$3.39 (6.5%)

Note. Table data demonstrates changes for the cohort of patients post-virtual triage recommendation for outpatient care. Data derived from the cohort of pre-triage outpatient care and outpatient care within 24 hours intent.

3.5 Estimated outpatient care de-escalation savings following VTCR

Table 5 shows that 35 unnecessary outpatient visits were avoided per 1,000 encounters, yielding a potential estimated savings of $3.39 (6.5%) per completed encounter among patients who had an initial intent to seek outpatient care.

4. DISCUSSION

4.1 Implications of key findings

Virtual triage and care referral improved acuity alignment between patient pre-triage care intent and actual clinical need, with a 91.3% reduction of patients with indecision or uncertainty about what care to seek. This may yield a net reduction in avoidable medical costs across a health plan member population by engaging patient care earlier in the course of disease, when therapeutic interventions are often less complex and costly. Improved care acuity alignment can reduce care delays, which often result in greater hospital length of stay and potentially avoidable ICU admissions.[8, 19–22] De-escalation of care acuity was particularly notable in a large increase in intent to engage self-care following VTCR (56.5%, 6.2 PP), which can potentially reduce avoidable or unnecessary care

service delivery.

The greatest post-VTCR escalation in care acuity occurred in routine outpatient care, which almost doubled in absolute magnitude (and 37.2 PP). This indicates an ability of VTCR to expedite needed care while patient acuity is still low, when care effectiveness is high and costs and patient dislocation are low relative to urgent outpatient (within 24 h) or ED care. While most patients with symptoms acute enough to warrant consideration of an ED visit will not consult with VTCR, there was nonetheless a concomitant decrease in ED care intent by 35.7% (0.5 PP). These changes in care recommendation were regarded by patients positively, as indicated by an 84% VTCR satisfaction rate. These findings are similar to those reported in other analyses.[10, 12] Also notable in the overall use pattern of VTCR was the technology's ability to encourage candid patient reporting of disease risk factors, with 35.3% of encounters where such data was reported.

These findings parallel other studies which evidence that VTCR, through its ability to appropriately realign patient care intent with the level of care acuity actually needed, can deliver meaningful clinical and operational value by reducing avoidable, clinically unwarranted higher acuity ED and urgent outpatient care utilization.[10, 12] We estimated the potential net cost savings per encounter in this cohort of patients was $4.27 or 8.6% across all levels of care acuity, and $288.55 potential net savings (72.2%) for de-escalation of care from unneeded ED visits to routine, non-urgent outpatient care. Further, 35 unnecessary outpatient visits were avoided per 1,000 encounters, conveying estimated potential plan savings of $3.39 or 6.5% per completed encounter among patients who intended to seek outpatient care prior to VTCR. In addition, almost 40% or 399 patients per 1,000 encounters intended to book a telemedicine visit as recommended after virtual triage. These estimates do not consider the patient and clinician satisfaction resulting from expedited respective care flows and lower wait times for patients to receive care, qualitative outcomes that should also be the focus of further research. We are also unable from the data to estimate the value of clinical care capacity created within care delivery workflows by relieving clinicians from delivery of care to patients whose clinical acuity does not warrant an in-person consultation.

4.2 Limitations of current study

In interpreting these findings, it is important to bear in mind that the final care acuity decision of patients may often be influenced or limited by their current health plan coverage, access to resources for self-care, and the availability of and ability to access non-urgent outpatient care services. Patient sampling may also introduce potential selection bias, as patients engaging with digital health tools may be systematically different in key characteristics from the general population in terms of internet access and literacy, health literacy, or care engagement and seeking behavior. VTCR users in this cohort of patients were disproportionately younger and female, which limits the generalizability of these findings. For example, elderly patients may experience anxiety or have fears about using technology, and may be less candid in disclosing key health or symptom information during the VTCR encounter.

This study design did not allow for the collection of data regarding possible health disparities based on patient income, race, or those with literacy challenges, or who may have marginal access to technology. Future research should endeavor to capture pertinent data on these important variables that impact healthcare intent, care seeking behavior, ability to secure care, and patient outcomes.

The current study design also relied on self-reported healthcare intent, which may not fully translate into actual care seeking behavior or care services delivered. Reliance on patient self-reporting of care intent prior to and following VTCR as a means to assess the impact of the technology on patient healthcare choices and care seeking behavior is a limitation of the present study. Patients may not always be truthful in reporting their care intentions during VTCR encounters, and actual patient care seeking behavior following VTCR might not align with the intent reported during the triage encounter. Post-VTCR validation of actual care sought in future research can evaluate whether or not reported patient intent translated into real world care behavior, reducing the potential issues around the internal validity and generalizability of the findings reported in the present study.

4.3 Future research directions

It is of course impossible to precisely quantify the financial value of specific changes in care acuity realignment without data conveying actual patient care flow and utilization, site of intake, services rendered and clinical outcomes - all beyond the scope of this study. Future research should include clinical validation of patient diagnosis and care services delivered as a primary outcome in order to confirm the potential savings identified in this study. Nonetheless, the combined impact of all changes observed in care seeking intent was a substantial overall potential reduction of inappropriate care utilization and associated care and administrative costs, as well as potential recovery of clinical care capacity to accelerate appropriate treatment of higher acuity patients with more urgent care needs. This likely improves clinical outcomes and financial performance, although further research is needed to validate the full impact of improving care acuity

alignment through VTCR.

Systematically and prospectively evaluating how changes in care intent impact care utilization and health outcomes should constitute the next phase of research on the integration of VT into existing triage and care referral workflows. Given advances in generative and conversational AI, most recently the advent of large language models, VTCR may evolve to offer a voice automated capability. Voice automation in VTCR may convey further reductions in the costs of live and automated call centers, and can divert routine cases from busy clinicians so they have more resources to focus on higher acuity, more urgent patient presentations. VTCR impact on the clinical and financial performance of health plans and healthcare delivery organizations should also be an ongoing and expanded focus of future research.

5. Conclusions

VTCR was found to be clinically effective and potentially cost-effective in re-directing patients who had an initial care intent not supported by their actual clinical acuity, and in potentially reducing avoidable care utilization. Care acuity intent was both appropriately escalated and de-escalated following VTCR encounters. In particular, VTCR greatly reduced patient uncertainty about what acuity level or kind of care to engage, and patient satisfaction with VTCR was high. Future research should include a randomized clinical trial that follows patient and clinician workflows to validate and expand on these findings with respect to actual care resources utilized, patient outcomes and plan financial performance.

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Authors contributions

GAG, TP, and AKK designed the study methodology and interpreted the data; GAG wrote the first draft of the manuscript; GAG, TP, AKK and GLG edited all subsequent drafts of the manuscript; TP, AKK and GAG reviewed and organized the data, validated the data analyses, and co-authored the results interpretation and the discussion sections; GLG assisted with project management, literature search, reference integration, and completing journal submission.

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Conflicts of Interest Disclosure

All authors are either advisors to or employees of Infermedica.

Informed consent

Patient-users provided their consent during the virtual triage encounter for their data to be used in a fully de-identified manner within aggregate analyses.

Ethics approval

The Publication Ethics Committee of the Association for Health Sciences and Education. The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

Study data may be made available upon reasonable request.

Data sharing statement

No additional data are available.

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