Rapid influenza diagnostic test at triage can decrease emergency department length of stay

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Abstract
Objective: Even if performing rapid influenza diagnostic test will not change clinical decision making, we sometimes perform at triage to reduce length of stay in Japan. Whether performing rapid influenza diagnostic tests at triage may shorten emergency department (ED) length of stay (LOS) is remains unclear. We aimed to determine the utility of rapid influenza diagnostic tests at triage in shortening ED length of stay LOS.

Methods: We retrospectively reviewed medical records of patients discharged from our ED after receiving results from rapid influenza diagnostic tests during the influenza season from December, 2013 to March, 2019. Eligibility criteria were a walk-in visit, age ≥15 years, triage performed, rapid influenza diagnostic test administered, and no admission. The triage group received rapid influenza diagnostic tests at triage. The after-examination group received their tests only after examination by a doctor. The primary outcome was ED LOS after propensity score matching to adjust for several covariates.

Results: Of 2,768 eligible patients, 2,554 patients were enrolled in the triage group (n = 363) or after examination group (n = 2,191). There were 329 matched pairs after propensity score matching. Median ED LOS was significantly shorter in the triage group than in the after-examination group after propensity score matching (81 min (interquartile range [IQR] 60 to 111) vs 106 min (IQR 80–142); median difference 24 min (95% confidence interval 17–30)).

Conclusions: Performing rapid influenza diagnostic tests at triage was associated with shorter ED LOS during the influenza season.

KEYWORDS
crowding, emergency department, influenza, length of stay, point-of-care testing, propensity score, triage

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INTRODUCTION

1.1 Background

Rapid influenza diagnostic tests are rarely necessary for seasonal influenza because diagnosis can usually be made based on symptoms. This test is not often used in the diagnostic process, except in limited situations for patients at high risk for influenza complication. However, patients in Japan may seek rapid influenza diagnostic tests at the request of schools or companies despite the lack of medical necessity. Furthermore, the rapid influenza diagnostic tests have a low sensitivity at illness onset, and physicians sometimes recommend a repeat rapid influenza diagnostic test the following day according to the wishes of patients who need a more reliable diagnosis of influenza, even in patients who are not high risk. It is estimated from government statistics that at least 10 million individuals seek medical treatment for influenza every year in Japan. Moreover, seasonal influenza appears to be 1 of the major causes of crowding in the emergency department.

To use medical resources properly, physicians should explain and make consensus with patients about why the test is not necessary for diagnosis of influenza. However, patients sometimes refuse this information and visit other clinics or hospitals because of the request of schools or companies, which is a lost opportunity to educate patients. These patients will continue to seek medical service unless someone corrects the misunderstanding. Thus, in our hospital, we explain that we can diagnose as influenza without doing a rapid influenza diagnostic test first. We perform the test only when patients ask for it, even if it will not change clinical decision making. After the result is available, we try to educate patients again at discharge.

The Infectious Diseases Society of America published guidelines in 2018 recommending that clinicians consider rapid influenza diagnostic tests to shorten the ED length of stay and avoid further testing or unnecessary antibiotics in patients without strong risk factors for influenza-related complications, who are likely to be discharged home.

1.2 Importance

Although some evidence suggests that performing rapid influenza diagnostic tests in the ED shortens length of stay, 1 report found that rapid influenza diagnostic tests did not significantly shorten ED length of stay. Furthermore, it has been reported that radiography, electrocardiography, and laboratory investigations performed at triage do shorten ED length of stay. To our knowledge, no reports have shown that performing rapid influenza diagnostic tests at triage shortens ED length of stay.

1.3 Goals of this investigation

We hypothesized that performing rapid influenza diagnostic tests at triage would be effective in shortening ED length of stay if performed during the ED stay and conducted this study to confirm this hypothesis.

METHODS

2.1 Study design and setting

We retrospectively reviewed the medical records of patients who presented to the ED at St. Luke’s International Hospital, Tokyo, Japan, during the influenza season between December 1, 2013 and March 31, 2019 and received a rapid influenza diagnostic test. The ED volume is ∼45,000 visits per year. The study protocol was approved by the local ethics committee of St. Luke’s International Hospital (approval number 19-R017). The need for informed consent was waived.

2.2 Selection of study participants

Patients were enrolled in the study if they met the following eligibility criteria: a walk-in visit, age 15 years or older, triage received, rapid influenza diagnostic test performed, and no admission. The exclusion criteria were: no record of arrival time, triage, no rapid influenza diagnostic test order or results, no discharge time, missing data for vital signs (temperature, pulse rate, and blood pressure), no information on the Japan Triage and Acuity Scale score (developed from the Canadian Triage and Acuity Scale with some modifications for the local context and widely used in Japan), and triage performed more than 1 hour after arrival, which showed errors in input of triage time. Patients who remained in the ED for more than 6 hours were also excluded. These extremely long ED length of stay times were mainly caused by early registration before arrival or an accounting delay. In such cases, the apparent ED length of stay was longer because we defined ED length of stay to include the interval between registration time and completion of payment.

2.3 Triage

We triaged patients only during busy periods; that is, 08:00–24:00 on weekends or holidays and 16:00–24:00 on weekdays. Patients were...
We used the following definitions: ED length of stay, interval between arrival time (time of registration on the ED index) and time of finishing payment at discharge (Figure 1); order time, time of rapid influenza diagnostic test order recorded on the patient's medical record; result time, time when the results of the rapid influenza diagnostic test were recorded on the patient’s medical record; and triage time, time recorded on the triage chart.

2.6 Measurements

For each patient, we recorded the following parameters: age and sex; whether the presentation was on a work day or on a day off; hour, month, and year of presentation; whether or not the patient was in residential care; past medical history of influenza-related complications18; use of steroids; clinical symptoms (fever, chills, fatigue, cough, nasal discharge, throat pain, joint pain, headache, sputum production, and muscle pain); vital signs (temperature, pulse rate, mean blood pressure); Japan Triage and Acuity Scale score; rapid influenza diagnostic test result; time of presentation; discharge time; rapid influenza diagnostic test order and result time; triage time; other examinations (chest radiography, blood investigations, blood culture, and urine test); medication (any parenteral medication, parenteral antibiotics, prescription for antibiotics, parenteral anti-influenza medication, prescription for an anti-influenza agent); and bounce-back admission within 7 days. All necessary data was exported to spreadsheet from electronic charts. The author search keyword and coded about clinical symptoms, past medical history, regular medicine, and whether or not the patient was in residential care.

2.7 Outcomes

The primary outcome was ED length of stay. Secondary outcomes were the implementation of examinations other than rapid influenza diagnostic tests (radiographs, blood tests, blood culture, urine tests, urine culture, and cerebrospinal fluid analysis), medication (any parenteral medications, antibiotics, or anti-influenza medications), bounce-back admission within 7 days, and charges.

2.8 Data analysis

Patients who received a rapid influenza diagnostic test at triage were assigned to a triage group and those who only received the test after examination by a doctor were assigned to an after-examination group as a control group. Baseline characteristics were compared between the 2 groups using the Wilcoxon test for continuous variables (presented as the mean and SD) and Fisher’s exact test for binary and categorical variables (presented as a percentage). Primary and secondary outcomes were evaluated after propensity score (PS) matching for age, sex, risk factors for influenza-related complications, whether or not the presentation was during a work day or on a day off, hour, month, and year of arrival, Japan Triage and Acuity Scale score, and time from arrival to triage. We performed 1:1 nearest-neighbor matching on the propensity score with a caliper of ≤0.2. To compare the timing of ED discharge, we plotted Kaplan-Meier curves and compared the
3.2 After propensity score matching

There were 329 matched pairs after propensity score matching. The baseline characteristics were well balanced between the 2 groups (Table 1; Supporting Information Appendices S1 and S2).

3.3 Outcomes

Median ED length of stay was significantly shorter in the triage group than in the after-examination group after propensity score matching (81 minutes [interquartile range (IQR) = 60–111] versus 106 minutes [IQR = 80–142]; median difference 24 minutes [95% confidence interval (CI) = 17–30]). Median time from arrival to ordering the rapid influenza diagnostic test was significantly shorter in the triage group (23 minutes [IQR = 14–34] versus 52 minutes [IQR = 33–74]; median difference 26 minutes [95% CI = 22–30]). In contrast, median time from availability of the rapid influenza diagnostic test result to discharge was longer in the triage group (32 minutes [IQR = 20–56] versus 28 minutes [IQR = 17–46]); median difference −4 minutes [95% CI = −7 to −1]; Table 2).

Kaplan-Meier curves for the 2 groups are shown in Figure 3. The probability of ED length of stay was significantly higher in the triage group than in the after-examination group (P < 0.001, log-rank test).

Fewer patients in the triage group received additional tests (7.6% versus 22.2%; odds ratio [OR] = 0.29 [95% CI = 0.17–0.48]) and the median associated charges were lower in this group (14,300 yen [IQR = 11,900–17,200] versus 15,000 yen [IQR = 12,400–18,500]; median difference 10,700 yen [95% CI = 2600–18,500]). There was no statistically significant difference in the number of patients who were prescribed antibiotic or anti-influenza medication or in the bounce-back admission rate between the 2 groups (Table 3).
TABLE 1 Baseline characteristics

|                        | Before PS matching | After examination group (n = 2191) | Standardized difference (%) | After PS matching | After examination group (n = 329) | Standardized difference (%) |
|------------------------|--------------------|------------------------------------|-----------------------------|------------------|-----------------------------------|----------------------------|
| **Triage group** (n = 363) |                    |                                    |                             | **Triage group** (n = 329) |                    |                                    |
| Age (y), mean (SD)     | 40.5 ± 15.0        | 43.3 ± 17.5                        | 0.175                       | 40.8 ± 15.1      | 41.3 ± 16.7                      | 0.033                      |
| Sex (male)             | 200 (55.1%)        | 1,016 (46.4%)                      | 0.175                       | 173 (52.6%)      | 172 (52.3%)                      | 0.006                      |
| **Risk factors for influenza-related complications** |                    |                                    |                             |                  |                                    |
| Any of the following symptoms: | 363 (100%)        | 2,169 (99.0%)                      | 0.142                       |                  | 329 (100%)                      | NA                        |
| Fever                  | 350 (96.4%)        | 2,009 (91.7%)                      | 0.201                       |                  | 316 (96.0%)                      | 0.050                      |
| Chill                  | 129 (35.5%)        | 846 (38.6%)                        | 0.064                       |                  | 119 (36.2%)                      | 0.033                      |
| Fatigue                | 77 (21.2%)         | 397 (18.1%)                        | 0.078                       |                  | 68 (20.7%)                       | 0.008                      |
| Cough                  | 236 (65.0%)        | 1,528 (69.7%)                      | 0.101                       |                  | 214 (65.0%)                      | 0.071                      |
| Nasal discharge        | 163 (44.9%)        | 1,119 (51.1%)                      | 0.124                       |                  | 152 (46.2%)                      | 0.030                      |
| Throat pain            | 220 (60.6%)        | 1,354 (61.8%)                      | 0.024                       |                  | 202 (61.4%)                      | 0.038                      |
| Joint pain             | 160 (44.1%)        | 1,094 (49.9%)                      | 0.118                       |                  | 143 (43.5%)                      | 0.049                      |
| Headache               | 133 (36.6%)        | 1,000 (45.6%)                      | 0.184                       |                  | 127 (38.6%)                      | 0.035                      |
| Sputum production      | 84 (23.1%)         | 697 (31.8%)                        | 0.195                       |                  | 80 (24.3%)                       | 0.094                      |
| Muscle pain            | 48 (13.2%)         | 282 (12.9%)                        | 0.010                       |                  | 44 (13.4%)                       | 0.009                      |
| **Vital signs**        |                    |                                    |                             |                  |                                    |
| Temperature (°C), mean (SD) | 38.2 ± 0.8        | 38.1 ± 0.9                         | 0.115                       |                  | 38.2 ± 0.8                       | 0.076                      |
| Pulse rate (bpm), mean (SD) | 101.3 ± 15.3     | 100.1 ± 16.5                       | 0.073                       |                  | 101.2 ± 15.5                     | 0.068                      |
| MAP (mm Hg), mean (SD) | 91.3 ± 14.2        | 92.3 ± 15.1                        | 0.068                       |                  | 90.9 ± 14.4                      | 0.032                      |
| JTAS score             | 0.255              | 0.304                              | 0.040                       |                  | 0.305                             | 0.040                      |
| 1                      | 0                  | 0                                  | 0                           | 0                | 0                                 | 0                          |
| 2                      | 5 (1.4%)           | 72 (3.3%)                          | 5 (1.5%)                    | 4 (1.2%)         | 4 (1.0%)                         | 0.005                      |
| 3                      | 94 (25.9%)         | 773 (35.3%)                        | 88 (26.7%)                  | 84 (25.5%)       | 84 (25.5%)                       | 0.005                      |
| 4                      | 261 (71.9%)        | 1,327 (60.6%)                      | 234 (71.1%)                 | 239 (72.6%)      | 239 (72.6%)                      | 0.005                      |
| 5                      | 3 (0.8%)           | 19 (0.9%)                          | 2 (0.6%)                    | 2 (0.6%)         | 2 (0.6%)                         | 0.005                      |
| Positive RIDT (A or B) | 187 (51.5%)        | 756 (34.5%)                        | 162 (49.2%)                 | 160 (48.6%)      | 160 (48.6%)                      | 0.012                      |
| Arrival-to-triage time (min), median (IQR) | 19 (12–32)        | 14 (9–22)                          | 0.394                       | 18 (12–28)       | 17 (10–29)                       | 0.003                      |

MAP, systolic pressure + 2 x diastolic pressure)/3. Arrival-to-triage time, from the time the patient was registered to the ED index to the triage time recorded on the triage template. Risk factors for influenza-related complications are described in detail in the Supporting Information Appendix S2. ED, emergency department; IQR, interquartile range; JTAS, Japan Triage and Acuity Scale; MAP, mean arterial pressure; PS, propensity score; RIDT, rapid influenza diagnostic test.

could not ascertain the effect of rapid influenza diagnostic tests at triage in patients at high risk of influenza-related complications. More research is needed to address these issues.

In addition, we should include variables related to crowding in the ED in the PS model, which was usually how many in the waiting room, how many arrivals in the previous 4 hours or how many patients boarding at the time of patient arrival. However, these variables were unlikely to be indicators of ED crowding in Japan because patients waited in waiting area after doctor examination, not in examination room until testing results were available. Crowding would be unlikely to affect work up or withholding of necessary testing. Instead of these variables, we used time from arrival to triage and date characteristics.

The single-center design may have affected the generalizability of these findings.

5 DISCUSSION

Our findings suggest that performing the rapid influenza diagnostic tests at triage can shorten stayed length of stay during the influenza season with no effect on the bounce-back admission rate. Such early
TABLE 2  Emergency department length of stay

|                                    | Triage group                  | After examination group | Median difference (95% CI) |
|------------------------------------|-------------------------------|-------------------------|----------------------------|
| ED length of stay (min), median (IQR) | 83 (61–114)                  | 100 (76–137)            | 16 (12–21)                 |
|                                    | After PS matching             |                         |                            |
|                                    | Triage group                  | After examination group | Median difference (95% CI) |
|                                    | (n = 363)                     | (n = 2191)              | (n = 329)                  | (n = 329)                  | (n = 329)                  |
| Arrival-to-order time (min), median (IQR) | 25 (15–35)                  | 45 (31–64)              | 20 (18–22)                 |
| Order-to-result time (min), median (IQR) | 18 (15–24)                  | 18 (15–24)              | 0 (−1–0)                   |
| Result-to-discharge time (min), median (IQR) | 32 (20–56)                  | 26 (17–47)              | −5 (−7 to −2)              |

Arrival-to-order time, from the time patients was registered to ED index to the time RIDT was ordered at medical chart. Order-to-result time, from the time RIDT was ordered on the medical chart to the time the RIDT result was recorded on the medical chart. Result-to-discharge time, from the time the RIDT result was recorded on the medical chart to the time patient had completed payment.

CI, confidence interval; IQR, interquartile range; PS, propensity score; RIDT, rapid influenza diagnostic test.

FIGURE 3  Kaplan-Meier curves for time spent in the emergency department.*P < 0.05 was considered statistically significant. ED, emergency department

strategic testing with decreased length of stay could also decrease the need for additional tests and the associated costs.

Previous studies have found that focused diagnostic tests, such as chest radiography, urine testing, and electrocardiography, at triage shorten ED length of stay.9–15 Moreover, a drive-through influenza examination model and a dedicated influenza clinic were also reported to shorten ED length of stay.4,21 Performing rapid influenza diagnostic tests likely has a similar effect on ED length of stay.

After propensity score matching, the between-group time difference was ~25 minutes. This time is almost the same as the rapid influenza diagnostic test examination time, which also includes part of the waiting time before examination by a doctor, as shown by our results that the rapid influenza diagnostic test examination time mainly seemed to shorten ED length of stay.

Even though fewer additional tests were performed in the triage group, the time from availability of the rapid influenza diagnostic
| Test                      | Before PS matching | After PS matching |
|--------------------------|--------------------|-------------------|
|                          | Triage group       | After examination group |
|                          | (n = 363)          | (n = 2191)        |
|                          |                    | Odds ratio        |
|                          |                    | (95% CI)          |
|                          |                    | Triage group       | After examination group |
|                          |                    | (n = 329)          | (n = 329)          |
|                          |                    | Odds ratio        |
|                          |                    | (95% CI)          |
| Further test             | 25 (6.9%)          | 529 (24.1%)       | 0.23 (0.15–0.35)   |
| Chest radiograph        | 16 (4.4%)          | 317 (14.5%)       | 0.27 (0.15–0.46)   |
| Computed tomography of chest | 0 (0.0%)    | 23 (1.0%)         | 0 (0–1.04)         |
| Blood test               | 16 (4.4%)          | 336 (15.3%)       | 0.25 (0.14–0.43)   |
| Blood culture            | 12 (3.3%)          | 155 (7.1%)        | 0.45 (0.22–0.82)   |
| Urine test               | 7 (1.9%)           | 151 (6.9%)        | 0.27 (0.10–0.57)   |
| Urine culture            | 0 (0.0%)           | 7 (0.3%)          | 0 (0–4.19)         |
| Cerebrospinal fluid analysis | 0 (0.0%)   | 0 (0–NA)          | NA                 |
| Any parenteral medications | 17 (4.7%)  | 272 (12.4%)       | 0.34 (0.20–0.57)   |
| Parenteral antibiotics   | 2 (0.6%)           | 50 (2.3%)         | 0.23 (0.03–0.91)   |
| Any prescription         | 136 (37.5%)        | 951 (43.4%)       | 0.78 (0.62–0.99)   |
| Antibiotic prescription  | 17 (4.7%)          | 203 (9.3%)        | 0.48 (0.27–0.80)   |
| Any anti-influenza medications | 44 (12.1%) | 216 (9.9%)        | 1.26 (0.87–1.79)   |
| Bounce-back admission within 3 days | 0 (0.0%) | 28 (1.3%)         | 0 (0–0.84)         |
| Bounce-back admission within 7 days | 0 (0.0%)  | 42 (1.9%)         | 0 (0–0.55)         |
| Cost (yen, thousand)     | 14.3 (12.1–17.2)   | 14.6 (11.5–18.7)  | 6.4 (0.50–12.70)   |

CI, confidence interval; IQR, interquartile range; NA, not applicable; PS, propensity score.

Whether performing a rapid influenza diagnostic test at triage is a useful way of addressing ED crowding is unclear, although it certainly may reduce ED length of stay. It may also reduce additional testing. If it is an effective approach to improve crowding and reduce additional tests, performing a rapid influenza diagnostic test at triage could streamline clinical practice. However, we performed rapid influenza diagnostic tests in more than half of our patients who were not at high risk of influenza-related complications during the study period, and we were not sure whether the prescription of anti-flu medications increased. Thus, we were not able to recommend performing rapid influenza diagnostic testing routinely for all patients, particularly in the influenza season, because testing results did not change clinical management in most cases. From an economic point of view, we should avoid rapid influenza diagnostic tests unless necessary. However, even when we explain that there was no need for rapid influenza diagnostic tests during the influenza season, many patients still request the test. This is possibly due to a need to confirm the illness with an employer or because educational institutions in Japan require a rapid influenza diagnostic test to exclude influenza before children can attend school. Before performing rapid influenza diagnostic tests routinely to shorten ED length of stay, we should educate patients and society at large that there is no need for rapid influenza diagnostic tests during the influenza season. Like several other hospitals in Japan, we are now attempting to address this problem by providing patients with written discharge instructions in addition to a fact sheet at triage. However, the effects of this strategy are thus far limited. For now, the best plan may be to tackle the problem at a national policy level to avoid unnecessary flu testing. After that, we can confirm the real effect of performing rapid influenza diagnostic tests at triage, particularly for patients at high risk of influenza-related complications or to alleviate ED overcrowding. Although different at present, there is a possibility the rapid influenza diagnostic test would be useful within limited indication.
summary, performing rapid influenza diagnostic tests at triage is associated with shorter ED length of stay during the influenza season, but more research is needed to determine the impact of rapid influenza diagnostic tests at triage in high-risk patients.

CONFLICTS OF INTEREST
The authors declare no conflicts of interest to disclose.

AUTHOR CONTRIBUTIONS
TI conceived the study, designed the trial, collected the data, and drafted the manuscript. TH and KH provided statistical advice on the study design and analyzed the data. All authors contributed substantially to the revision of the manuscript. TI takes responsibility for the paper as a whole.

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SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section at the end of the article.

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