The impact of rapid molecular diagnostic testing for respiratory viruses on outcomes for emergency department patients

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The known: Rapid polymerase chain reaction (PCR) testing for influenza and respiratory syncytial viruses (RSV) was introduced in New South Wales in July 2017. Its impact on outcomes for emergency department (ED) patients has not been investigated.

The new: Compared with standard PCR testing, rapid PCR was associated with significantly fewer hospital admissions, more rapid test turnaround, more patients receiving test results before leaving the ED, and reduced numbers of some other common microbiology tests. It did not significantly affect ED length of stay.

The implications: Rapid PCR testing of ED patients for major respiratory viruses can benefit patients and reduce resource use.

The health and economic burdens associated with acute respiratory infections by influenza and respiratory syncytial viruses (RSV) are significant in Australia and overseas.1-5 Polymerase chain reaction (PCR) testing is effective for confirming respiratory viral infections.3 Multiplex PCR can detect numerous respiratory viruses, including influenza and parainfluenza viruses, RSV, adenovirus, rhinovirus, human metapneumovirus, enterovirus, bocavirus and coronavirus with very high sensitivity and specificity.6 Although the results of standard multiplex PCR are accurate and comprehensive, it has traditionally been performed in a central laboratory with a lengthy turnaround time, which may be inconvenient in settings where test results are urgently required, including emergency departments (EDs).

Rapid, easy-to-use PCR-based respiratory virus diagnostic tests have been introduced in recent years.6-7 the GeneXpert system (Cepheid), for instance, was introduced in New South Wales in July 2017. Rapid PCR tests were expected to facilitate timely and appropriate initiation of treatment, improve outbreak prevention and infection control measures, and expedite the assessment of patients in EDs.

In this study, we analysed routinely collected data to determine whether rapid PCR testing for influenza and RSV infections in EDs is associated with improved patient and laboratory outcomes. We compared data for patients tested for influenza A/B viruses and RSV immediately after rapid PCR diagnosis was introduced (July–December 2017) with data for patients tested with a standard multiplex PCR system during July–December 2016.

Methods

Setting

We undertook a before-and-after study in four metropolitan public hospital EDs in Sydney, NSW: three general hospitals (EDs A, B and C; 76 228, 54 443 and 50 025 annual ED presentations respectively) and one children’s hospital (ED D; 36 700 annual ED presentations; all data for January–December 2016). The four hospitals were served by a single pathology laboratory provider.

Results: Compared with those tested by standard PCR, fewer patients tested by rapid PCR were admitted to hospital (73.3% v 77.7%; P < 0.001) and more received their test results before leaving the ED (67.4% v 1.3%; P < 0.001); the median test turnaround time was also shorter (2.4 h [IQR, 1.6–3.9 h] v 26.7 h [IQR, 21.2–37.8 h]). The proportion of patients admitted to hospital was also lower in the rapid PCR group for both children under 18 (50.6% v 66.6%; P < 0.001) and patients over 60 years of age (84.3% v 91.8%; P < 0.001). Significantly fewer blood culture, blood gas, sputum culture, and respiratory bacterial and viral serology tests were ordered for patients tested by rapid PCR. ED LOS was similar for the rapid (7.4 h [IQR, 5.0–12.9 h]) and standard PCR groups (6.5 h [IQR, 4.2–11.9 h]; P = 0.27).

Conclusion: Rapid PCR testing of ED patients for influenza virus and RSV was associated with better outcomes on a range of indicators, suggesting benefits for patients and the health care system. A formal cost–benefit analysis should be undertaken.

Abstract

Objective: To determine whether rapid polymerase chain reaction (PCR) testing for influenza and respiratory syncytial viruses (RSV) in emergency departments (EDs) is associated with better patient and laboratory outcomes than standard multiplex PCR testing.

Design, setting: A before-and-after study in four metropolitan EDs in New South Wales.

Participants: 1491 consecutive patients tested by standard multiplex PCR during July–December 2016, and 2250 tested by rapid PCR during July–December 2017.

Main outcome measures: Hospital admissions; ED length of stay (LOS); test turnaround time; patient receiving test result before leaving the ED; ordering of other laboratory tests.

Results: Compared with those tested by standard PCR, fewer patients tested by rapid PCR were admitted to hospital (73.3% v 77.7%; P < 0.001) and more received their test results before leaving the ED (67.4% v 1.3%; P < 0.001); the median test turnaround time was also shorter (2.4 h [IQR, 1.6–3.9 h] v 26.7 h [IQR, 21.2–37.8 h]). The proportion of patients admitted to hospital was also lower in the rapid PCR group for both children under 18 (50.6% v 66.6%; P < 0.001) and patients over 60 years of age (84.3% v 91.8%; P < 0.001). Significantly fewer blood culture, blood gas, sputum culture, and respiratory bacterial and viral serology tests were ordered for patients tested by rapid PCR. ED LOS was similar for the rapid (7.4 h [IQR, 5.0–12.9 h]) and standard PCR groups (6.5 h [IQR, 4.2–11.9 h]; P = 0.27).

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Methods

Setting

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Populations and data sources

We analysed data for all patients tested for influenza virus or RSV. During July–December 2016, patients were tested with the standard PCR system, a central laboratory-based multiplex PCR test for sixteen respiratory viruses (including RSV and influenza viruses A and B), available as a referral test at the central laboratory in Hospital B. During July–December 2017, patients were tested with the rapid PCR system, a hospital laboratory-based test specific for RSV and influenza viruses A and B. Hospitals A, B and D have onsite laboratories that perform rapid PCR testing; Hospital C sends samples to the nearby Hospital A.

All tests were conducted in virology laboratories by trained staff, and test results were entered into laboratory information system datasets. We obtained relevant patient characteristics and
We analysed data for 3741 patients presenting to the four EDs during two periods: 1491 consecutive patients during July–December 2016 (standard PCR) and 2250 during July–December 2017 (rapid PCR). Baseline characteristics for the two groups were similar in terms of sex, triage category, and arrival day of the week, but differed significantly for age, arrival time, and mode of arrival (Box 1). Among those tested by rapid PCR, supplementary standard PCR tests were ordered for 133 patients (5.9%), and standard PCR tests for respiratory viruses other than influenza viruses A/B and RSV were requested for a further 320 patients (14.2%).

A total of 134 people in the standard PCR group (9.0%) were positive for influenza A/B (37 patients), RSV (96 patients), or both (one patient); a further 333 people (22.3%) were positive for at least one other respiratory virus (but not influenza A/B or RSV). Of the patients in the rapid PCR group, 790 (35.1%) were positive for influenza A/B (372 patients), RSV (56 patients), or both (two patients). In the children’s hospital (ED D), 53 children in the standard PCR group (18%) were positive for RSV (49 children) or influenza A/B (five children); a further 144 (48%) were positive for at least one other respiratory virus. Of those tested by rapid PCR, 54 children (35%) were positive for influenza A/B (46 children) or RSV (eight children).

## Results

### Baseline characteristics and PCR test results

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74.2–78.7%) were admitted to hospital (after adjusting for baseline characteristics: aOR, 1.5; 95% CI, 1.2–1.8) (Box 3).

**Secondary outcomes**

The overall numbers of tests per patient were similar in the standard PCR (mean, 7.2 tests; SD, 3.8) and rapid PCR groups (mean, 7.1 tests; SD, 3.4). The mean number of microbiology tests per patient was significantly lower for the rapid PCR group (1.5 tests; SD, 1.8) than for the standard PCR group (2.0 tests; SD, 2.1; \(P < 0.001\) after controlling for baseline characteristics).

The 16 265 biochemistry/haematology and microbiology tests comprised 71.1% of the 22 876 other tests (that is, not including PCR virus testing) ordered for patients in the study. After adjusting for baseline characteristics, the proportions of patients for whom full blood count, electrolyte/urea/creatinine levels, liver function, or C-reactive protein were assessed were similar, as were the proportions for urine microscopy, culture and sensitivity tests. Significantly fewer blood culture, blood gas, sputum culture, and respiratory bacterial and viral serology tests were ordered for patients in the rapid PCR group (Box 4).

**Sensitivity analyses**

Of the 452 patients under 18 years of age in the standard PCR group, 301 (66.6%; 95% CI, 62.0–70.9%) were admitted to hospital, as were 158 of the 312 children (50.6%; 95% CI, 44.9–56.3%) in the rapid PCR group (standard \(v\) rapid PCR: aOR, 1.7; 95% CI, 1.3–2.4). Of the 670 patients over 60 years of age in the standard PCR group, 615 (91.8%; 95%, 89.4–93.8%) were admitted to hospital, as were 1167 of the 1384 patients of this age (84.3%; 95% CI, 82.3–86.2%) in the rapid PCR group (standard \(v\) rapid PCR: aOR, 2.1; 95% CI, 1.5–2.9) (Supporting Information, figure 1).

ED LOS was similar for the standard PCR and rapid PCR groups in both age-based subgroups (Supporting Information, figure 2A). The differences in test turnaround time identified in the main analysis were also evident for each age-based subgroup (Supporting Information, figure 2B).

**Discussion**

In this before-and-after study, we found that rapid PCR testing of ED patients for major respiratory viruses was associated with significantly fewer admissions to hospital, more rapid delivery of test results, more patients receiving their test results before leaving the ED, and less frequent ordering of some common microbiology tests.

Other studies have also reported that hospital admission numbers were significantly lower when rapid influenza virus testing was used in EDs. An analysis of outcomes for more than 300 adults at a tertiary care centre in New York found that early diagnosis of respiratory infections was associated with significantly fewer hospitalisations of influenza-positive patients. In a small Irish study (73 patients), the hospital admission rate for obstetric patients declined from 88% to 45% after on-site rapid influenza PCR testing was introduced. The differences in clinical setting and patient group may explain the smaller decline in our study (from 78% to 67%). Non-PCR-based rapid diagnostic tests for respiratory viruses have also been associated with lower hospital admission rates.

The main reason for fewer hospital admissions of patients tested by rapid PCR may be that the earlier availability of results enables clinicians to quickly diagnose or exclude respiratory infections and to make timely and informed decisions about whether to discharge the patient or admit them to hospital. When standard
PCR was used, in contrast, our findings suggest that these decisions were made before the test results were available. The possible benefits of not admitting patients to hospital, beyond those for individual patient management, include better infection control and outbreak prevention, as well as reduced demands on hospital resources. The impact of rapid PCR testing on outbreak prevention and infection control measures should be evaluated. Rapid influenza virus testing may also have practical implications for hospital bed management.

ED LOS was similar in our study before and after the introduction of rapid PCR methods. This finding was not unexpected, as test turnaround time is not the only rate-limiting factor for decision making in EDs. Before rapid PCR methods were introduced, the long turnaround time of multiplex PCR did not necessarily extend a patient’s stay in the ED, as they were usually admitted to hospital or discharged home before the results were available. Consequently, more rapid delivery of test results alone would not reduce ED LOS.

Reports on the effect of rapid influenza virus testing and LOS have been conflicting. While evidence for an association between rapid testing and shorter overall inpatient LOS has been conflicting, 7,17,18 the association with ED LOS was similar in our study before and after the introduction of rapid PCR; inpatient LOS did not differ between the two groups, but ED LOS was actually 26 minutes longer with rapid PCR than for those tested by standard PCR, despite the lower rate of positive results for patients tested by rapid PCR. 6

The higher rate of positive results for patients tested by rapid PCR than for those tested by standard PCR may reflect a higher prevalence of influenza during 2017 than in 2016.
for influenza virus and RSV, and to control for differences in baseline patient characteristics by applying multivariate modeling. As medications data were not available to us, we were unable to assess the impact of rapid PCR testing on antibiotic and antiviral drug use. Similarly, the cost–benefit balance of rapid testing was not evaluated because relevant data were not available. The cost per patient of rapid PCR testing is generally higher than for central laboratory testing, but our findings suggest potential savings through lower numbers of hospital admissions and reduced resource use. This question could be evaluated in a further study.

Conclusion

Rapid PCR testing for influenza virus and RSV infections in patients attending EDs was associated with significant improvements in a range of patient and laboratory outcomes, suggesting potential benefits for both the patients and the health care system. A cost–benefit analysis could examine the impact of rapid PCR testing on bed management and antimicrobial drug prescribing.

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