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ORIGINAL RESEARCH

# Impact of patient isolation on emergency department length of stay: A retrospective cohort study using the Registry for Emergency Care

Gerard M O'REILLY [1,2,3] Rob D MITCHELL [1,2] Biswadev MITRA [1,2,3] Michael P NOONAN,[1,3,4] Ryan HILLER,[1] Lisa BRICHKO,[1,2,5] Carl LUCKHOFF,[1] Andrew PATON,[1,6] De Villiers SMIT[1,2] and Peter A CAMERON [1,2]

[1]Emergency and Trauma Centre, Alfred Health, Melbourne, Victoria, Australia, [2]School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia, [3]National Trauma Research Institute, Alfred Health, Melbourne, Victoria, Australia, [4]Trauma Service, Alfred Health, Melbourne, Victoria, Australia, [5]Emergency Department, Cabrini Hospital, Melbourne, Victoria, Australia, and [6]Adult Retrieval Victoria, Ambulance Victoria, Melbourne, Victoria, Australia

## Abstract

***Objective***: The number of patients with suspected COVID-19 presenting to Australian EDs continues to impose a burden on healthcare services. Isolation is an important aspect of infection prevention and control, but has been associated with undesirable consequences among hospital inpatients. The aim of the present study was to determine if isolation is associated with an increased length of stay (LOS) in the ED.

***Methods***: The Registry for Emergency Care Project is a prospective cohort study with a series of nested sub-studies. The present study was a retrospective analysis of adult patients allocated an Australasian Triage Scale category of 1 or 2 who presented to a tertiary ED between 18 and 31 May 2020. The primary outcome was ED LOS. Regression methods were used to determine the independent association between ED isolation and LOS.

***Results***: There were 447 patients who met inclusion criteria, of which 123 (28%) were managed in isolation. The median (interquartile range) ED LOS was 259 (210–377) min for the isolation group and 204 (126–297) min for the non-isolation group, a difference in median ED LOS of 55 min ($P < 0.001$). Isolation was independently associated with a 23% increase in ED LOS ($P = 0.002$) and doubled the odds of an ED stay of more than 4 h (adjusted odds ratio 2.2 [1.4–3.4], $P = 0.001$).

***Conclusion***: Consistent with the anecdotal experience of Australian ED clinicians, the present study demonstrated an increased ED LOS for patients managed in isolation. Enhanced infection prevention and control precautions will be required during and beyond the current pandemic, creating significant ongoing challenges for emergency care systems.

### Key findings

- The median ED length of stay increased by 55 min for patients requiring isolation.
- Patient isolation was independently associated with a 23% increase in ED length of stay.
- Patient isolation more than doubled the odds of an ED stay of more than 4 h.

**Key words:** *COVID-19*, *emergency*, *isolation*, *quality improvement*, *registry*.

## Background

Although Australia has been relatively successful at containing the spread of the SARS-CoV-2 virus, a significant number of patients presenting to Australian EDs meet case definition criteria for 'suspected COVID-19'.[1,2] In response to this 'new normal', EDs have endeavoured to improve infection prevention and control (IPC) through clinical redesign, infrastructure modifications and process changes.[2,3]

Isolation is an important component of IPC for patients requiring

Correspondence: Associate Professor Gerard M O'Reilly, Emergency and Trauma Centre, The Alfred, 55 Commercial Road, Melbourne, VIC 3004, Australia. Email: gerard.oreilly@monash.edu

Gerard M O'Reilly, MBBS, MPH, MBiostat, FACEM, PhD, Emergency Physician, Adjunct Clinical Associate Professor, Head of Epidemiology and Biostatistics, NHMRC Research Fellow; Rob D Mitchell, MBBS (Hons), BMedSc (Hons), MPH&TM, GradCertDisRefHlth, FACEM, Emergency Physician, PhD Scholar; Biswadev Mitra, MBBS, MHSM, FACEM, PhD, Director of Emergency Medicine Research, Professor, Head of Clinical Research; Michael P Noonan, MBChB (Hons), BPhty (Hons), MMEd, FACEM, Emergency Physician, Honorary Consultant, Trauma Consultant; Ryan Hiller, MBBS, BMedSc (Hons), Emergency Registrar; Lisa Brichko, MBBS (Hons), MHM, DCH, AFRACMA, FACEM, Emergency Physician, Adjunct Research Associate; Carl Luckhoff, MBChB, FACEM, Emergency Physician; Andrew Paton, MBChB, FACEM, CHIA, Emergency Physician, Retrieval Consultant; De Villiers Smit, MBChB, FACEM, Emergency Physician, Director, Adjunct Associate Professor, Head of Emergency Medicine Program; Peter A Cameron, MBBS, FACEM, MD, Emergency Physician, Adjunct Professor.

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**TABLE 1.** *Baseline characteristics, comparing patients requiring isolation (isolation+) procedures for any period during their ED presentation to patients not requiring isolation (isolation−)*

| Variable | Isolation+ (*n* = 123) | Isolation− (*n* = 324) | *P*-value for difference |
|---|---|---|---|
| Age (years), mean (SD) | 57 (23) | 49 (21) | <0.001 |
| Male, *n* (%) | 74 (60) | 200 (62) | 0.76 |
| Arrived by ambulance, *n* (%) | 95 (77) | 192 (59) | <0.001 |
| Arrived on weekend, *n* (%) | 37 (30) | 112 (35) | 0.37 |
| Arrived on night shift, *n* (%) | 35 (28) | 96 (30) | 0.81 |
| Triage category 1, *n* (%) | 18 (15) | 14 (4) | <0.001 |
| First ED $SpO_2$ (%), mean (SD) | 97 (4) | 98 (3) | 0.001 |
| First ED temperature (°C), mean (SD) | 36.6 (0.7) | 36.5 (0.5) | 0.01 |
| First ED systolic BP (mmHg), mean (SD) | 135 (30) | 140 (26) | 0.08 |
| Hospital admission, *n* (%) | 109 (89) | 259 (80) | 0.03 |
| ED disposition destination, *n* (%) | | | |
| Home | 14 (11) | 65 (20) | <0.001 |
| Ward | 52 (42) | 100 (31) | |
| ICU | 18 (15) | 10 (3) | |
| Operating theatre | 1 (1) | 13 (4) | |
| Other hospital | 3 (2) | 6 (2) | |
| Died in ED | 1 (1) | 0 (0) | |
| Left after being seen | 0 (0) | 4 (1) | |
| ED short stay unit | 34 (28) | 124 (38) | |
| Other | 0 (0) | 2 (1) | |

contact, droplet or airborne precautions, such as those with suspected COVID-19. Notwithstanding the obvious benefits for communicable disease control, isolation has been associated with a number of undesirable patient outcomes.[4,5] For example, increased rates of falls, pressure ulcers and medication errors have been reported in medical and geriatric units.[4] There is also evidence of negative psychological impacts.[5] In the more acute setting of the ED, the effects of isolation on patient outcomes and departmental processes are not well understood.

The increased focus on IPC has highlighted the risks associated with ED overcrowding, including increased morbidity and mortality.[6–10] Causes include 'output' factors such as access block and delayed disposition decision-making, and 'input' factors such as a large burden of patients with complex care needs.[11] There is widespread acknowledgement that, as part of the 'new normal', hospitals must actively address ED overcrowding and access block to mitigate the risk of harm.[12–15]

Building on the COVID-19 ED Project, which is focused on the clinical features and outcomes of SARS-CoV-2 positive cases, the Registry for

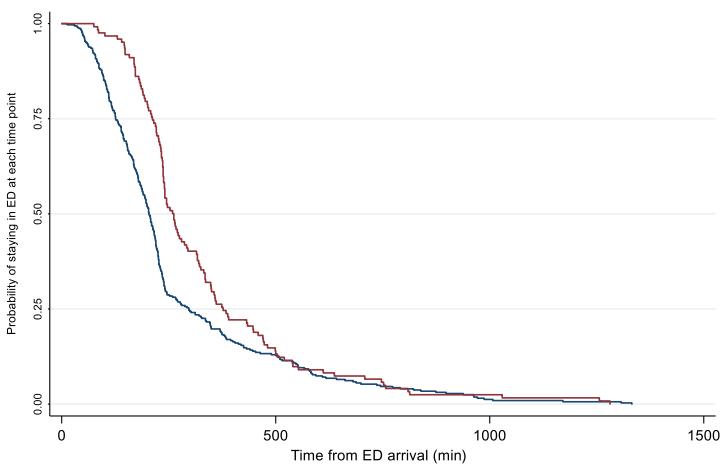


**Figure 1.** *Kaplan–Meier plot for probability of continuing to stay in ED. Log-rank test for equality of survivor functions:* P = *0.001. (——) No isolation in ED; (——) Isolation in ED.*

Emergency Care (REC) was established to examine the care of all ED patients during the COVID-19 pandemic.[16,17] The aim of the present study was to use the REC to determine the impact of patient isolation on ED length of stay (LOS). Specifically, the study addressed the following PECO (population, exposure, comparator and outcome) question: Among ED patients with time-sensitive healthcare needs (P), what is the impact of contact, droplet or airborne precautions ('isolation') (E), as opposed to no isolation (C), on LOS in the ED? (O).

## Methods

The protocol for the REC Project has been published previously.[17] In summary, it is a prospective cohort study with a series of nested substudies (each with a specified primary exposure and primary outcome).

The initial REC Project site is the Alfred Hospital in Melbourne, a tertiary, adult, level 1 trauma centre with an ED census of approximately 70 000. All adult patients presenting to the ED are eligible to be included in the registry. Outcome measures include ED LOS and discharge destination (including ICU admission). A more comprehensive list of exposure and outcome variables is available in the project protocol.[17] REC data are automatically extracted from the Alfred Hospital's electronic medical record (EMR) through the Alfred Health data warehouse, and then securely transferred to a REDCap (Research Electronic Data Capture) electronic database hosted by Helix (Monash University). REDCap is a secure, web-based application designed to support data capture for research studies.[18] Ethics approval for the REC Project was obtained from the Alfred Human Research Ethics Committee (project no. 282/20) on 12 May 2020 and was registered with Monash University Human Research Ethics Committee on 15 May 2020 (project no. 24723).

The present study is a retrospective analysis of a sub-group of patients meeting REC eligibility.

**TABLE 2.** *Univariable and multivariable analysis of association between the natural log of ED length of stay (LOS) and (i) the primary exposure variable, i.e. requiring isolation in the ED; and (ii) potential confounders*

| Variable | Regression coefficient (univariable) (95% CI, *P*-value) | % Change in ED LOS (univariable) (95% CI) | Regression coefficient (adjusted) (95% CI, *P*-value) | % Change in ED LOS (adjusted) (95% CI) |
|---|---|---|---|---|
| Isolation+, *n* (%) | 0.35 (0.21 to 0.49, <0.001) | +41.9 (+23.3 to +63.2) | 0.21 (0.08 to 0.34, 0.002) | +23.4 (+8.3 to +40.5) |
| Age (years), mean (SD) | 0.01 (0.00 to 0.01, <0.001) | +0.7 (+0.4 to +1.0) | 0.01 (0.00 to 0.08, <0.001) | +1.0 (+1.0 to +8.3) |
| Arrived by ambulance, *n* (%) | 0.53 (0.41 to 0.65, <0.001) | +69.9 (+50.7 to +91.6) | 0.45 (0.32 to 0.58, <0.001) | +56.8 (+37.7 to +78.6) |
| Triage category 1, *n* (%) | −0.06 (−0.31 to 0.19, 0.65) | −5.8 (−26.7 to +20.9) | — | — |
| First $SpO_2$ (%), mean (SD) | −0.02 (−0.38 to −0.00, 0.05) | −2.0 (−31.6 to −0.0) | 0.01 (−0.01 to 0.02, 0.53) | +1.0 (−1.0 to +2.0) |
| First ED temperature, mean (SD) | −0.04 (−0.16 to 0.08, 0.49) | −3.9 (−14.8 to +8.3) | — | — |
| Hospital admission, *n* (%) | 0.29 (0.13 to 0.47, <0.001) | +33.6 (+13.0 to +60.0) | 0.01 (−0.16 to 0.17, 0.94) | +1.0 (−14.8 to +18.5) |

Inclusion criteria were adult patients assigned an Australasian Triage Scale category 1 or 2 who presented to The Alfred Hospital Emergency and Trauma Centre in the period of 18–31 May 2020. The exposure was defined by being assigned an isolation order at any time during the patient's ED presentation, as recorded in the patient's EMR. The primary outcome variable was ED LOS, defined as the time, in minutes, between registration of the patient's ED presentation and their ED disposition. In addition, a subgroup analysis of the association between isolation and ED LOS was conducted among those patients who were admitted to hospital (general ward, emergency short stay unit, ICU or operating theatre) and those who were discharged from hospital (home, self-discharged against medical advice and died in ED).

Symmetrical numerical data were summarised using mean (SD), while skewed numerical data and ordinal data were summarised using median (interquartile range). Nominal data were summarised using frequency (percentage). For the unadjusted analysis, ED LOS was determined to be asymmetrical (right skewed). Therefore, the measure of association used to determine the unadjusted association between ED LOS and isolation was the difference in medians. Statistical significance was tested using the Wilcoxon rank-sum test.

A Kaplan–Meier plot was used to further describe any differences in ED LOS, and the log-rank test applied to test for a statistically significant difference between those who were isolated in the ED *versus* those who were not isolated in the ED. To determine the independent association between ED LOS and isolation in the adjusted analysis, the dependent outcome variable (ED LOS) was log-transformed. This was necessary because it did not fulfil the assumptions necessary for linear regression (i.e. normal distribution). Potential confounders were included in a multivariable linear regression analysis according to whether or not they had a statistically significant association with both the primary exposure variable (contact, droplet or airborne precautions, summarised as isolation status) and the primary outcome variable (log ED LOS). The measure of association used to summarise the effect sizes in the univariable and multivariable models was the coefficient for the isolation variable. For all analyses, a *P*-value of less than 0.05 was considered to be statistically significant.

The above steps were repeated to examine the impact of isolation on ED LOS after dichotomising using a 4-h cut-off, a widely utilised emergency access target linked to better patient outcomes.[19,20] The unadjusted association between isolation and an ED LOS of greater or less than 4 h was analysed using univariable logistic regression, while multivariable logistic regression was used to determine the independent association between an ED LOS of greater or less than 4 h and isolation. Again, potential confounders were included in the regression analysis according to whether or not they had a statistically significant association with both the primary exposure variable and the primary outcome variable. The odds ratio (95% confidence interval [CI]) was used as the measure of association to summarise the effect sizes in the univariable and multivariable models. All analyses were conducted using STATA version 15.0 (College Station, TX, USA).

## Results

There were 447 patients who met inclusion criteria, of whom 123 (28%) were managed in isolation during their ED stay. Table 1 summarises the baseline data. Compared to patients not requiring isolation in the ED, patients who required isolation were generally older, were more likely to arrive by ambulance, and were more frequently assigned the higher triage category. Isolated patients were more likely to be admitted to hospital, with a higher proportion going to ICU (rather than a standard ward or ED short stay) compared with non-isolated patients. One patient died in the ED in the setting of isolation.

The median (interquartile range) ED LOS was 259 (210–377) min for the isolation group and 204 (126–297) min for the non-isolation group, a difference in median ED LOS of 55 min

**TABLE 3.** *Univariable and multivariable analysis of association between ED length of stay (LOS) being greater than 4 h and (i) the primary exposure variable, i.e. requiring isolation in the ED; and (ii) potential confounders*

| Variable | ED LOS >4 h (*n* = 169) | ED LOS ≤4 h (*n* = 278) | OR (univariable) (95% CI, *P*-value) | OR (adjusted) (95% CI, *P*-value) |
|---|---|---|---|---|
| Isolation+, *n* (%) | 69 (41) | 54 (19) | 2.8 (1.9–4.4, <0.001) | 2.2 (1.4–3.4, 0.001) |
| Age (years), mean (SD) | 57 (23) | 47 (20) | 1.0 (1.0–1.0, <0.001) | 1.0 (1.0–1.0, 0.003) |
| Arrived by ambulance, *n* (%) | 143 (85) | 144 (52) | 5.1 (3.2–8.3, <0.001) | 3.9 (2.4–6.5, <0.001) |
| Triage category 1, *n* (%) | 14 (8) | 18 (6) | 0.8 (0.4–1.6, 0.47) | — |
| First $SpO_2$ (%), mean (SD) | 97 (2) | 98 (4) | 0.9 (0.9–1.0, 0.05) | — |
| First ED temperature, mean (SD) | 36.5 (0.6) | 36.5 (0.5) | 1.0 (0.7–1.4, 1.0) | — |
| Hospital admission, *n* (%) | 156 (92) | 212 (76) | 3.7 (2.0–7.0, <0.001) | 2.1 (1.1–4.2, 0.03) |

($P < 0.001$). The Kaplan–Meier curve comparing the ED LOS between isolated and non-isolated patients is displayed in Figure 1; the log-rank test confirmed a difference in ED LOS ($P = 0.001$).

Table 2 displays the results of the univariable and multivariable analysis for ED LOS following log-transformation. There was an independent association between the log of the ED LOS and isolation (0.21 [95% CI 0.08–0.34], $P = 0.002$). The antilog equivalent, expressed as the percentage increase in ED LOS for isolated patients, was 23.4 (8.3–40.5). Among those who were admitted to hospital, there was a statistically significant association between the log of ED LOS and isolation ($P = 0.003$); among those who were not admitted, there was no statistically significant association ($P = 0.35$).

Table 3 displays the results of the univariable and multivariable analysis for ED LOS greater or less than 4 h and isolation. The adjusted odds for an ED LOS of more than 4 h was 2.2 (95% CI 1.4–3.4, $P = 0.001$). For those who were admitted to hospital, the odds ratio was 2.2 (1.4–3.6, $P = 0.001$); for those who were not admitted, the odds ratio was 1.7 (0.4–7.5, $P = 0.46$).

## Discussion

The present study, the first from the REC Project, has established that management in isolation as part of IPC was associated with a longer ED stay. The odds of spending longer than 4 h in the ED were more than doubled, even after adjusting for confounders. This association appeared more prominent among patients who were admitted to hospital, suggesting a significant impact on access block and ED overcrowding. With more than a quarter of emergency patients currently meeting criteria for isolation, there is potential for a substantial impact on clinical capacity and patient flow in the ED.

Although these are the first data on this topic from the COVID-19 pandemic in Australia, the result is consistent with the anecdotal experience of many Australian emergency care clinicians.[14] The present study highlights the 'triple challenge' facing Australian EDs: maintaining 'business as usual' while simultaneously providing clinical care for patients with confirmed COVID-19 and containing further spread through IPC precautions for suspected cases.[2]

The present study was conducted during a period when there were relatively few patients testing positive for SARS-CoV-2.[1] Given the recent rise in case numbers within Victoria, the impacts of isolation may change. This will require constant monitoring in order to minimise downstream consequences, such as ED overcrowding and delayed access to definitive care. A proactive approach will be required to mitigate the impact of the pandemic on ED patients with non-COVID conditions.[21]

Looking forward, the consequences of enhanced IPC measures in EDs are likely to outlast the current surge in SARS-CoV-2 cases. The COVID-19 pandemic has illustrated pre-existing deficiencies and ongoing challenges for effective IPC in EDs, and highlighted the need for more resilient emergency care systems. Improvements in ED design, patient flow, staffing and clinical processes will be required to facilitate safe and effective care in the post-COVID era.[14,15]

The present study was limited in being conducted over a 2-week period at one hospital and did not examine patient-level clinical outcomes. Nevertheless, the sample size was relatively large, and the analysis of system-level data generated a clear answer to the research question. The validity of 4 h as a cut-off point has also been questioned, given the risk of an adverse outcome attributable to a prolonged ED stay is likely to be proportional to the LOS (albeit in a non-linear fashion).[19,20,22] That said, 4 h is a widely used threshold and has been endorsed as an access target in multiple jurisdictions. It has also been linked to improved patient outcomes.[22]

The REC Project is intended to determine and monitor potential impacts of the pandemic, and other exposures, on ED care. This focused but important study has illustrated the potential role of the registry in improving healthcare safety and quality, and will hopefully serve as a catalyst for multi-site expansion of the project.

## Conclusion

Patient isolation in the ED comes at a cost. Isolated patients are more likely to experience a delay in leaving the ED and reaching the location of their definitive care. While IPC procedures are essential, the present study has highlighted the potential for negative consequences from ED overcrowding and access block.

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### *Author contributions*

All authors listed have contributed to the concept and design of this Original Research, including its analysis plan, and have critically reviewed the Original Research for content.

### *Competing interests*

GMOR, BM and PAC are section editors for *Emergency Medicine Australasia*.

### *Data availability statement*

Data that support the findings of this study may be available upon reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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