



Flow impacts of hot/cold zone infection control procedures during the COVID-19 pandemic in the emergency department

Scott Odorizzi¹ · Eric Clark¹ · Marie-Joe Nemnom² · Jennifer Clow¹ · Edmund Kwok¹ · Joseph Kozar¹ · Jeffrey J. Perry^{1,2}

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Abstract

Background The COVID-19 pandemic forced emergency departments (EDs) to change operations to minimize nosocomial infection risk. Many EDs cohort patients using provincial screening tools at triage. Despite cohorting, staff exposures occurred in the 'cold zone' due to lack of personal protective equipment (PPE) use with patients deemed low risk, resulting in staff quarantines. The cohorting strategy was perceived to lengthen time to physician initial assessment and ED length of stay times in our ED without protecting staff well enough due to varying PPE use. The objective of this study was to assess the impact of hot/cold zones for patient cohorting during a viral pandemic on ED length of stay.

Methods We conducted an interrupted time series analysis 3 weeks before and after the removal of hot/cold zone care space cohorting in our ED. In the before period, staff did not routinely wear full PPE to see cold zone patients. After removal, staff wore full PPE to see almost all patients. We collected data on ED length of stay, physician initial assessment times, arrival-to-room times, patient volumes, Canadian Triage Acuity Score (CTAS), admissions, staff hours of coverage, as well as proportions of patients on droplet/contact precautions and COVID-19 positive patients. The primary outcome was median ED length of stay.

Results After the removal of the hot/cold divisions, there was a decrease in the adjusted median ED length of stay by 24 min (95% CI 14; 33). PPE use increased in the after arm of the study. The interrupted time series analysis suggested a decrease in median ED length of stay after removal, although the change in slope and difference did not reach statistical significance.

Conclusion Cohorted waiting areas may provide a safety benefit without operational compromise, but cohorting staff and care spaces is likely to compromise efficiency and create delays.

Keywords Patient cohorting · Emergency department · ED operations · COVID-19

Résumé

Contexte La pandémie de COVID-19 a contraint les services d'urgence (SU) à modifier leur fonctionnement afin de minimiser le risque d'infection nosocomiale. De nombreux SU regroupaient des patients à l'aide d'outils de dépistage provinciaux au triage. Malgré la constitution de cohortes, les expositions du personnel se sont produites dans la "zone froide" en raison du manque d'utilisation d'équipements de protection individuelle (EPI) avec des patients jugés à faible risque, ce qui a entraîné la mise en quarantaine du personnel. Dans notre service d'urgence, la stratégie de cohorte a été perçue comme prolongeant l'évaluation initiale des médecins et la durée du séjour dans le service sans pour autant protéger suffisamment le personnel

✉ Scott Odorizzi
sodorizzi@toh.ca

¹ Department of Emergency Medicine, The Ottawa Hospital, University of Ottawa, Civic Campus, Room 254, 1053 Carling Avenue, Ottawa, ON K1Y 4E9, Canada

² Clinical Epidemiology Program, The Ottawa Hospital Research Institute, Ottawa, ON, Canada

en raison de l'utilisation variable des EPI. L'objectif de cette étude était d'évaluer l'impact des zones chaudes/froides pour le regroupement de patients lors d'une pandémie virale sur la durée du séjour à l'urgence.

Méthodes Nous avons réalisé une analyse de séries chronologiques interrompues trois semaines avant et après la suppression de la cohorte d'espace de soins en zone chaude/froide dans nos urgences. Au cours de la période précédente, le personnel ne portait pas systématiquement un EPI complet pour voir les patients des zones froides. Après le retrait, le personnel a porté un EPI complet pour voir presque tous les patients. Nous avons recueilli des données sur la durée du séjour aux urgences, les délais d'évaluation initiale par les médecins, les délais d'arrivée en salle, le volume de patients, L'échelle canadienne de triage et de gravité (ÉTG), les admissions, les heures de couverture du personnel, ainsi que les proportions de patients ayant reçu des précautions contre les gouttelettes et les contacts et de patients positifs au COVID-19. Le critère de jugement principal était la durée médiane du séjour aux urgences.

Résultats Après la suppression des divisions chaudes/froides, la durée médiane ajustée du séjour aux urgences a diminué de 24 minutes (IC à 95 % : 14 ; 33). L'utilisation des EPI a augmenté dans le groupe suivant de l'étude. L'analyse des séries chronologiques interrompues suggère une diminution de la durée médiane de séjour aux urgences après le retrait, bien que le changement de la pente et de la différence n'ait pas atteint la signification statistique.

Conclusion Les zones d'attente en cohorte peuvent offrir un avantage en matière de sécurité sans compromis sur le plan opérationnel, mais le regroupement du personnel et des espaces de soins est susceptible de compromettre l'efficacité et de créer des retards.

Clinician's capsule

What is known about the topic?

EDs have implemented various strategies to decrease nosocomial COVID-19 transmission risk, including cohorting patients based on symptoms.

What did this study ask?

What was the impact on emergency department (ED) length of stay when removing a hot/cold zone cohorting strategy for patients with symptoms consistent with COVID-19?

What did this study find?

This interrupted time series study found a 24-min decrease in ED length of stay after the removal of hot/cold zone cohorting.

Why does this study matter to clinicians?

The hot/cold zone cohorting method may lengthen ED length of stay and may evoke a false sense of security when assessing patients in the cold zone, placing staff at risk of exposure.

provincial triage screening tool [6] to determine a patient's risk of having COVID-19 and then separated our urgent care area, a high-traffic area which sees lower acuity ambulatory patients. The area normally consists of 24 assessment spaces, but was divided into a 10-bed hot zone and a 14-bed cold zone, each with an internal waiting area.

Over the pandemic, we noticed bed blocking issues with 'hot zone' patients needing to wait for a room before being placed for assessment. This led to perceived increases in physician initial assessment times and ED length of stay. Further, multiple staff exposures occurred in the 'cold zone' due to lack of personal protective equipment (PPE) use, resulting in staff isolations. Because of these exposures, our ED leadership felt the triage screening tool was ineffective and deemed that the hot/cold zone division was adding a flow barrier with no clinical or safety benefit. Consequently, the hot/cold zone was removed and staff were advised to use contact/droplet PPE for all patient encounters. Our objective was to assess the impact of hot/cold zones on ED length of stay.

Methods

Study design and time period

This was an interrupted time series analysis from February 7 to March 27, 2021, encompassing 21 days before and after dissolution of the hot/cold zone, with a 1-week buffer immediately after dissolution to allow acclimatization. This resulted in 2767 patients in the before arm and 2762 in the after arm. This study received research ethics board exemption for quality improvement initiatives.

Introduction

The COVID-19 pandemic had a dramatic impact on emergency department (ED) operations [1]. To decrease nosocomial transmission, many EDs implemented pathways to cohort patients with COVID-19 symptoms [2, 3].

Many departments [4, 5], including our own, chose to separate care areas into 'hot zones' and 'cold zones' based on the patient's risk of having COVID-19. Our ED used a

Study setting and population

This study took place at The Ottawa Hospital—General Campus ED. This initiative involved patients triaged to the urgent care area, which sees low-acuity ambulatory patients not requiring heavy nursing resources or cardiac monitoring. The urgent care area has 24 assessment spaces open 24 h/day with up to quadruple (50–64 h/day) physician coverage. There are three to four nurses in the area depending on time of day and the area sees ~ 130 patients per day, 65–70% of our daily volume.

Intervention

Before the intervention, with hot/cold zones in place, triage nurses used the provincial screening tool [6] to identify COVID-19 symptoms. Patients who screened positive were designated as ‘hot zone’ patients and contact/droplet precautions were initiated. Those who screened negative went to the ‘cold zone’. The ‘hot zone’ comprised 40% of the urgent care area and was separated from the ‘cold zone’ by physical barriers. Staff used PPE for all ‘hot zone’ patients, but not for ‘cold zone’ patients. After assessment, patients waited for results in cohorted internal waiting rooms based on their precautions, freeing up the assessment space for a new patient. Physicians were not assigned to work in a specific zone; however, nurses were split evenly between the two.

After dissolution of zoning, patients could be seen in any of the 24 assessment spaces, regardless of precautions, and staff wore PPE to see almost all patients. After physician

assessment, patients continue to cohort in separate internal waiting rooms based on their precautions. The hot zone waiting room had four chairs separated by plexiglass barriers, but if these chairs were occupied, additional patients waited in the main waiting room until reassessment.

Newly arriving patients were not cohorted in the main waiting room before or after the intervention. Plexiglass dividers were installed between chairs and physical distancing employed when possible; however, there were no physical barriers in the waiting room to prevent mixing (see Fig. 1).

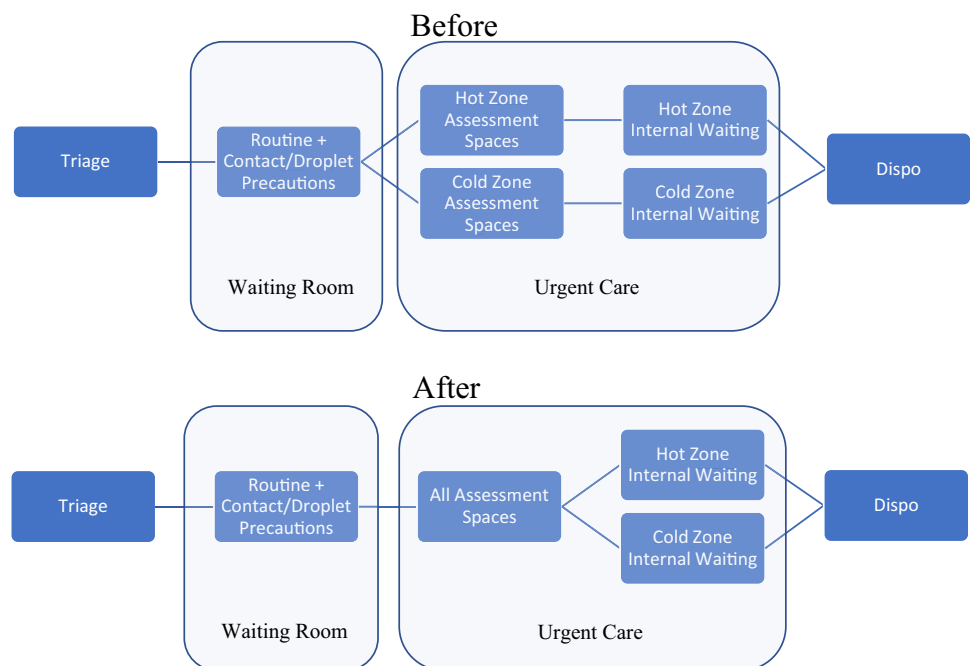
Outcome measures

The primary outcome measure was median ED length of stay. Secondary outcomes included median arrival-to-room time and median physician initial assessment time. To assess for confounders, admitted volume in the ED and urgent care, Canadian Triage Acuity Score (CTAS), daily census, the proportion of confirmed COVID-19 patients, the proportion on droplet/contact precautions, and both physician and nursing coverage hours were tracked in the before and after phases of the study.

Data analysis

Patient characteristics and institution metrics were presented using frequencies and percentages for categorical variables, and medians with interquartile ranges (IQR) and 90th percentiles for continuous variables. Characteristics

Fig. 1 Flow diagram showing the cohorting strategies before and after the intervention



of the before and after arms were compared using Chi-squared or Mann–Whitney *U* tests, as appropriate.

We conducted linear segmented autoregression of daily aggregated data to determine if the intervention was associated with a change in ED length of stay. The model included coefficients representing the level and slope before the intervention and after the intervention. Predicted ED length of stay values for the end of the study period, incorporating the effect of zoning dissolution, were compared with counterfactual values (i.e., what would have happened if zoning continued).

Linear regression analysis was conducted to adjust for patient characteristics and institution metrics that may have changed over time. These models used log-transformed outcomes and included a coefficient representing the intervention. The intercept value and changes in the outcome (for every one-unit increase in the covariate) were exponentiated to reflect time in minutes. All analyses were done using SAS 9.4 (SAS Institute Inc., Cary, NC, USA.).

Results

The urgent care area of the ED received 5529 patients during the 6-week study period. During the post-intervention phase, there were no clinically or statistically meaningful changes in daily arrivals, admitted volume, CTAS distribution, number of patients on droplet/contact precautions, number of patients with confirmed COVID-19 infection, or nursing or physician coverage hours (Table 1).

Table 2 summarizes our multiple linear regression analysis. After adjusting for patient characteristics and institution metrics, median ED length of stay decreased by 24 min (95% CI 14; 33) from the baseline of 323 min. Median arrival-to-room time decreased by 3 min (95% CI 2; 5) from a baseline of 35 min, and median physician initial assessment time decreased by 6 min (95% CI 1; 12) from a baseline of 157 min after the removal of the hot/cold division. Table 2 also summarizes the effect of other covariates. Notably,

Table 1 Baseline characteristics in the before and after periods

Patient characteristics			
Patient <i>N</i> (%)	Before (<i>N</i> =2,767)	After (<i>N</i> =2,762)	<i>p</i> -value
CTAS ⁺			0.30*
1	0%	0%	
2	17.9%	15.9%	
3	58.6%	60.0%	
4	18.0%	18.1%	
5	5.4%	5.9%	
Contact/droplet precautions	46.2%	44.4%	0.19*
COVID-19 positive	0.9%	0.6%	0.27*
ED length of stay in minutes			0.002 [^]
Median (IQR)	352 (234–483)	336.5 (238–461)	
90th percentile	686.2	609.0	
Arrival-to-room time			0.006 [^]
Median (IQR)	124.9 (53.3–210.8)	114 (52.5–194.7)	
90th percentile	288.3	274.6	
Physician initial assessment time			0.88 [^]
Median (IQR)	208.1 (124.8–297.3)	209.2 (131.6–291.5)	
90th percentile	404.1	398.6	
Institutional metrics			
<i>Daily arrivals: median (IQR)</i>			
All ED	215 (197–219)	217 (199–229)	0.55
Urgent care	129 (122–140)	133 (120–139)	0.81
<i>Admitted volume: median (IQR)</i>			
All ED	25 (22–30)	21 (19–29)	0.35
Urgent care	2 (1–4)	1 (0–3)	0.23
<i>Urgent care coverage hours: mean (range)</i>			
RNs	80 (80–80)	80 (80–84)	0.46
MDs	55 (50–64)	55 (50–64)	0.89

IQR interquartile range. ⁺CTAS is missing for four patients before and two patients after. *Chi-squared test, [^]Mann–Whitney *U* test

Table 2 Factors independently associated with ED length of stay, arrival-to-room time, and physician initial assessment time as determined by linear regression

<i>N</i> = 5,523 ⁺	ED length of stay	Arrival to room	Physician initial assessment time
Intercept (95% CI) [^]	323 min (204; 514)	35 min (18; 68)	157 min (90; 272)
Absolute change in minutes (95% CI)*			
Period			
Before	Reference	Reference	Reference
After	-24 (-33; -14)	-3 (-5; -2)	-6 (-12; -1)
CTAS ⁺			
1–2	Reference	Reference	Reference
3	-5 (-19; 9)	2 (-1; 4)	2 (-6; 11)
4	-53 (-67; -38)	2 (-1; 5)	0 (-10; 10)
5	-98 (-115; -80)	3 (-1; 7)	-21 (-33; -8)
Daily arrivals			
All ED	4 (4; 4)	1 (1; 1)	3 (2; 3)
Urgent care	-5 (-5; -4)	-1 (-1; -1)	-3 (-4; -3)
Admitted volume			
Total	2 (1; 3)	1 (0; 1)	2 (1; 2)
Urgent care	-4 (-8; 0)	0 (-1; 0)	-4 (-7; -2)
Hours of coverage			
RNs	0 (-2; 1)	0 (-1; 0)	0 (-1; 1)
MDs	-2 (-4; -1)	0 (0; 0)	-2 (-3; -1)
Contact/droplet precautions			
COVID-19 Positive	80 (68; 93)	5 (4; 7)	13 (7; 20)
	-40 (-88; 17)	-7 (-14; 1)	20 (-15; 64)

CI confidence interval. *Absolute change in the outcome for every one-unit increase in the covariate, in minutes [^]Exponentiated values to reflect time in minutes ⁺CTAS is missing for six patients

contact/droplet precautions were associated with an 80-min ED length of stay prolongation, while daily arrival rate, admitted volume and staff coverage hours (within the range studied) had minimal impact on ED length of stay.

Figure 2 is an interrupted time series plot summarizing median ED length of stay over time. This figure shows a rising ED length of stay trend of +2 min per day during the pre-intervention (cohorting) phase, a 21-min level change immediately after the elimination of cohorting, and a decreasing ED length of stay trend of 4 min per day during the post-intervention phase. These improvements are potentially clinically important but did not achieve statistical significance.

Discussion

Interpretation of findings

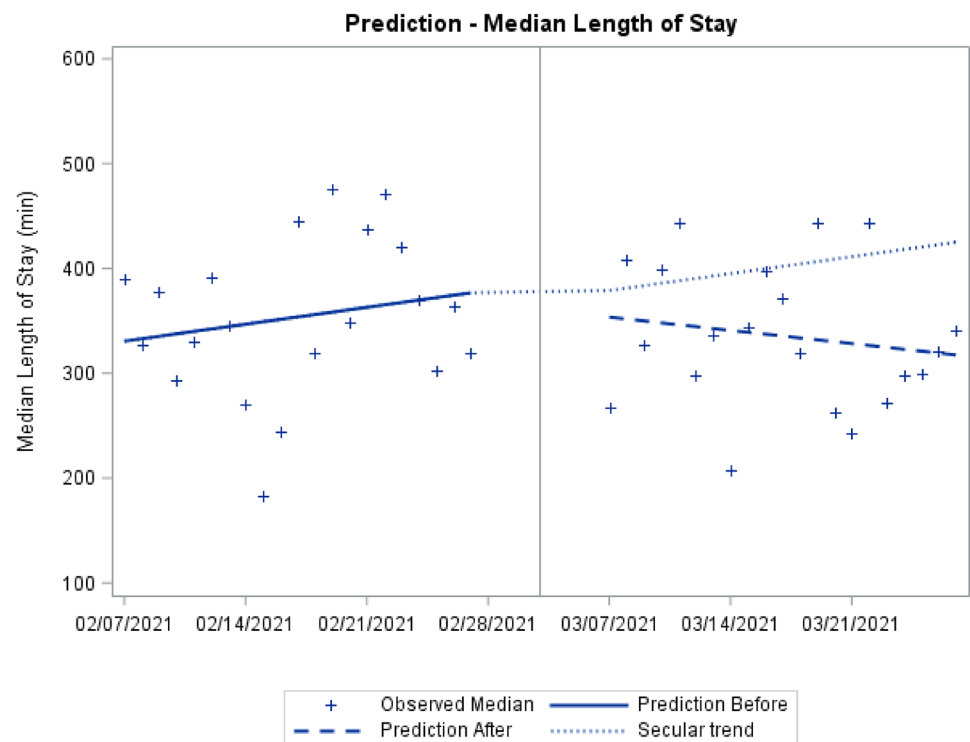
Modifying bottleneck resources such as staff and assessment spaces can have significant impacts on flow. We found that cohorting our staff and assessment spaces was associated with increased access block, room turnover times,

and order processing times. Removing this division led to potentially important flow improvements. With access to all assessment spaces, the next patient could be roomed immediately instead of waiting for a cohort-specific bed. After eliminating cohorting, median ED length of stay decreased by 24 min. We believe that reduced bed blocking led to improvements in ‘arrival-to-room’ times and physician initial assessment times.

Comparison to previous studies

While some authors [2, 3] recommend dividing care areas into hot/cold zones to decrease nosocomial infection risk, others [7, 8] suggest only cohorting patients with confirmed diagnoses. Cohorting potential COVID-19 patients has the potential to impede flow and reduce efficiency. We found that cohorting added a false sense of security for staff seeing ‘cold zone’ patients, which led to staff exposures. After eliminating assessment space cohorting and encouraging staff to wear PPE for all encounters, our departmental flow and PPE use improved, which may have reduced infection risk. We believe nosocomial risk was not increased by the elimination of cohorting. All patients were exposed to

Fig. 2 Observed and predicted median ED length of stay during the study period. Solid line shows the actual pre-intervention performance trend. Vertical line represents the intervention (elimination of ED cohorting strategy). Dotted line shows the expected post-intervention trend (counterfactual). Dashed line shows the observed post-intervention performance trend



Solid line shows actual pre-intervention performance trend. Vertical line represents the intervention (elimination of ED cohorting strategy). Dotted line shows the expected post-intervention trend (counterfactual). Dashed line shows observed post-intervention performance trend.

potential pre-assessment risk in an uncohorted main waiting room and had their own assessment room inside urgent care. Post-assessment internal waiting areas remained cohorted in both phases of the study. Since waiting areas are not bottleneck resources, cohorted waiting likely had minimal impact on flow.

Strengths and limitations

We did not track nosocomial infections, which is a study limitation, but public health and the hospital infection control unit identified no ED COVID-19 exposures after our removal of cohorting. Our interrupted time series analysis was brief; longer follow-up would have provided greater clarity regarding sustainability of our results. Finally, while the intervention was static, ED length of stay was dynamic during the post-phase, suggesting other factors may have influenced ED length of stay improvements.

Clinical implications

Cohorted waiting areas may provide a safety benefit without operational compromise, but cohorting staff and care spaces (bottleneck resources) is likely to compromise efficiency and create delays. Efforts to maximize efficiency should attempt to retain infection control practices as much as possible to minimize staff and patient nosocomial risk.

Conclusion

Cohorted waiting areas may provide a safety benefit without operational compromise, but cohorting staff and care spaces is likely to compromise efficiency and create delays.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s43678-022-00278-0>.

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Declarations

Conflict of interest The authors declare no conflicts of interest and have received no payment in the preparation of this manuscript.

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