RESEARCH

Effect of widespread restrictions on the use of hospital services during an outbreak of severe acute respiratory syndrome

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ABSTRACT

Background: Restrictions on the nonurgent use of hospital services were imposed in March 2003 to control an outbreak of severe acute respiratory syndrome (SARS) in Toronto, Ont. We describe the impact of these restrictions on health care utilization and suggest lessons for future epidemics.

Methods: We performed a retrospective population-based study of the Greater Toronto Area (hereafter referred to as Toronto) and unaffected comparison regions (Ottawa and London, Ont.) before, during and after the SARS outbreak (April 2001–March 2004). We determined the adjusted rates of hospital admissions, emergency department and outpatient visits, diagnostic testing and drug prescribing.

Results: During the early and late SARS restriction periods, the rate of overall and medical admissions decreased by 10%–12% in Toronto; there was no change in the comparison regions. The rate of elective surgery in Toronto fell by 22% and 15% during the early and late restriction periods respectively and by 8% in the comparison regions. The admission rates for urgent surgery remained unchanged in all regions; those for some acute serious medical conditions decreased by 15%–21%. The rates of elective cardiac procedures declined by up to 66% in Toronto and by 71% in the comparison regions; the rates of urgent and semi-urgent procedures declined little or increased. High-acuity visits to emergency departments fell by 37% in Toronto, and inter-hospital patient transfers fell by 44% in the circum-Toronto area. Drug prescribing and primary care visits were unchanged in all regions.

Interpretation: The restrictions achieved modest reductions in overall hospital admissions and substantial reductions in the use of elective services. Brief reductions occurred in admissions for some acute serious conditions, high-acuity visits to emergency departments and inter-hospital patient transfers suggesting that access to care for some potentially seriously ill patients was affected.

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In spring 2003 the largest outbreak of severe acute respiratory syndrome (SARS) outside Asia occurred in Toronto, Ont., including 257 probable cases and 43 deaths.[1] Transmission of SARS was largely confined to hospitals through contact with infected patients. To limit the spread of SARS, a provincial health emergency was declared, with widespread restrictions on the nonurgent use of hospital-based services at all 32 hospitals in the Greater Toronto Area. Ambulatory and inpatient medical and surgical activity was restricted to urgent cases, and respiratory isolation rooms were expanded. In addition, visitor access was severely restricted, and the use of personal protective equipment by staff in high-risk areas was mandated. Three community hospitals were closed for a few weeks to several months. A centralized system was created to screen all requests for inter-hospital patient transfers.[2] These restrictions lacked measures to mitigate the impact on potentially vulnerable patients, such as those with chronic diseases, elderly patients and low-income patients.

Our objectives were to determine the extent to which these restrictions reduced the use of elective hospital-based services. We also sought to determine whether these restrictions disrupted urgent services or affected vulnerable patient groups and whether there were spillover effects into other sectors of the health care system or areas of the province that were not targeted by the restrictions. The results of our study may assist health care planners in designing large health care systems with better adaptability during epidemics, when restrictions may be needed to limit nosocomial spread or to increase hospital capacity.

Methods

The study population comprised all Ontario residents with a valid health insurance number who resided in the Greater Toronto Area (hereafter referred to as Toronto), London or Ottawa from March 2000 to April 2004. All of the hospitals that were subject to SARS restrictions were located in Toronto. Ottawa and London were chosen as regions for comparison because they are large urban centres with multiple hospital sites and tertiary care hospitals that form organizationally complex, self-contained health care systems and because they are sufficiently distant from Toronto to make

travel for medical care unlikely. Regions were created by aggregating hospital service areas representing local health care markets for community-based inpatient care.[3,4] We created an additional region, the circum-Toronto region, to allow for analyses of inter-hospital patient transfers. This region was defined as hospital service areas from which more than 20% of acute-care patient transfers are to Toronto hospitals.

Patient records were linked using unique patient identifiers across multiple Ontario health administrative databases containing information about publicly insured health care services. We used the Discharge Abstract Database for hospital admissions, procedures and acute care transfers; the National Ambulatory Care Reporting System for emergency department visits and emergency department-to-hospital transfers (excluding Ottawa owing to incomplete data); the Ontario Health Insurance Plan (OHIP) for physician billing for outpatient visits and diagnostic tests; the Ontario Drug Benefits Program for drug prescriptions; and the Ontario Registered Persons Database for patient residence (postal code), demographic information and deaths. Admission diagnoses were captured in the Discharge Abstract Database using ICD-9 (International Classification of Diseases, 9th revision) codes before, and ICD-10-CA (ICD, 10th revision, Canadian version) codes after, Apr. 1, 2002. For specific causes of admission to hospital, the diagnosis most responsible for length of stay, excluding complications, was used. The degree of urgency was obtained from the admission category. Procedures were identified using the Canadian Classification of Procedures before Apr. 1, 2002, and the Canadian Classification of Interventions thereafter. Acuity of emergency department visits was measured using the Canadian Triage and Acuity Scale, grouped as high (resuscitative and emergent), medium (urgent) and low (less urgent and nonurgent). Physician specialty was determined by OHIP codes. Population and neighbourhood income information was derived from Statistics Canada 2001 census estimates.

Hospital admission rates were reported as overall, medical (admission with no operative procedure) and elective or urgent surgical (based on the 20 procedures with the highest volume). Cardiac revascularization procedures were reported by urgency and by type (coronary artery bypass graft or percutaneous coronary intervention). Inter-hospital patient transfers were not counted as readmissions. Cause-specific admissions were reported for select conditions among adults 20 years and older and for obstetric deliveries among women aged 15–44 years. In addition, 3 specific groups of conditions were chosen for study: acute conditions for which physician consensus exists regarding diagnosis and need for admission to hospital (births, hip fracture, acute myocardial infarction and intracranial hemorrhage);[5,6] acute conditions for which patient or physician discretion exists in diagnosis or management or that require complex coordination of multiple health system resources (pulmonary embolism, ruptured abdominal aortic aneurysm, respiratory cancer, gastrointestinal bleed);[6,7] and ambulatory care sensitive conditions for which lack of access to timely and effective outpatient care may result in avoidable admission to hospital (chronic obstructive pulmonary disease, congestive heart failure).[8–10] Ambulatory care visits to cardiologists and general internists and primary care visits (overall, prenatal, well baby and immunizations for children aged ≤ 2 years) were reported. Outpatient diagnostic tests excluded multiple tests to the same patient on the same day. Prescriptions for select evidence-based drug therapies were reported for patients 65 years and older who did not reside in long-term care facilities. Inter-hospital patient transfers were reported according to patient location at the sending facility (inpatient or emergency department).

We computed the crude rate (total number of events divided by the corresponding population) for each outcome, according to age group, sex, week and region. Rates were indirectly adjusted for age and sex to the provincial rates in 2001.[11] We defined the beginning of the SARS epidemic as Mar. 15, 2003 (the date of formal notification of an outbreak of atypical pneumonia). The SARS restriction periods were categorized as early (Mar. 15–May 14, 2003) and late (May 15–July 14, 2003) to evaluate the temporal nature of the response to the restrictions.

To model the temporal patterns of health care utilization, we used generalized estimating equations for clustered count data to account for correlations among outcomes over time, using an autoregressive correlation structure with periods of 4 weeks.[12,13] The unit of analysis was age group, sex and week stratum. The dependent variable was the event count in each stratum. We used separate Poisson regression models for each outcome and region, with stratum population as the offset parameter. Models were adjusted for age group (< 5, 5–19, 20–45, 45–54, 55–64, 65–74, 75–85, ≥ 85 years), sex and interaction of age group and sex. We combined the estimates from London and Ottawa because the results were similar. We stratified by age (< 64 v. ≥ 65) and income (below v. above median) to see whether the restrictions affected these 2 groups differently.

We used data from March 2000 to March 2003 to model the pre-SARS trends, and we projected these trends to the early and late restriction periods to obtain the predicted rates in the absence of the restrictions. Long-term temporal trends in the pre-restriction period were modelled with the use of linear or quadratic terms. We modelled the seasonal cyclical fluctuations in the pre-restriction period using variables for the 12 calendar months, because annual peaks and troughs for each outcome showed similar patterns. We computed the predicted rate for a specific calendar month in the post-restriction period was computed as the adjusted rate for the corresponding pre-restriction month, incorporating the annual trend. The relative change in utilization rates after the restrictions were imposed was obtained by exponentiating the linear combination of regression parameters corresponding to the difference in observed and predicted post-restriction monthly terms. We defined a significant change as 2 consecutive months with a statistically significant relative change (> 5%). Return to baseline occurred when there was no significant difference for 2 consecutive months.

All statistical tests were computed at the 5% level of significance and were 2 sided. The institutional research ethics board of the Sunnybrook and Women's College Hospital approved this study.

Results

Both overall and medical admission rates decreased by 10%–12% in Toronto during both the early and late SARS re-
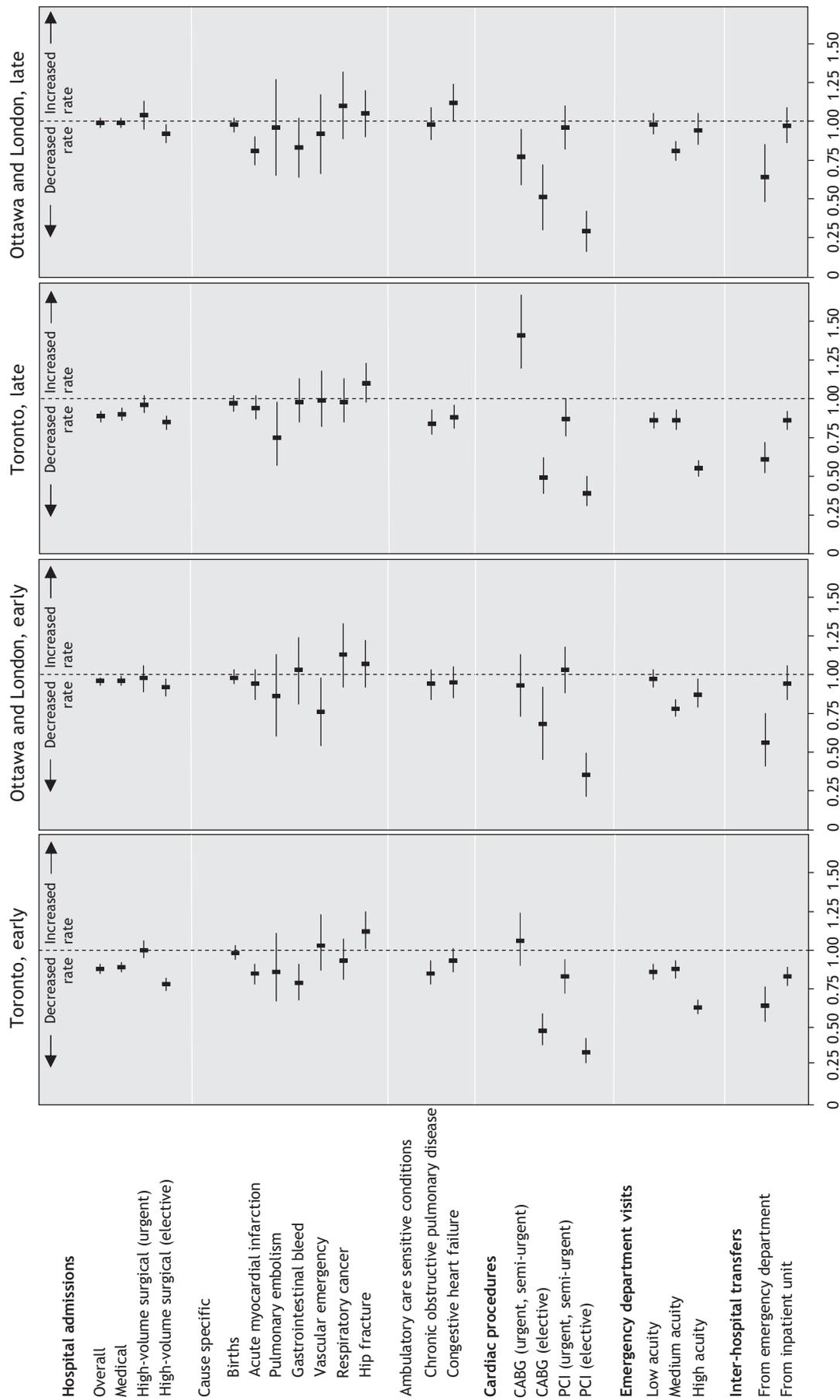
Fig. 1: Hospital services utilization in Toronto and comparison regions in Ontario (Ottawa and London) during the 2003 outbreak of severe acute respiratory syndrome (SARS). Adjusted relative changes (and 95% confidence intervals) are presented in the rates of hospital admissions, cardiac procedures, emergency department visits and inter-hospital patient transfers during the early (Mar. 15 to May 14, 2003) and late (May 15 to July 14, 2003) hospital utilization restriction periods compared with baseline rates during the pre-SARS period (March 2000 to March 2003). Note: CABG = coronary artery bypass graft, PCI = percutaneous coronary intervention.

striction periods. There was no change in these rates in the comparison regions. During the early and late restriction periods, the rate of elective surgery in Toronto decreased by 22% and 15% respectively. In both periods, this rate decreased by 8% in the comparison regions. The rate of urgent surgery remained unchanged in all regions (Fig. 1, Fig. 2, Appendix 1 [available online at www.cmaj.ca/cgi/content/full/176/13/1827/DC1]). To put this in context, across Ontario in 2001/02 (the middle year of the pre-SARS period) 71% of all admissions (excluding births) were elective and 42% of all admissions were surgical.

The rate of elective percutaneous coronary intervention and coronary artery bypass graft declined dramatically in both the early and late periods in all regions. The rates of urgent and semi-urgent percutaneous coronary intervention and coronary artery bypass graft declined little or increased. Admission rates in Toronto returned to baseline levels within 3 to 6 months of the start of the restrictions, except for the rates of coronary artery bypass graft and elective percutaneous coronary intervention, which did not recover in the post-SARS period (Fig. 1, Fig. 2, Appendix 1 [available online at www.cmaj.ca/cgi/content/full/176/13/1827/DC1]).

The decrease in the rate of emergency department visits was 3 times greater for high-acuity visits than for low-acuity visits in Toronto; this decrease was much smaller in the comparison regions (Fig. 1, Appendix 1 and 2 [available online at www.cmaj.ca/cgi/content/full/176/13/1827/DC1]). The rates of admission because of acute myocardial infarction and gastrointestinal bleeds fell substantially in Toronto but returned to expected levels within 1 to 2 months. The rate of admission rates because of ambulatory-care sensitive conditions was lower than expected only in Toronto and returned to expected levels within 4 months.

The overall rate of primary-care visits did not change in any region. Visits for childhood immunizations and well-baby care dropped slightly in Toronto but returned to expected levels within 1 to 2 months. Visits to cardiologists and internists dropped by 18% in Toronto and took 6 months to return to expected levels. Utilization of complex outpatient diagnostic tests (magnetic resonance imaging, cardiac catheterization) decreased in Toronto more than the utilization of simple tests (electrocardiogram, echocardiogram). There was no change in the rate of essential drug prescribing in any region (Appendix 3 and 4 [available online at www.cmaj.ca/cgi/content/full/176/13/1827/DC1]).

The largest decrease in the rate of emergency department-to-hospital transfers occurred in the circum-Toronto region (Fig. 1, Appendix 5 [Available online at www.cmaj.ca/cgi/content/full/176/13/1827/DC1]). Decreases in this rate persisted in the late SARS restriction period in the Toronto and circum-Toronto regions. The rate of transfer of inpatients between acute care hospitals decreased in Toronto and to a lesser extent in the comparison regions; no declines were seen in the circum-Toronto region.

There was no meaningful difference in the results for different age or income groups in any model.

Interpretation

Restrictions on the use of hospital services resulted in a 12% decrease (95% confidence interval [CI] 9%–15%) in the overall rate of hospital admissions in Toronto, a modest decline given
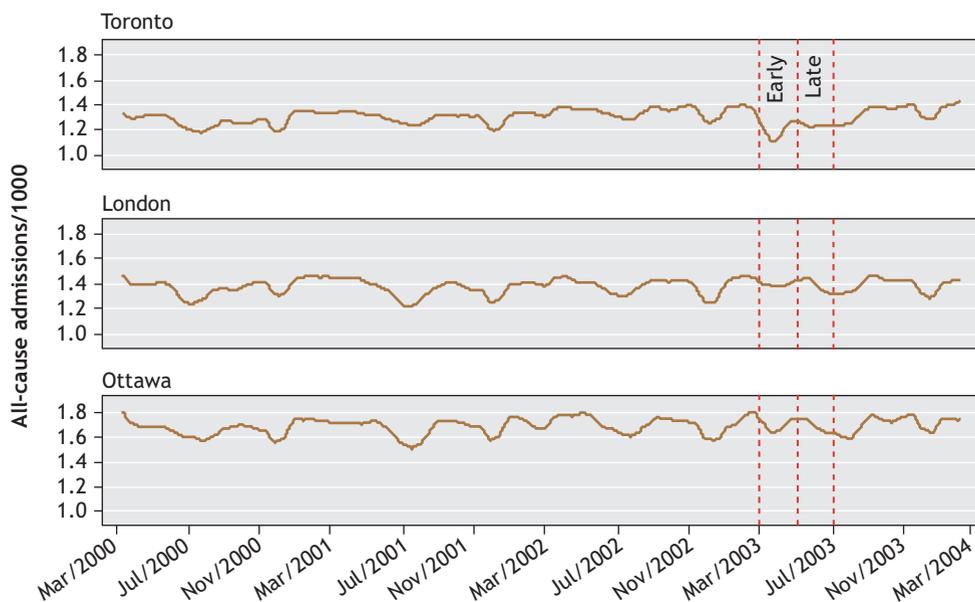

Fig. 2: Weekly rates of all-cause hospital admissions in Toronto and 2 comparison regions (Ottawa and London, Ont.) before the 2003 outbreak of severe acute respiratory syndrome (SARS; Mar. 14, 2000, to Mar. 14, 2003), during the early (Mar. 15, 2003, to May 14, 2003) and late (May 15, 2003, to July 14, 2003) restriction periods, and after the restrictions had been lifted (July 2003 to March 2004).

7 of 10 admissions were for elective procedures before the SARS restrictions. Large decreases were seen in the rate of elective cardiac revascularization procedures, high-acuity emergency department visits and emergency department to hospital transfers. Moderate decreases were seen in the rate of noncardiac elective surgery, outpatient diagnostic testing, inpatient transfers and specialist visits, and small decreases were seen in the rate of medical admissions. There were no decreases in the rates of urgent surgery, primary care visits or essential drug prescribing. Vulnerable subgroups were not differentially affected. Use of nonurgent hospital services returned to expected levels within 4 to 6 months after the start of the restrictions. As intended, the restrictions had the greatest effect on reducing the number of elective admissions and procedures, and there was minimal spillover effect into other parts of the health care system in Toronto. There were small, short-lived decreases in hospital services utilization in the comparison regions.

The rates of elective cardiac procedures decreased by as much as 66%, compared with a 22% decrease in the rate of elective noncardiac surgery. The different effect of the SARS restrictions on these 2 rates probably reflects the fact that these cardiac procedures are highly regionalized through a central network[14] that manages regional wait lists, with priority determined based on uniform, clinically derived definitions of urgency.[15] This resulted in a more coordinated and substantial reduction in elective procedures in response to the SARS outbreak than was observed for other surgical services, which are less regionalized and lack a coordinated process for prioritizing procedures.

Some unintended consequences of the restrictions occurred. Decreases in admissions because of acute myocardial infarction, gastrointestinal bleed and pulmonary embolism were seen, although these decreases were largely confined to Toronto and returned to baseline rates within 1 to 2 months after the start of the restrictions. Inter-hospital patient transfers declined (primarily in the circum-Toronto region), as did the rate of high-acuity visits to emergency departments. These changes suggest that some potentially seriously ill patients did not present to hospital, and access to specialized care may have been more limited than in the pre-SARS period. Patients' fear of seeking hospital-based care may have been an important determinant of hospital services utilization during the SARS outbreak. Changes in physician decision-making (e.g., altered admission and inter-hospital transfer thresholds) may have also occurred, although this seems less probable for conditions such as acute myocardial infarction, because care is more standardized for this condition. Planners should consider ways to mitigate these unintended consequences, such as the use of a telephone advice line to encourage appropriate use of hospital services and the development of protocols that ensure continued access to highly regionalized programs.

Our findings suggest that the ability of a health care system to admit large numbers of affected patients during a community-based outbreak (surge capacity) will be limited by continued high levels of hospital occupancy.[16–18] Plans to increase surge capacity by restricting nonurgent use of hospital services[17,18] result in only modest increases in capacity. For example, the 12% decrease in the overall rate of hospital admissions seen during the SARS re-

striction period could represent as little as one-quarter of the expected number of admissions if an influenza pandemic were to occur in Toronto.[19] More effective implementation of restrictions on elective procedures should be possible, since 7 of 10 admissions in Ontario are for elective procedures. Reducing admissions for elective procedures would require common definitions of urgency, such as the uniform patient prioritization guidelines[20] recently developed in Ontario for elective knee and hip arthroplasty.[21] These measures are being implemented to reduce wait times and to increase the appropriate use of hospital resources under normal circumstances, but they might have the added benefit of improving the responsiveness of the health care system if hospital use must be restricted.

Our study is affected by some limitations. Administrative data lack the rich clinical detail found in medical charts; thus, it was not possible to determine the severity of certain conditions such as acute myocardial infarction and gastrointestinal bleed. Some inaccuracy in administrative data is inevitable because these data are not collected for research purposes; however, recent studies have confirmed the validity and reliability of using administrative data to study Canadian health services.[22–29] Our study is of population-based trends, and it is unlikely that coding accuracy varied meaningfully over time or between regions during the study period. Data were not available for out-of-hospital deaths or births.

The SARS-related restrictions resulted in an intended but modest decrease in the rate of admissions for elective procedures; however, hospitals subject to the restrictions continued to allow elective admissions. Most urgent services were preserved, but some unintended consequences did occur. The restrictions as implemented would have resulted in only a modest increase in hospital surge capacity. Restrictions on hospital services utilization during an outbreak should be accompanied by public health initiatives that encourage the continued use of the health care system by patients with potentially serious conditions. Policies are needed to ensure continued access to specialized and regionalized health services.

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