# 2021 NEDI-Singapore study: an updated inventory of emergency department characteristics

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## Abstract

**Introduction:** The last national emergency department (ED) inventory was performed in 2007, and major changes in population demographics, healthcare needs and infrastructure have since occurred. We sought to obtain an updated inventory of EDs in Singapore to identify and describe changes in their characteristics and capabilities across the years.

**Methods:** In 2021, the National Emergency Department Inventories (NEDI) instrument was administered to the leadership of Singapore EDs. Emergency departments in Singapore are opened round the clock, have no restrictions on who can access care and are equipped to handle general medical emergencies. The questionnaire comprises 16 items across three categories: (a) general characteristics, (b) patient volume and (c) medical capabilities.

**Results:** We achieved 100% response rate from all 17 EDs — nine EDs in public hospitals and eight in private hospitals. In 2021, the EDs saw a total of 1,140,388 visits, an increase of 27% from 2007, with the median number of visits almost doubling (from 39,450 to 77,989); 41% and 59% of the EDs reported over 20% of visits arriving by ambulance and over 20% of visits resulting in inpatient admission, respectively. A clear distinction between public and private EDs across these metrics remained. Medical capabilities grew: 59% had access to a dedicated computed tomography scanner (up from 46%) and 82% had negative pressure isolation facilities (up from 54%). Overall, 41% of EDs self-assessed to be operating above their capacity.

**Conclusion:** Singapore EDs have progressed in capabilities and capacity. Despite this, the increasing volume, complexity and acuity of patients are imposing strains on the emergency care system, signalling potential for systems improvement.

**Keywords:** Emergency care systems, emergency department, health policy, Singapore

## INTRODUCTION

Singapore is a small Southeast Asian city-state with a land area of 734.3 km$^2$ (283.5 square miles).[1] Its population size has increased, from 4.59 million in 2007 to 5.64 million in 2021.[2] Singapore's healthcare system comprises private and public hospitals, with public (also termed 'restructured' as they function as private companies wholly owned by the government) hospitals funded through a system of compulsory savings, subsidies and price controls.[3] Emergency medicine (EM) was first recognised as a speciality in Singapore in 1984, and there are now a total of 234 registered emergency physicians (EPs).[4] Since the establishment of the first modern emergency department (ED) at Singapore General Hospital, Singapore, in 1948, a number of EDs have since been established in both the private and public sectors.[5] They play crucial roles in the provision of emergency healthcare in Singapore.

A national inventory of Singapore's ED (National Emergency Department Inventories [NEDI]-Singapore) was first

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## SUMMARY BOX

### What is known?

The last inventory of Singapore's Emergency Departments (EDs) was in 2007. There have been notable changes in population growth and healthcare infrastructure since then.

### What is new?

The 2021 survey of 17 EDs shows a 27% increase in patient visits and improved capabilities, such as more EDs with CT scanners and isolation facilities. Despite these advancements, many EDs are operating above capacity.

### What is the impact?

The findings indicate that while ED capabilities have improved, the system is under strain from rising patient volumes and complexity, highlighting the need for further enhancements to emergency care infrastructure.

conducted in 2007 using the NEDI instrument.[6] The NEDI is an international collaboration with ongoing surveys around the world to provide a benchmark for ED capabilities based on a set of internationally comparable characteristics.[7] The 2007 NEDI-Singapore study, which provided a useful baseline for serial measurement of emergency care capabilities across the nation, found that patient characteristics and capabilities of EDs varied according to whether they were in public or private hospitals.[6]

Subsequently, key events have affected the EM landscape in Singapore, prompting reflection on whether ED processes and workflows require a reassessment. The major events that have impacted EM in Singapore over the last 14 years include the opening of three new public hospitals, the establishment of two urgent care centres and the coronavirus disease 2019 (COVID-19) pandemic.[8] The COVID-19 pandemic took a heavy toll on ED capacities[9] and healthcare staff.[10] Singapore identified its first COVID-19 case in January 2020.[11] These events have necessitated an update on the 2007 inventory of all EDs in Singapore. For this first follow-up study in the global NEDI collaboration, which occurred during the management of the COVID-19 pandemic, we quantified the evolution of ED characteristics against the backdrop of events that occurred over the years. The objective of this updated inventory was to provide an indication of how the standard of emergency care in Singapore had evolved over the years, and to better plan for future infrastructure and workforce planning decisions.[12]

## METHODS

This was a cross-sectional survey administered in early 2022, with reference to data from calendar year 2021, in the midst of the COVID-19 pandemic. A sampling frame was designed to enumerate every eligible ED by searching the lists of healthcare facilities, including those from the Ministry of Health, Singapore, and verified for completeness by several authors. Consistent with the case definition used in NEDI-USA to permit valid global comparisons, eligible EDs were those that fulfilled all three criteria: (a) open round the clock, (b) without restrictions on who can access care, and (c) equipped to handle general medical emergencies.

The department head/manager of each ED was invited to participate in this study through email. They were allowed to jointly respond, or delegate this task to, a senior member of their staff. The NEDI instrument was administered to these EDs using a secure web-based survey tool (FormSG, Government Technology Agency, Singapore).

The questionnaire was materially similar to the one used in the 2007 NEDI-Singapore study, with minor revisions made for clarity and data granularity. The questionnaire comprises 16 items, which were divided into three categories: (a) general characteristics (inclusive of both the 'ED characteristics' and 'ED patient characteristics' categories from 2007), (b) patient volume, and (c) medical capabilities. General characteristics included whether they functioned as an official department in a hospital organisation, facility contiguity, capacity and triage systems. Patient volume was assessed based on objective measures such as ED attendance, conveyance, admission data, and data in the 2021 Ministry of Health statistical bulletin, and a subjective general assessment by the department head. Medical capabilities included organic ED staff and availability of specialist support from other medical and surgical disciplines, the types of medical emergencies that could be managed in ED and specific resources available in ED. Descriptive statistics were reported as counts and percentages. Statistical analysis was performed using Microsoft Excel 2021. Ethics approval for this study was obtained from the SingHealth Centralised Institutional Review Board (Reference: 2021/2726).

## RESULTS

### General characteristics

The general characteristics of the EDs are shown in Table 1. All 17 EDs (response rate 100%) in Singapore participated in the study; they were all independent departments operating in contiguous facilities within hospitals. Nine (53%) EDs were in public hospitals, while the remaining eight (47%) EDs were in private hospitals. Sixteen (94%) EDs saw both adults and children, and one (6%) ED saw only children. Across Singapore, the EDs had a total of 628 ED beds, a two-fold increase from 2007 (287 beds), with the majority of beds (555 beds; 88%) being in public healthcare institutions. Similarly, 58 out of 70 (83%) resuscitation bays were situated in public EDs.

All EDs triaged patients by clinical acuity, and the most common triage systems used were the Singapore Patient Acuity Category Scale (65% of EDs) and the Australasian Triage Scale (18% of EDs). While these systems have proven useful for optimising resource utilisation within each institution,

**Table 1. General characteristics and patient volumes of emergency departments (ED) in Singapore.**

| Variable | Proportion of EDs | | | |
|---|---|---|---|---|
| | 2007 ($n$=13)[a] | 2021 ($n$=17)[a] | Public sector, 2021 ($n$=9) | Private sector, 2021 ($n$=8) |
| General characteristics, % | | | | |
| Open 24/7 | 100 | 100 | 100 | 100 |
| Hospital based | 100 | 100 | 100 | 100 |
| Independent department | 92 | 100 | 100 | 100 |
| Contiguous facility | 100 | 100 | 100 | 100 |
| Capacity, *n* | | | | |
| No. of resuscitation bays | – | 70 | 58 | 12 |
| Total no. of beds | 287 | 628 | 555 | 73 |
| Triage, % | | | | |
| By clinical acuity | – | 100 | 100 | 100 |
| By speciality field | – | 0 | 0 | 0 |
| By triage-trained nurses | – | 88 | 100 | 75 |
| By senior doctors | – | 6 | 0 | 13 |
| Collect ED fees before consultation | – | 24 | 34 | 13 |
| Patient volume | | | | |
| Annual ED attendances, *n* | | | | |
| *Median visits* | 39,450 | 77,989 | 105,752 | 23,401 |
| *Mean visits* | 69,308 | 67,082 | 10,5992 | 24,857 |
| *Total visits* | 901,002 | 1,140,388 | 953,931 | 198,858 |
| General assessment, % | | | | |
| *Under capacity* | 23 | 18 | 11 | 25 |
| *Good balance* | 31 | 12 | 11 | 13 |
| *At capacity* | 38 | 29 | 11 | 50 |
| *Over capacity* | 8 | 41 | 67 | 13 |
| Percentage of ED patients arriving by ambulance, % | | | | |
| <20 | 100 | 53 | 22 | 88 |
| 20–39 | 0 | 41 | 78 | 0 |
| Unknown | 0 | 6 | 0 | 13 |
| Percentage of hospital admissions through ED, % | | | | |
| <20 | 15 | 35 | 11 | 63 |
| 20–39 | 0 | 12 | 0 | 25 |
| 40–59 | 15 | 12 | 22 | 0 |
| 60–79 | 8 | 12 | 22 | 0 |
| ≥80 | 23 | 24 | 44 | 0 |
| Unknown | 38 | 6 | 0 | 13 |
| Percentage of ED visits leading to admission, % | | | | |
| <20 | 46 | 35 | 22 | 50 |
| 20–39 | 38 | 47 | 56 | 38 |
| 40–59 | 0 | 6 | 11 | 0 |
| 60–79 | 0 | 6 | 11 | 0 |
| Unknown | 15 | 6 | 0 | 13 |
| Average length of stay in ED, % | | | | |
| <1 h | 23 | 18 | 11 | 25 |
| 1–6 h | 77 | 65 | 56 | 75 |
| >6 h | 0 | 18 | 34 | 0 |
| Average waiting time for inpatient bed, % | | | | |
| <1 h | – | 12 | 0 | 25 |
| 1–6 h | – | 59 | 44 | 75 |
| >6 h | – | 29 | 56 | 0 |

The response rate was 100%.

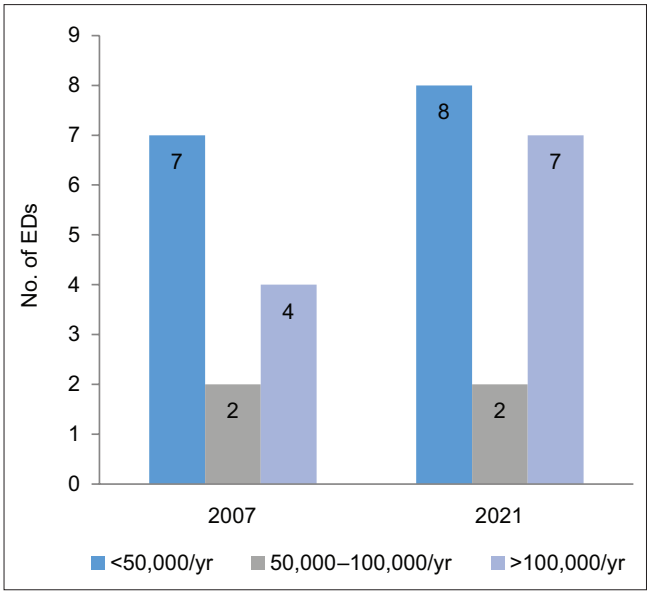


**Figure 1.** Graph shows the volume of annual attendance of Singapore emergency departments (EDs) in 2021 as compared to 2007.

this discrepancy might present challenges in tracking patient demographics at a national level. None of the EDs had triage to service (i.e. triage of patients to a specific speciality field). Triage was primarily conducted by triage-trained nurses (88%), with one (6%) ED deploying a senior doctor in this role.

## Patient characteristics

The general characteristics and patient volumes of the EDs are shown in Table 1. In 2021, the 17 EDs collectively saw 1,140,388 visits (202 visits per 1000 population), which was 27% more than that of 2007 (901,002 visits, 196 visits per 1000 population). Public sector ED visits accounted for 84% of total patient volume. The median number of ED visits almost doubled from 39,450 to 77,989. The 2007 study stratified EDs into three groups based on visit numbers, and the figures for the same groups in 2021 are shown in Figure 1. (1) Annual attendance of <50,000 patients — eight EDs were in this group (seven private and one public), with a mean visit volume of 11,984 (range 3120–26,000) for adults and 4111 (range 85–12,401) for children. (2) Annual attendance of 50,000–100,000 patients — two EDs were in this group (one private and one public), with a mean visit volume of 83,995 (discrete visits). (3) Annual attendance of >100,000 patients — all seven EDs were in the public sector, of which six were adult hospitals that saw both adults (mean visit volume 108,967 [range 98,896–126,000]) and children (7723 [573–12,600]), and one was a children's ED with an annual visit volume of 150,000 children.

The EDs also saw a rise in the number of patients presenting with higher acuity, with 41% of EDs (0% in 2007) reporting >20% of their patients arriving by ambulance. In seven out of nine public EDs, between 20% and 39% of patients arrived by ambulance. In the remaining two public EDs and in all eight private EDs, <20% of the patients arrived by ambulance. Up to 59% (38% in 2007) of EDs reported that >20% of their visits eventually resulted in in-hospital admission. All these were public EDs. Only one public ED (an urgent care centre) and all private EDs reported <20% of their visits resulting in in-hospital admission. Among the public EDs, only two had between 40% and 59% of all inpatients coming through ED. In the other six EDs, more than 80% of their inpatients were admitted through ED. The ED remains a major source of in-hospital admissions for public sector hospitals, with six out of nine public sector EDs reporting that the ED contributed to >80% of in-hospital admissions, while two EDs reported that the ED contributed 40%–59% of their in-hospital workload. In contrast, all eight private sector EDs and the urgent care centre in the public hospital contributed to <40% of their hospitals' in-hospital admissions, with only two providing 20%–39% of their inpatient hospital load and the others providing <20% of their inpatient hospital load. None of the EDs required the patients to have a referral from a primary care practitioner or other doctors to receive emergency care.

## Capacity

The rise in workload is also reflected in the self-assessment of ED capacity, with a much higher proportion of EDs in 2021 reporting that they were operating above capacity as compared to EDs in 2007 (41% vs. 8%) [Table 1]. In two of the private hospitals and the single public sector urgent care centre, the average duration of patient stay in ED was <1 h. In all the other private EDs and four of the public EDs, the mean duration of ED stay was within 1–6 h. However, in the remaining three EDs, the average duration of stay exceeded 6 h. Nearly one-third of EDs (all from the public sector) reported average waiting times for inpatient beds exceeding 6 h. Once a decision to admit the patient as an inpatient was made, five of the public EDs reported that patients waited an average of >6 h for their inpatient bed. Each of these EDs served >100,000 patients per annum. The other four public EDs and six of the private EDs reported an average wait of between 1 h and 6 h for an inpatient bed. Two private EDs reported an average wait time of <1 h for an inpatient bed.

Up to 53% of EDs initiated requests for ambulance diversion, if they perceived that patient loads exceeded the resources available. Of those that requested for ambulance diversion, 56% were in the public sector.

## Resources and capabilities

The medical capabilities of EDs in Singapore are shown in Table 2. All the EDs had a physician on-site on a 24/7 basis. Only the nine public sector EDs (53%) had specialist board-certified EPs physically present 24/7, while three private sector EDs had board-certified EPs on staff but not throughout the day. Round-the-clock in-person support was widely available, except from psychiatry (available in

**Table 2. Medical capabilities of emergency departments (ED) in Singapore.**

| Variable | Proportion of EDs, % | | | |
|---|---|---|---|---|
| | 2007 ($n$=13)[a] | 2021 ($n$=17)[a] | Public sector, 2021 ($n$=9) | Private sector, 2021 ($n$=8) |
| Organic staff | | | | |
| Physician in ED 24/7 | 100 | 100 | 100 | 100 |
| Emergency physician in ED 24/7 | – | 65 | 100 | 0 |
| Specialist support available 24/7 | | | | |
| General surgeon | 92 | 82 | 100 | 63 |
| Orthopaedic surgeon | 92 | 76 | 89 | 63 |
| Anaesthesiologist | 84 | 71 | 89 | 50 |
| Cardiologist | 92 | 71 | 78 | 63 |
| Neurosurgeon | 84 | 71 | 89 | 50 |
| Plastic surgeon | 69 | 65 | 67 | 63 |
| Neurologist | 77 | 59 | 56 | 63 |
| Obstetrician–Gynaecologist | 77 | 47 | 34 | 63 |
| Psychiatrist | 69 | 29 | 34 | 25 |
| Emergencies managed in ED 24/7 | | | | |
| Cardiology (e.g. arrhythmia, acute myocardial infarction) | 92 | 100 | 100 | 100 |
| Medical (e.g. urinary tract infection, acute asthma) | 100 | 100 | 100 | 100 |
| Urological (e.g. kidney stone) | 100 | 100 | 100 | 100 |
| Ear, Nose, Throat (e.g. severe epistaxis) | 92 | 100 | 100 | 100 |
| Orthopaedic surgery (e.g. long bone fractures) | 92 | 100 | 100 | 100 |
| General surgery (e.g. acute appendicitis, pneumothorax) | 100 | 100 | 100 | 100 |
| Oromaxillofacial surgery (e.g. jaw fractures, oral abscesses) | 62 | 94 | 100 | 88 |
| Plastic surgery (e.g. severe lip laceration) | 84 | 94 | 89 | 100 |
| Neurological and neurosurgical (e.g. acute thromboembolic stroke, ICH) | 84 | 88 | 89 | 88 |
| Ophthalmological (e.g. acute glaucoma, eye injury) | 92 | 88 | 89 | 88 |
| Hand surgery (e.g. tendon injury) | 92 | 88 | 78 | 100 |
| Oncology (e.g. fever and neutropenia) | 100 | 82 | 78 | 88 |
| Trauma (e.g. motor vehicle crash, gunshot wound) | 92 | 82 | 100 | 38 |
| Toxicological (e.g. overdose, carbon monoxide poisoning) | 92 | 82 | 89 | 75 |
| Gynaecological (e.g. ruptured ovarian cyst, yeast infection) | 84 | 71 | 44 | 100 |
| Obstetrical (e.g. complications of pregnancy) | 77 | 65 | 34 | 100 |
| Psychiatric (e.g. psychosis) | 77 | 59 | 56 | 63 |
| Dental (e.g. tooth extraction) | 69 | 47 | 56 | 63 |
| Medical resources | | | | |
| Diagnostic modalities | | | | |
| *Clinical laboratory or blood gas analyser* | – | 94 | 100 | 88 |
| *Point-of-care ultrasonography* | – | 88 | 100 | 75 |
| *Dedicated computed tomography scanner* | 46 | 59 | 89 | 25 |
| Monitoring and interventions | | | | |
| *Cardiac monitor* | 92 | 100 | 100 | 100 |
| *Mechanical ventilator* | 61 | 76 | 100 | 50 |
| *Mechanical cardiopulmonary resuscitation* | – | 76 | 89 | 38 |
| *Emergency blood supply (unmatched O-)* | – | 71 | 78 | 63 |
| *Body cooling unit* | – | 18 | 34 | 0 |
| *Extracorporeal membrane oxygenation* | – | 12 | 22 | 0 |
| Prehospital linkages | | | | |
| *Direct communications with emergency medical services* | – | 59 | 89 | 13 |
| *Receive prehospital electrocardiogram* | – | 53 | 78 | 13 |
| *Request emergency medical services diversion* | – | 35 | 56 | 50 |
| Pandemic preparedness | – | | | |

*Contd...*

**Table 2. Medical capabilities of emergency departments (ED) in Singapore.**

| Variable | Proportion of EDs (%) | | | |
|---|---|---|---|---|
| | 2007 ($n$=13)[a] | 2021 ($n$=17)[a] | Public sector, 2021 ($n$=9) | Private sector, 2021 ($n$=8) |
| *Fever and epidemiological screening* | – | 100 | 100 | 100 |
| *Distinct area for fever and infectious disease* | – | 100 | 100 | 100 |
| *Respiratory isolation (negative pressure)* | 54 | 82 | 100 | 38 |
| CBRNE and toxicology | | | | |
| *Decontamination facility* | – | 59 | 89 | 25 |
| *Toxicological consultation* | – | 47 | 56 | 38 |
| Paraclinical infrastructure | | | | |
| *Computer system to collect clinical data* | 69 | 100 | 100 | 100 |
| *Internet access in clinical area* | – | 88 | 78 | 100 |
| Research and training | | | | |
| *Training of emergency medicine residents* | – | 65 | 89 | 0 |
| *Clinical and/or health services research* | – | 41 | 78 | 0 |

The response rate was 100%. CBRNE: Chemical, Biological, Radiological, Nuclear, and Explosives, ICH: intracranial haemorrhage

seven public and three private sector EDs) and obstetrics–gynaecology (partially available in three public and six private sector EDs).

The majority of EDs had access to a clinical laboratory or blood gas analyser (94%) and point-of-care ultrasonography (POCUS) (88%). Moreover, 59% of EDs had access to a dedicated computed tomography (CT) scanner, up from 46% in 2007. While the majority of EDs had access to resources essential for resuscitation (e.g., cardiac monitors, mechanical ventilators, emergency blood supply), only two (12%) EDs could initiate extracorporeal membrane oxygenation (ECMO) using the hospital's organic resources and only three (18%) had body cooling units. Eight public sector EDs and one private sector ED received patients conveyed by the national prehospital emergency medical services provider.

All the EDs conducted fever and epidemiological screening for infectious diseases and had distinct areas to attend to higher-risk patients. Negative pressure isolation facilities were available in 82% of EDs, up from 54% in 2007. More than half (59%) of the EDs (all public sector) had a decontamination facility for chemically contaminated casualties. A total of eight EDs (five public and three private sector EDs) provided toxicological consultation services for other healthcare providers. All the EDs used electronic medical records to record and access clinical data (up from 69% in 2007).

Of the nine public EDs, eight participated in the national EM residency training programme and seven were also actively involved in research and published their studies regularly. The private EDs did not participate in either. However, most private EDs conducted continuing medical education programmes for their medical staff.

## DISCUSSION

This cross-sectional survey of all Singapore EDs using the NEDI instrument has achieved full response rate and surfaced several important observations. Similar to the previous inventory, we again demonstrated differences between private and public EDs in Singapore. Compared to the previous inventory, we demonstrated increased workload by EDs in terms of volume, complexity and acuity. We found indications that the number and capabilities of EDs have improved over time. Despite this, there was evidence of increasing strain on the resources of EDs.

While the total number of patients seen by EDs has risen, the results also suggest that these patients are of higher acuity. The increased proportion conveyed by ambulance, and eventually admitted, implies that more patients are entering ED with conditions that present emergently or are severe enough to warrant inpatient management. The rising complexity of patient care is not unexpected, given the ageing patient population.[13] The data also indicate the likelihood of less non-emergency patients being seen at EDs. This would be testament to the effectiveness of public education programmes on the correct use of ED in Singapore.

### Resourcing

Diagnostic and therapeutic capabilities have grown, and most EDs are able to provide advanced cardiac life support and advanced trauma life support level care. The increased accessibility of CT machines in ED parallels worldwide trends.[14] Computed tomography has significant clinical utility in diagnosing patients with neurological symptoms, acute surgical conditions and in trauma care, among other areas. Despite debate surrounding its cost-effectiveness and potential overuse, it is likely that CT will continue to be a mainstay of EDs in

Singapore, similar to many healthcare systems across the globe. On the other end of the cost spectrum, POCUS is becoming increasingly ubiquitous. Recognition for its potential extends beyond ED to numerous subspecialities and clinical settings in Singapore,[15] and these results seem to confirm its widespread acceptance as an accessible, accurate, yet cost-effective diagnostic modality alongside other commonly administered point-of-care tests. Nevertheless, it is also acknowledged that this constitutes just one step in integrating POCUS into clinical practice, as training and proficiency catch up.[16]

Currently, ECMO support is available only in two tertiary public sector EDs. Given that ECMO is a relatively recent development that is extremely expensive, resource intensive and time dependent,[14] there might be a role for mobile ECMO teams with robust interhospital referral programmes and ECMO transport capabilities to support transfers for suitable patients.

Notably, pandemic preparedness among EDs has developed significantly. While previous outbreaks, such as the severe acute respiratory syndrome in 2003, first brought these needs to light, the unprecedented scale of COVID-19 has catalysed infrastructural growth further. Moreover, the availability of electronic medical records in all EDs is a positive development for emergency care, allowing providers to efficiently attain a more comprehensive picture of ED attendees' medical histories upon presentation. All that remains is for the various forms of electronic medical records to be available, at least for viewing, on a single platform, which will aid patient care, especially for patients who choose to move between different EDs for emergency care.

Support from other medical disciplines to ED remains strong, with most specialists being available on a 24/7 basis in nearly two-thirds of EDs. However, compared to 2007, the level of specialists' physical presence in EDs seems to have trended slightly downwards. Clinical protocols for the management of psychiatric and gynaecological emergencies, and systems for cross-hospital referral and easy transport to these centres, decrease the need for ready on-site availability of these medical disciplines.

The high level of participation by public sector ED in research and education activities reflects the increasing importance being given to these areas of clinical medicine nationwide. As more board-certified EM specialists move to the private sector, there could be scope for the private EDs to play a greater academic role in the training of future EPs and in joint research activities. A previous study established a strong association between academic status and better outcomes for out-of-hospital cardiac arrest of Singapore hospitals,[17] pointing to the potential for collaboration across private and public institutions for a wide range of conditions. This would more likely ensure equivalent standards of care across medical institutions in a small country like Singapore.

## Emergency care workload

The number of ED beds have increased for a more equitable distribution of ED patient visits across the island to decrease the instances of crowding, which are a constant feature of EDs across the world. However, patients are also staying longer and more EDs are functioning over their capacity, reflecting the greater issue of access block that contributes to ED crowding; EDs are increasingly engaged in investigative and treatment interventions in an effort to mitigate potential delays in patient care resulting from unavailability of inpatient beds.

Future iterations of NEDI may also need to consider the case-mix of ED patients in different hospitals and its impact on time spent in ED, and the influence of quality of care on clinical outcomes.

The issue of ambulance diversions is another cause for concern. Delays in patient care resulting from ambulance diversions must be addressed. The need for private EDs, which appear to have shorter patient stays and lower ED-to-inpatient admission rates and times, to take on such diversions should be considered in line with the building up of emergency expertise in private EDs and hospitals.

## Healthier SG

In future, ED utilisation could be a useful metric to assess public health efforts. Most notably, Singapore's 'Healthier SG' was launched in 2023, involving several initiatives such as registering every citizen to a designated general practitioner's clinic, bolstering community health programmes and an overall shift in emphasis towards preventative care.[18] These ED statistics can be contextualised against the performance of these programmes to assess the nationwide drive towards holistic healthcare[19] and away from primarily managing acute presentations of disease. Concomitantly, efforts to grow robust emergency care capabilities cannot be neglected. Front-loading critical interventions in emergencies, such as stroke[20] and acute coronary syndromes,[21] will be crucial in reducing these patients' recovery runway and returning them to the community.

## Public and private sector differences

While EDs in Singapore are structurally similar (independent hospital-based clinical departments operating contiguous care facilities) and share basic characteristics such as triage systems, the first NEDI-Singapore study found that differences among Singapore EDs were primarily driven by whether they were in the public or private sector. A similar pattern was observed in this iteration of the study. This study also found that all public sector EDs had EPs available at all times, while only a quarter of the private sector EDs had such an arrangement, and some had no EPs at all, opting instead to staff their EDs with other physicians. Upgrading private sector EDs to the level of medical and nursing expertise found in public sector EDs may be the way forward and will likely allow for less concentration of emergency patients in the public

healthcare system. This will, of course, require conversations with private hospital operators. Movement in this direction will also have an impact on the number of EM specialists the country would need to train in order to staff both public and private sector EDs.

While specialist training in EM is likely to remain in the public sector for a long time to come owing to the available emergency workload critical for training, a gradual shift of EPs to the private sector may encourage more ED-based research activities in the private sector and a gradual change in current practices of conveyance of emergency patients to these private hospitals.

## Strengths and limitations

The study's key strength is its 100% response rate, which mitigates non-response bias, strengthens the internal validity of the study and increases confidence in its findings. The high response rate also demonstrates strong collaboration and engagement from the healthcare community, showcasing a unified commitment to improving emergency healthcare services. Future studies may consider additional parameters that would reflect on the case-mix of patients presenting to different EDs and the impact of different triage systems being used in different EDs.

The survey's reliance on self-reported data might place limitations on its accuracy. The availability of nationally available and easily accessible ED patient census data from both the public and private sectors as well as the sharing of common triage systems and emergency care protocols would naturally allow emergency care planners to better understand how emergency care in the country could be more equitably distributed. Furthermore, the COVID-19 pandemic would have affected ED utilisation in 2021, though its impact would be small, as case numbers had decreased and public health measures had stepped down in a mostly vaccinated population. Finally, the survey instrument could benefit from special components to be incorporated for individual countries to better portray the spread of emergency care resources within their systems and their unique strengths and weakness.

In conclusion, the Singapore emergency care landscape has evolved over the past 15 years. As the patient population grows in size and complexity, emergency care infrastructure will need to keep pace, so that the needs of the patients in the community can be better addressed. Public and private sector EDs will continue to function alongside each other with differences in their modes of operation. With a comprehensive set of insights into resource distribution, utilisation and gaps across the entire healthcare system, it is hoped that local and international policymakers will be able to make better informed decisions to develop emergency care as we move into the future.

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## Conflicts of interest

Ho AFW is a member of the SMJ Editorial Board, and was thus not involved in the peer review and publication decisions of this article.

## REFERENCES

1. Department of Statistics Singapore. DOS | SingStat Website - Environment. 2023. Available from: https://www.singstat.gov.sg/publications/reference/ebook/society/environment. [Last accessed on 2023 Sep 25].
2. Department of Statistics Singapore. DOS | SingStat Website - Singapore Population. 2023. Available from: https://www.singstat.gov.sg/modules/infographics/population. [Last accessed on 2023 Sep 25].
3. Lim J. Myth or Magic-The Singapore Healthcare System. Select Publishing; 2013.
4. Singapore Medical Council. SMC Annual Report 2021. 2021. Available from: https://www.healthprofessionals.gov.sg/docs/librariesprovider2/publications-newsroom/smc-annual-reports/smc-annual-report-2021.pdf.
5. Lim SH, Anantharaman V. Emergency medicine in Singapore: Past, present, and future. Ann Emerg Med 1999;33:338-43.
6. Wen LS, Venkataraman A, Sullivan AF, Camargo CA. National inventory of emergency departments in Singapore. Int J Emerg Med 2012;5:38.

7. EMNet. NEDI-International – Emergency Medicine Network. 2023. Available from: https://www.emnet-usa.org/research/studies/nedi/nedi-international/. [Last accessed on 2023 Sep 25].
8. FW Ho A, ZY Se To B, Koh JM, Cheong KH. Forecasting Hospital Emergency Department Patient Volume Using Internet Search Data. IEEE Access 2019;7:93387-95.
9. Liu Z, Teo TL, Lim MJ, Nadarajan GD, Segaram SSC, Thangarajoo S, *et al*. Dynamic emergency department response to the evolving COVID-19 pandemic: The experience of a tertiary hospital in Singapore. J Am Coll Emerg Physicians Open 2020;1:1395-403.
10. Low MJW, Dong C, Quek DYJ, Ng JH, Gan HN, Lau TP, *et al*. Stress among emergency medicine residents during the COVID-19 pandemic: A qualitative study. Ann Acad Med Singapore 2022;51:58-61.
11. Goh T, Wei TT. Singapore confirms first case of Wuhan virus; second case likely. The Straits Times. 2020 Jan 23. Available from: https://www.straitstimes.com/singapore/health/singapore-confirms-first-case-of-wuhan-virus. [Last accessed on 2023 Oct 13].
12. Hong Chuen T. Singapore Medical Association. 2021. POCUS in Singapore EDs. Available from: https://www.sma.org.sg/news/2021/April/pocus-in-singapore-eds. [Last accessed on 2023 Sep 25].
13. Weber MD, Rosenblatt S, Conlon T. Point-of-Care ultrasound: The future is now. Ann Acad Med Singapore 2020;49:628-9.
14. Lim JH, Chakaramakkil MJ, Tan BKK. Extracorporeal life support in adult patients with out-of-hospital cardiac arrest. Singapore Med J 2021;62:433-7.
15. Leow L, Papadimas E, Subbian SK, MacLaren G, Ramanathan K. Organization of extracorporeal membrane oxygenation services for COVID-19. Asian Cardiovasc Thorac Ann 2021;29:165-9.
16. Yong See Q. Attitudes and perceptions of general practitioners towards the National Electronic Health Record (NEHR) in Singapore. Eur Med J 2020;5:86-93.
17. Australasian College for Emergency Medicine. Position Statement - ACEM. 2022. Available from: https://acem.org.au/getmedia/c0bf8984-56f3-4b78-8849-442feaca8ca6/S127_v01_Statement_Access_Block_Mar_14.aspx.
18. Bavry AA, Kumbhani DJ, Rassi AN, Bhatt DL, Askari AT. Benefit of early invasive therapy in acute coronary syndromes: A meta-analysis of contemporary randomized clinical trials. J Am Coll Cardiol 2006;48:1319-25.
19. Foo CD, Chia HX, Teo KW, Farwin A, Hashim J, Koh GCH, et al. Healthier SG: Singapore's multi-year strategy to transform primary healthcare. Lancet Reg Health – West Pac [Internet]. 2023;37. Available from: https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065(23)00179-7/fulltext. [Last cited on 2023 Sep 25]
20. Hayes SH, Carroll SR. Early intervention care in the acute stroke patient. Arch Phys Med Rehabil. 1986;67:319-21.
21. Bavry AA, Kumbhani DJ, Rassi AN, Bhatt DL, Askari AT. Benefit of Early Invasive Therapy in Acute Coronary Syndromes: A Meta-Analysis of Contemporary Randomized Clinical Trials. J Am Coll Cardiol. 2006;48:1319-25.