BRIEF REPORT

Medical Emergency Team Event Characteristics from an Australian Pediatric Hospital: A Single-Center, Retrospective Study

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ABSTRACT

OBJECTIVES: To describe the characteristics of medical emergency team (MET) events at an Australian pediatric, tertiary-care center in a way that would allow for comparison with other MET systems.

METHODS: A retrospective, single-center, observational study. Consecutive MET events that occurred between January 2013 and July 2014 at Princess Margaret Hospital for Children in Perth, Western Australia, were included.

RESULTS: There were 46 445 hospital admissions during the study period and 197 MET events in children. This gives a rate of 4.2 MET events per 1000 admissions. Out of 197 pediatric MET events analyzed, there were 2 deaths (1.0%) that occurred during the MET events. All 197 patients were actively treated, with none receiving "do not attempt resuscitation" orders. Of pediatric MET events, 24% (48 of 197) were admitted to the PICU, and 75% (149 of 197) stayed in the ward where the call was made.

CONCLUSIONS: In this tertiary-care, pediatric hospital in Australia, the MET event rate and the rate of admission to the PICU because of MET events are lower than those reported for US pediatric hospitals. Despite these differences, Australian data suggest that outcomes are similar to US pediatric hospitals.

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Medical emergency teams (MET), also known as rapid response teams, are teams of specially trained doctors and nurses who are mobilized from the ICU to a deteriorating patient in the ward. Their purpose is to decrease adverse events and in-hospital cardiorespiratory arrest.[1–3] The MET system is made of 3 parts.[2] The afferent limb is the call made from the wards when a patient is identified as deteriorating. The integrating center is the ICU, where the call is received and from where a team is mobilized. The efferent limb is the team reaching out to the deteriorating patient in the ward and initiating treatment as well as deciding on disposition.[2,4]

MET systems are used by pediatric hospitals in many countries and function in a similar fashion across borders.[5–8] This is true despite significant differences in the health systems in which the pediatric hospitals exist.[9] There are data that reveal the characteristics of the MET systems in pediatric hospitals in the United States.[5,10] By comparing MET systems in different countries, it might be possible to better understand how MET systems function and how they can be improved.

Our objective in this study was to describe the characteristics of MET events in a tertiary-care, pediatric hospital in Australia. In doing this, Australian data can be compared with US pediatric hospital data, which can provide pediatric hospitals with insight on how to improve pediatric MET systems.

METHODS

This was a hospital-based, retrospective study at Princess Margaret Hospital for Children (PMH) in Perth, Western Australia. This university-affiliated hospital is the main referral center for pediatrics in the state, with >46 000 admissions per year.

Data were collected from consecutive patients who had an MET event between January 1, 2013, and July 31, 2014. Information regarding age, sex, time of the call, activation triggers, interventions by the MET, and outcomes was collected. Descriptive statistics with percentages and fractions were used. When these data are compared, it is done so against previously published data from US hospitals, mainly the American Heart Association's Get With The Guidelines-Resuscitation (GWTG-R) registry,[10] which is a large report of 3647 MET events that included hospitals that look after sick children.

Missing data from PMH are likely to have occurred at random, and this was dealt with by analyzing only the data that were available. Ethics approval was sought from the hospital's human research ethics committee. Approval was given after an abridged review, and the requirement for consent was waived.

RESULTS

During the 19-month study period, there were a total of 46 445 admissions to the hospital and 1901 admissions to the PICU.

There were 210 MET events; 13 of these were for adults and therefore excluded, leaving 197 MET events for admitted pediatric patients. This gives a rate of 4.2 MET review calls per 1000 patient admissions.

PMH uses a 2-tier MET system. The first tier is called an "MET call" and refers to children who have vital signs outside the normal range for their age and are in need of medical review but are otherwise still stable. This triggers review by the PICU team and the attending medical team. The second tier is called a Code Blue and refers to children who are in a peri-arrest situation or have arrested, and they commonly require airway management or cardiopulmonary resuscitation. This triggers a response from the PICU, the admitting medical team, as well as emergency department and anesthetics medical officers.

In this cohort, 71% (139 of 197) of MET events were first tier, and 29% (58 of 197) were second tier. There were 2 deaths (1.0%) that occurred during the MET events, with both of these being second-tier calls. All 197 patients were actively treated, with none being offered end-of-life care.

Of pediatric MET events, 24% (48 of 197) were admitted to the PICU, and 76% (149 of 197) stayed in the ward where the call was made.

Data about patient demographics, the time of the event, event triggers, and treatment provided during the MET event were collected and are presented and compared with the GWTG-R registry data in Table 1.

To help put the results of this study in perspective, a description of how PMH compares with the hospitals that contributed data to the GWTG-R registry can be seen in Table 2.

DISCUSSION

The results of this study reveal a snapshot of how the MET system of pediatric hospitals in Australia functions. With these numerical descriptions, we can compare this MET system to MET systems from pediatric hospitals in the United States.

Firstly, by comparing hospital characteristics of PMH and the hospitals that contributed data to the GWTG-R registry, we can see that there are both similarities and differences. PMH is an urban, teaching hospital like the US hospitals from which a large percentage of GWTG-R registry data came from, but at the same time, PMH is relatively small in overall size and has a small number of PICU beds. This combination of characteristics within PMH might be due to the idiosyncrasy of the state of Western Australia having a relatively small population that is scattered throughout an enormous land area of 252 641 786 hectares (975 455.4 square miles).[11] This means that there will be no other referral pediatric hospital in its vicinity, the closest being in the city of Adelaide, South Australia, which is 2697 km (1843 miles) away. PMH needs to be self-sufficient and provide as many of the services that a population will need as possible.

PMH has a much lower rate of MET events, with 4.2 per 1000 patient admissions compared with reports that describe 24.41 per 1000 patient admissions in US pediatric hospitals.[2,5] The questions from this are as follows: why is this the case, and does this affect outcomes? Population characteristics and the time distribution of events appear to be similar, and thus are not likely to drive the differing rates.

MET activation triggers are the mostly similar between PMH and US hospitals. Activation triggers depend on physiologic

TABLE 1 Comparison Between MET Event Characteristics at PMH and the American Heart Association's GWTG-R Registry Data

	PMH	GWTG-R
Population characteristics		
Median age, y (IQR)	3.5 (0.96–8.98)	3.0 (0.0–11)
Boys, % (95% CI)	55 (48.1–61.9)	54 (52.4–55.6)
MET activation time of day, % (95% CI)		
Daytime (07:00–22:59)	72 (65.7–78.3)	67 (65.5–68.5)
Most common MET activation triggers, % (95% CI)		
Tachycardia	53 (46–60)	18 (16.8–19.2)
Tachypnea	44 (37.1–50.9)	23 (21.3–24.4)
Desaturation	42 (35.1–48.9)	32 (30.5–33.5)
Drop in GCS	36 (29.3–42.7)	20 (18.7–21.3)
Increased work of breathing	28 (21.7–34.3)	26 (24.6–27.4)
High CEWT score	24 (18–30)	NA
Concern by staff	12 (7.5–16.5)	24 (22.6–25.4)
Seizures	15 (10–20)	14 (12.9–15.1)
Most common MET interventions, % (95% CI)		
Oxygen	63 (56.3–69.7)	60 (58.4–61.6)
Analgesia	12 (7.5–16.5)	NA
Blood tests	26 (19.9–32.1)	NA
Observation only	19 (13.5–24.5)	10 (9–11)
Intravenous fluids	22 (16.2–27.8)	21 (19.7–22.3)
CPR	9 (5–13)	8 (7.1–8.9)
MET outcomes, % (95% CI)		
PICU admission	24 (18–30)	52 (50.4–53.6)
Stayed in the ward	73 (66.8–79.2)	40 (38.4–41.6)
Died during MET event	1 (0–2.4); $n = 2$	0.1 (0.7–1.3); $n = 5$
Declared DNAR during MET event	0	5 (4.3–5.7)

CI, confidence interval; CPR, cardiopulmonary resuscitation; DNAR, do not attempt resuscitation; GCS, Glasgow Coma Scale; IQR, interquartile range; NA, not applicable.

parameters and staff concern. In US hospitals, they seem to be more evenly distributed across all possible triggers, whereas at PMH, it seems more skewed toward tachycardia and tachypnea. This leads us to ask whether the triggers for activating an MET event are more sensitive in US pediatric hospitals, resulting in more MET events.

The use of the Children's Early Warning Tool (CEWT) score, known in other places as the Pediatric Early Warning Score, was different between PMH and the GWTG-R registry.[12] These scoring systems allocate points to changes in physiologic parameters, and when the total score adds up to more than a predetermined value, it triggers an MET event. They have been validated and found to work well in tertiary-care centers.[13] At PMH, a CEWT score is calculated every hour and recorded on the vital signs observation charts of every patient. A CEWT score of ≥8 triggers a first-tier MET event, or an MET call. In the GWTG-R registry report, data were not collected about early warning scoring systems, and it is not determined if the hospitals contributing data used or did not use 1 of these scoring systems. It would be difficult to arrive at a conclusion on how these scores are related to outcomes in relation to the data presented here.

TABLE 2 Similarities Between PMH and US Pediatric Hospitals Included in the GWTG-R Registry

PMH Characteristics	Percentage of MET Events in the GWTG-R Registry From Similar US Hospitals
Urban	98.9
Major teaching hospital	81.1
Children as the primary service population	52.7
Nonprofit and government owned	94
Facility total bed count of 200–250 (220)	10.6
PICU bed count of 10–19 (10)	21.6

Numbers in parentheses indicate the PMH bed count for that category.

There was no large difference between the interventions administered by the MET at PMH and US pediatric hospitals. There were twice as many PICU admissions in US pediatric hospitals than at PMH, whereas more patients stayed in the ward at PMH to continue to be managed there. To try to explain this difference, it is useful to look at the availability of critical-care beds in different countries, which is something that could be playing a role here. The United States is 1 of the countries in the world with the most critical-care beds, with 20.0 to 31.7 ICU beds per 100 000 people, whereas Australia has 8.0 to 8.9 ICU beds per 100 000 people.[14] Given this difference, it would seem possible that in Australia, patients would need to be more severely ill and go through more rigorous triaging before they get admitted to an ICU environment to ensure that critical-care beds go to those who need them most. This happens when the demand for critical-care services is high.[15,16]

Despite this difference in PICU admissions, survival outcomes seem to be similar. The survival-to-discharge rate reported in the GWTG-R registry after an MET event was 93.3%.[10] According to the Australia and New Zealand Intensive Care Society's 2015 Australian and New Zealand Paediatric Intensive Care Registry, the percentage of patients who were discharged from the PICU to the ward or home was 95.9% for all pediatric hospitals in the region.[17]

The rate of patients who received a "do not attempt resuscitation" order was higher in the United States than at PMH. This is

consistent with previous reports that reveal a high incidence of life-support limitations in North America compared with other parts of the world, something that is potentially cultural.[18]

The strength of this report is that PMH is a tertiary-care hospital with similar characteristics to many of the hospitals included in the GWTG-R registry, so the findings can be compared. The limitations of this report are that it is a single-center study and that statistical analysis against US data could not be performed.

From this study, we can conclude that despite many of the characteristics of MET events being similar between an urban, teaching pediatric hospital in Australia and US pediatric hospitals, the rate of MET events and the rate of admission to the PICU is different, with no obvious difference in survival outcomes. This leads us to ask why that is. Asking these questions can potentially lead us to better understand how different systems function and help us improve our respective systems.

REFERENCES

1. DeVita MA, Braithwaite RS, Mahidhara R, Stuart S, Foraida M, Simmons RL; Medical Emergency Response Improvement Team. Use of medical emergency team responses to reduce hospital cardiopulmonary arrests. *Qual Saf Health Care*. 2004;13(4):251–254
2. Jones DA, DeVita MA, Bellomo R. Rapid-response teams. *N Engl J Med*. 2011;365(2):139–146
3. Hillman KM, Chen J, Jones D. Rapid response systems. *Med J Aust*. 2014; 201(9):519–521
4. Devita MA, Bellomo R, Hillman K, et al. Findings of the first consensus conference on medical emergency teams [published correction appears in *Crit Care Med*. 2006;34(12):3070]. *Crit Care Med*. 2006;34(9):2463–2478
5. Bonafide CP, Localio AR, Roberts KE, Nadkarni VM, Weirich CM, Keren R. Impact of rapid response system implementation on critical deterioration events in children. *JAMA Pediatr*. 2014; 168(1):25–33
6. Kinney S, Tibballs J, Johnston L, Duke T. Clinical profile of hospitalized children provided with urgent assistance from a medical emergency team. *Pediatrics*. 2008;121(6). Available at: www.pediatrics.org/cgi/content/full/121/6/e1577
7. Tibballs J, Kinney S, Duke T, Oakley E, Hennessy M. Reduction of paediatric in-patient cardiac arrest and death with a medical emergency team: preliminary results. *Arch Dis Child*. 2005;90(11): 1148–1152
8. Kukreti V, Gaiteiro R, Mohseni-Bod H. Implementation of a pediatric rapid response team: experience of the Hospital for Sick Children in Toronto. *Indian Pediatr*. 2014;51(1):11–15
9. Evans DB, Tandon A, Murray CJ, Lauer JA. Comparative efficiency of national health systems: cross national econometric analysis. *BMJ*. 2001;323(7308):307–310
10. Raymond TT, Bonafide CP, Praestgaard A, et al; American Heart Association Get With The Guidelines-Resuscitation Investigators. Pediatric medical emergency team events and outcomes: a report of 3647 events from the American Heart Association's Get With The Guidelines-Resuscitation Registry. *Hosp Pediatr*. 2016;6(2):57–64
11. Australian Bureau of Statistics. Western Australia (STE) (5). Available at: http://stat.abs.gov.au/itt/r.jsp?RegionSummary&region=5&dataset=ABS_REGIONAL_ASGS&geoconcept=REGION&datasetASGS=ABS_REGIONAL_ASGS&datasetLGA=ABS_REGIONAL_LGA&regionLGA=REGION&regionASGS=REGION. Accessed September 26, 2017
12. Duncan H, Hutchison J, Parshuram CS. The Pediatric Early Warning System score: a severity of illness score to predict urgent medical need in hospitalized children. *J Crit Care*. 2006;21(3):271–278
13. Haines C, Perrott M, Weir P. Promoting care for acutely ill children-development and evaluation of a paediatric early warning tool. *Intensive Crit Care Nurs*. 2006;22(2):73–81
14. Prin M, Wunsch H. International comparisons of intensive care: informing outcomes and improving standards. *Curr Opin Crit Care*. 2012; 18(6):700–706
15. Orsini J, Butala A, Ahmad N, Llosa A, Prajapati R, Fishkin E. Factors influencing triage decisions in patients referred for ICU admission. *J Clin Med Res*. 2013;5(5):343–349
16. Blanch L, Abillama FF, Amin P, et al; Council of the World Federation of Societies of Intensive and Critical Care Medicine. Triage decisions for ICU admission: report from the Task Force of the World Federation of Societies of Intensive and Critical Care Medicine. *J Crit Care*. 2016;36:301–305
17. Australian and New Zealand Intensive Care Society. CORE reports. Available at: www.anzics.com.au/Pages/CORE/CORE-Reports.aspx. Accessed September 18, 2017
18. Lago PM, Devictor D, Piva JP, Bergounioux J. End-of-life care in children: the Brazilian and the international perspectives. *J Pediatr (Rio J)*. 2007;83(suppl 2):S109–S116