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Impact of a standardised rapid response system on clinical outcomes of female patients: an interrupted time series approach

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ABSTRACT:

Background This study aimed to assess the impact of a standardised rapid response systems (the Between the Flags (BTF)) implemented across New South Wales (NSW), Australia, among female patients.

Methods We conducted an interrupted time series (2007–2013) population-based linkage study including 5 114 170 female patient (≥18 years old) admissions in all 232 public hospitals in NSW. We studied changes in levels and trends of patient outcomes after BTF implementation among four age groups of female patients.

Results Before the BTF system introduction (2007–2009), for the female patients as a whole, there was a progressive decrease in rates of in-hospital cardiopulmonary arrest (IHCA), IHCA-related mortality and hospital mortality for female patients. However, there were no changes in deaths in low-mortality diagnostic-related groups (DLMDRGs), IHCA survival to discharge and 1-year post-discharge mortality after surviving an IHCA. Only the female patients aged 55 years and older showed the same results as the whole sample. After the BTF programme (2010–2013), the same trends (except for DLMDRG) continued for female patients as a whole and for those aged 55 years or older. There was a significant reduction in DLMDRG among female patients aged 35–54 years ($p<0.001$), those aged 75 years and over ($p<0.05$) and female patients as a whole ($p<0.05$). The decreasing secular trend of surviving an IHCA to hospital discharge before the BTF system ($p<0.05$) among patients aged 18–34 years old was reversed after the BTF implementation ($p<0.01$).

Conclusions For female patients the BTF programme introduction was associated with continued reductions in the rates of IHCA, IHCA-related mortality and hospital mortality, as well as a new reduction in DLMDRG for 35–54 years old patients and those aged 75 years and older, and increased survival for those aged 18–34 years who had suffered an IHCA.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ There is inconsistent evidence of the effectiveness of rapid response systems (RRS) on reducing patient mortality and other adverse events for general adult inpatient populations. There was no published effectiveness evidence of RRS among different age groups of female inpatient populations.

WHAT THIS STUDY ADDS

⇒ This study provided comprehensive evidence of the impact of a standardised RRS on different age groups of female populations.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study showed significant impact of a standardised RRS in a large jurisdiction in improving female patient outcomes. Such results should be confirmed by other research in different jurisdictions with different RRSs. The targeted research on the impact of obstetrical and maternal RRS is urgently needed.

BACKGROUND

Rapid response systems (RRSs) that aim to provide timely intervention for deteriorating patients have been implemented in hospitals across the world. Systematic reviews provide support for RRS effectiveness[1 2] while acknowledging methodological limitations in observational before and after studies. A recent large study showed the positive effect of implementing a standardised RRS (ie, the Between the Flags (BTF) programme) in Australia in reducing the incidences of in-hospital cardiopulmonary arrests (IHCA), IHCA-related mortality and the deaths in low-mortality diagnostic-related groups (DLMDRG).[3] While the concept of obstetrical RRS has been introduced,[4] no studies have explored the potential effects of implementing RRSs on the female patient. Evidence suggests that female patients are more likely to have worse outcome for certain conditions such as complex endovascular aortic repair,[5] acute coronary syndrome,[6] acute myocardial infarction[7 8] when compared with male patients. Moreover, female patients were reported having significant worse outcomes[9–11] including when in their reproductive age (ie, 18–49)[12] in out-of-hospital cardiac arrests, than male patients. However, a recent systematic review[13] also reported that

female patients had better prognostic outcomes after suffering from IHCA.

In 2010, the Clinical Excellence Commission (CEC) in New South Wales, Australia, developed standardised policies and procedures for deteriorating patients and implemented the statewide RRS system (BTF programme) in all 232 state public hospitals. The implementation process received support from government, health administrators and clinicians. This was the first standardised RRS implemented across a large health jurisdiction in the world, at the time. One of the very unique features of the BTF programme is that it had developed specific standardised charts for paediatric, maternity and emergency department patients, respectively.[14 15] Moreover, as physiological clinical observations such as vital signs are different in pregnant women compared with non-pregnant women as are abnormal thresholds,[15] the CEC developed its own obstetrical observation chart. Despite that the BTF was shown to have an impact on patient outcomes for whole study population,[3] significant interaction effects across gender and age groups have been identified in the subsequent analyses.

Given the different physiology among different women age groups, the lack of effectiveness evidence on a specific type of BTF (BTF in obstetrical patients) and the existence of significant gender interaction effect on BTF outcomes, in this subgroup study, we set out to investigate the impact of implementing an RRS on the outcomes of adult female patients, of different age groups.

METHODS

Development and implementation of the BTF programme

The detailed development and implementation process have been described previously.[14 15] In short, the CEC developed a five-component strategy including: (1) a standardised documentation and response observation chart to be used in every hospital with criteria for defining two groups of deteriorating patients: (a) an at-risk but less urgent ('yellow zone') group and (b) an (urgent 'red zone') group (Supplemental Digital Content—online supplemental appendix 1); (2) a standardised response to deteriorating patients (including minimum skills of the responder and a minimum response time); (3) a governance structure with the chief executive officer of each institution responsible for implementing the programme; (4) an educational programme aimed at all hospital staff; and (5) a minimum data set to track the effectiveness of the programme. Preparation began in 2009 and the programme was launched in January 2010. The BTF programme released the New South Wales (NSW) Standard Maternity Observation Chart (SMOC, for women over 20 weeks gestation) in 2012 and cut-off calling criteria through a thorough literature review and nationwide consultation with clinical expert groups. The chart and calling criteria were piloted in hospitals prior to implementation across all NSW hospitals. The observation chart includes respiratory rate, SpO_2%, oxygen requirement, systolic blood pressure, diastolic blood pressure, heart rate, neurological status (ACVPU: A=Alert, C=new confusion/change in behaviour, V=Rousable by voice (collected through Glasgow Coma Score (GCS)), P=Rousable only by pain (collected through GCS), U=Unresponsive), temperature, pain, cumulative blood loss value, blood glucose level and urinalysis results (online supplemental appendix 1).[15]

Study design and sample

We adopted a modified interrupted time series design (ITS)/segmented regression modelling approach[16] to assess the change in patient outcomes before and after the implementation of BTF among adult women patients (>18 years old). We included all individual patient admission data in the analyses (in contrary to the conventional data management strategy to aggregate the outcome according to the time units). Such an approach enables the adjustment for both individual patient's and ecological confounding variables in the final analytical model and also includes explicit modelling of seasonal effects and avoids the necessity in adjusting for autocorrelation as required in the aggregated data setting. All other aspects of the approach still follows the analytical principle and interpretation of interrupted time series design.[16 17] The total number of public hospitals in the state of NSW, Australia (population: 7.3 millions), between 1 January 2007 and 31 December 2013 was 232. Patient outcomes and other related variables were derived from the NSW Admitted Patient Data Collection (APDC) database, which includes demographic and diagnostic information for each public and private hospital admission episode. All admissions to the study hospitals were linked to the NSW Registry of Births, Deaths, and Marriages through the Centre of Health Record Linkage, NSW Ministry of Health. This linked data made it possible to derive 1-year post-discharge mortality of patients who suffered an IHCA. This outcome is to ascertain whether there are unintended consequences of increased post-discharge mortality among female patients who suffered an IHCA.

Patient and public involvement statement

The design and analysis were also benefitted from the collaborations with related policymaking institutes (such as Clinical Excellence Commission of NSW) and their associated patient and consumer groups.

Study outcomes

The primary study outcomes were: (1) IHCA rate: the number of IHCA divided by total number of admissions (including same-day admissions); (2) IHCA-related mortality rate: the number of deaths among those patients who suffered an IHCA divided by the total number of admissions; (3) Hospital mortality rate: the number of hospital deaths divided by total number of hospital admissions; (4) Survival of IHCA to discharge: percentage of those whom survived an IHCA to discharge; (5) DLMDRG: the incidence of death in low-mortality

Table 1 The demographic characteristics of female patients before and after the implementation of the Between the Flags programme

	Before		Run-in		After		
	2007/2008		2009/2010		2011/2013		P values
	n=1 370 305	(%)	n=1 424 615	(%)	n=2 319 250	(%)	
Age groups							<0.001
18–34 year	323 562	(23.6)	319 592	(22.4)	506 685	(21.8)	
35–54 year	306 689	(22.4)	320 029	(22.5)	503 044	(21.7)	
55–74 year	377 574	(27.6)	401 008	(28.1)	667 649	(28.8)	
≥75 year	362 480	(26.5)	383 986	(27.0)	641 872	(27.7)	
Marital status							<0.001
Married/de facto	691 549	(50.5)	720 248	(50.6)	1 179 886	(50.9)	
Never married	213 168	(15.6)	222 279	(15.6)	374 129	(16.1)	
Widowed	306 753	(22.4)	316 289	(22.2)	491 515	(21.2)	
Divorced/separated	132 082	(9.6)	146 002	(10.2)	250 895	(10.8)	
Unknown	26 753	(2.0)	19 797	(1.4)	22 825	(1.0)	
Country of birth							<0.001
Australian and New Zealand	987 752	(72.1)	1 011 171	(71.0)	1 623 448	(70.0)	
UK, USA and Canada	72 571	(5.3)	74 564	(5.2)	116 788	(5.0)	
Non-English Europe	111 220	(8.1)	119 760	(8.4)	193 152	(8.3)	
North Africa and Middle East	47 544	(3.5)	54 431	(3.8)	90 559	(3.9)	
Asia	95 799	(7.0)	107 517	(7.5)	191 022	(8.2)	
Others	46 686	(3.4)	50 612	(3.6)	94 214	(4.1)	
Unknown	8733	(0.6)	6560	(0.5)	10 067	(0.4)	
SEIFA*							<0.001
First quartile	430 045	(31.4)	448 612	(31.5)	726 292	(31.3)	
Second quartile	377 729	(27.6)	396 914	(27.9)	651 454	(28.1)	
Third quartile	324 898	(23.7)	337 473	(23.7)	550 908	(23.8)	
Fourth quartile (most advantaged)	217 618	(15.9)	227 230	(16.0)	375 204	(16.2)	
Unknown	20 015	(1.5)	14 386	(1.0)	15 392	(0.7)	
Residence area							0.463
Metropolitan	848 279	(62.8)	889 977	(63.1)	1 464 587	(63.6)	
Rural and regional	478 856	(35.5)	496 026	(35.2)	799 406	(34.7)	
Other areas outside New South Wales	23 405	(1.7)	24 376	(1.7)	39 671	(1.7)	
Private health insurance							0.275
No private insurance	1 044 064	(78.4)	972 078	(76.5)	1 667 897	(75.3)	
Full cover	133 994	(10.1)	135 225	(10.6)	249 231	(11.3)	
Basic cover	122 533	(9.2)	135 289	(10.7)	253 691	(11.5)	
Unknown	31 527	(2.4)	27 362	(2.2)	43 827	(2.0)	
Hospital peer group†							0.007
A	659 938	(48.2)	691 073	(48.5)	1 115 410	(48.1)	
B	391 322	(28.6)	415 597	(29.2)	696 619	(30.0)	
C	224 791	(16.4)	224 755	(15.8)	367 764	(15.9)	
D	45 346	(3.3)	42 250	(3.0)	62 558	(2.7)	
F	48 908	(3.6)	50 940	(3.6)	76 899	(3.3)	

*SEIFA: *Socio-Economic Indexes for Areas* developed by Australian Bureau of Statistics.
†A: Principal Referral Group: Acute hospitals, treating 25 000 or more acute casemix weighted separations per annum, with an average cost weight greater than 1. B: Major hospitals: Acute hospitals, treating 10 000 or more acute casemix weighted separations per annum, but having less than 25 000 acute casemix weighted separations or an average casemix weight of less than 1; or Acute hospitals treating 10 000 or more acute casemix weighted separations per annum that are located in rural areas providing acute specialist and referral services for a catchment population from a large geographical area. C: District Group: Acute hospitals, treating 2000 or more, but less than 10 000 acute casemix weighted separations per annum. D: Hospitals treating less than 2000 acute casemix weighted separations per annum. F: All other public health facilities including the subacute and residential care facilities.

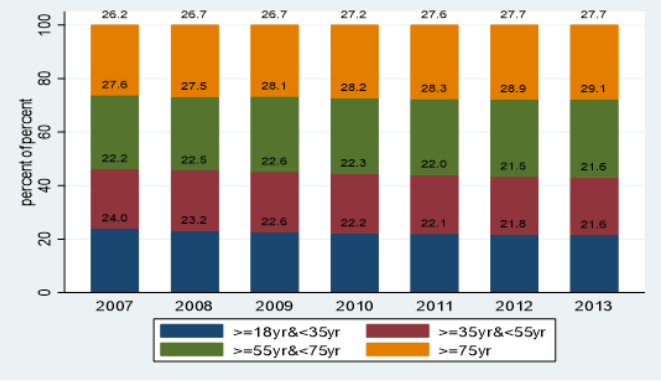

Figure 1 Age distributions of female patients across the study years (2007–2013).

diagnostic-related groups (LMDRG) per 1000 LMDRG admissions. As previously reported,[18] the LMDRGs were defined by combining all patients admitted under a DRG with a mortality <0.5% in any of the previous 3 years[18]; (6) 1-year post-discharge mortality after surviving an IHCA: percentage of the deaths within 1 year after discharge alive from hospital among patients who suffered from IHCA.

Death was defined as a patient documented as 'deceased' within the APDC database.

A cardiopulmonary arrest was identified from the International Classification of Disease, V.10, Australian Modification (ICD 10-AM, V.5.0–V.5.1) and defined as a state of pulselessness (I.46) and/or cessation of breathing (R09.2) which required cardiac massage, defibrillation or artificial ventilation. A patient coded as I.46 or R09.2 in any of the 52 non-principal diagnostic fields, but not coded for these as the principal diagnostic field, was defined as having had a cardiopulmonary arrest during hospitalisation. This process aimed to differentiate patients who suffered an IHCA from patients admitted after an out-of-hospital cardiopulmonary arrest. NSW implemented the ICD-10-AM system in 1998. Each NSW public hospital has accredited coders who code data based on the patient charts. There were no changes for relevant diagnostic definitions and coding during the study period.

Statistical analysis

To evaluate changes in baseline characteristics by calendar year (grouped as before (2007–2009), run-in (2010) and after (2011–2013) the implementation of the BTF), we applied the Rao-Scott χ^2 test which takes into account the hospital cluster effect. To assess the possible intervention effect of introduction of BTF, we used segmentation regression to estimate the monthly outcome trends before the programme (T1)and after the programme (T2), the change in the trend (ΔT) after the BTF intervention and the immediate level change in outcome after the intervention (Int).[16] Previously, we found significant interaction effects between gender and post-BTF trend among the total study population (n=9 799 081 admissions) (eg, p<0.001 for gender main effect and p=0.022 for the interaction effect between gender and post-BTF trend for hospital deaths). We also found significant interaction effects for age groups of female patients (ie, 18–34 years; 35–54 years; 55–74 years; ≥75 years). Thus, in the current study, we studied 5 114 170 female adult patient (>18 years old) admissions in all 232 public hospitals in NSW. We studied changes in trends for annual rates of all study outcomes before and after its introduction. We also explored the differential impacts of the BTF on four age groups of female patients. To assess changes in each outcome over calendar year, we derived an adjusted trend for each outcome variable including calendar year as a categorical variable (with 2007 as the baseline reference year). The time unit for the pre-BTF and post-BTF trends was specified as the consecutive month since the event. We specified a Poisson distribution to directly estimate rate ratios instead of ORs in the models.[19] A Huber/White Sandwich estimator was used to account for hospital cluster effect for all regression models.[20] In the adjusted model, we included year, age groups, marital status, country of birth, socio-economic status (SES) (based on the Socio-Economic Indexes for Areas developed by Australian Bureau of Statistics[21]), geographical area of hospitals (urban vs rural), private health insurance status and major hospital peer groups. We also included calendar months as indicator variables to adjust for potential seasonal effect. We examined baseline risk groups with the Elixhauser method and patient comorbidities with the Charlson Index based on ICD-10 coding.[22] We did not include baseline risk groups and the Charlson Index in the adjusted model given recent reporting of potential biases introduced by these methods.[23] The cases with missing covariate values were excluded from the final modelling. The proportion of cases excluded from the modelling was 17.9% for 1-year post-discharge mortality after surviving an IHCA and ranged between 6.3% and 8.6% for other five-study outcomes. We also provided related predictive ITS curves for those results with significant after-BTF trend changes.[24] A p value of 0.05 was used as indicative of statistical significance. All the analyses were conducted using Stata V.16.0 (StataCorp, 2019, College Station, Texas, USA). The authors had full access to the data used in the analyses.

Given that the current study results showed significant impact of BTF on reducing DLMDRG among 35–54 years old, 75 and older female patients, and increased IHCA survival of discharge among 18–34 years old female patients, we estimated the lives potentially saved by BTF for these outcomes based on a counterfactual base. We only estimated the lives saved between 2011 and 2013 as 2010 was a running-in year for all hospitals. The methodological details were presented in online supplemental appendix 2. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement checklist of items, extended from the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE), was presented in online supplemental appendix 3.

Table 2 Patient outcomes by age groups over the study years

Outcomes by age groups	2007 (n=678 841)	2008 (n=691 464)	2009 (n=701 531)	2010 (n=723 084)	2011 (n=743 639)	2012 (n=771 823)	2013 (n=803 788)	Change (%)*	RR†
IHCA incidences: /1000 admissions									
18–34 year	0.26	0.27	0.21	0.22	0.27	0.31	0.25	−3.8	–
35–54 year	0.92	0.81	0.88	0.79	0.68	0.71	0.54	−41.3	3.19‡
55–74 year	1.95	1.72	1.47	1.62	1.48	1.26	1.07	−45.1	6.66‡
≥75 year	4.08	3.25	2.73	2.38	2.31	1.91	1.79	−56.1	11.2‡
Total	1.87	1.59	1.39	1.33	1.27	1.11	0.98	−47.6	
IHCA survival to discharge: %									
18–34 year	53.49	31.82	41.18	42.86	42.22	48.08	65.12	21.7	
35–54 year	43.88	39.68	43.88	58.59	52.68	56.78	57.45	30.9	1.01
55–74 year	34.34	40.06	40.69	36.25	42.63	45.91	45.20	31.6	0.81§
≥75 year	18.62	20.80	24.51	26.28	24.84	30.07	29.57	37.0	0.53‡
Total	27.07	29.14	32.68	34.62	34.85	40.00	39.82	47.1	
IHCA mortality: /1000 admissions									
18–34 year	0.12	0.19	0.13	0.12	0.16	0.16	0.09	−25.0	
35–54 year	0.52	0.49	0.49	0.33	0.32	0.31	0.23	−55.8	2.51¶
55–74 year	1.28	1.03	0.87	1.03	0.85	0.68	0.59	−53.9	4.85‡
≥75 year	3.32	2.58	2.06	1.75	1.74	1.34	1.26	−62.1	5.81‡
Total	1.37	1.13	0.93	0.87	0.83	0.67	0.59	−56.9	
Died within 1 year of discharge after surviving an IHCA: %									
18–34 year	4.35	7.14	7.14	6.67	5.26	4.00	0.00	−100	
35–54 year	6.56	12.00	16.39	9.33	10.17	16.42	0.00	−100	3.12‡
55–74 year	24.00	22.14	30.51	21.67	21.05	24.81	15.79	−34.2	7.84‡
≥75 year	34.07	30.40	26.40	28.46	28.81	22.76	18.52	−45.6	16.2‡
Total	23.55	23.13	25.16	20.72	20.97	20.93	12.50	−46.9	
Death in low mortality diagnostic-related group: /1000 admissions									
18–34 year	0.12	0.12	0.06	0.11	0.11	0.12	0.15	25	
35–54 year	0.18	0.36	0.43	0.37	0.18	0.30	0.21	16.7	2.71‡
55–74 year	1.52	1.48	1.33	1.37	1.05	1.24	0.99	−34.9	12.1‡
≥75 year	9.01	10.38	9.11	8.04	8.02	7.56	6.84	−24.1	69.8‡
Total	2.13	2.51	2.29	2.13	2.00	1.97	1.73	−18.8	
Hospital mortality: /1000 admissions									
18–34 year	0.73	0.60	0.67	0.67	0.60	0.68	0.62	−15.1	

Continued

Table 2 Continued

Outcomes by age groups	2007 (n=678 841)	2008 (n=691 464)	2009 (n=701 531)	2010 (n=723 084)	2011 (n=743 639)	2012 (n=771 823)	2013 (n=803 788)	Change (%)*	RR†
35–54 year	4.71	4.70	4.53	4.38	4.27	4.15	3.75	−25.6	6.95‡
55–74 year	14.23	14.25	12.89	13.38	12.97	12.79	11.64	−18.2	20.8‡
≥75 year	39.49	39.45	36.56	34.67	34.28	33.64	29.97	−24.1	48.2‡
Total	15.48	15.66	14.55	14.34	14.20	14.06	12.63	−18.4	

*The percentage of change was calculated as the (value in 2013 – value in 2007)/value in 2007.
†RR: relative risk of age groups (adjusted) derived from the adjusted segmented regression model based on cluster robust Poisson regression estimator including covariates year, calendar month, age groups, marital status, country of birth, socio-economic status (based on the Socio-Economic Indexes for Areas (SEIFA) developed by Australian Bureau of Statistics 2011), geographical area of hospitals (urban vs rural), private health insurance status and major hospital peer groups.
‡p<0.001.
§p<0.01.
¶p<0.05.
IHCA, in-hospital cardiopulmonary arrest.

RESULTS

Patient demographic characteristics before and after BTF

Overall, the study sample included 5114170 female patient admissions aged 18 years or older between 2007 and 2013 (table 1). The average age increased from 56.6 years (SD: 21.8) in 2007/2008 to 57.3 years (SD: 21.7) in 2009/2010 and 57.8 years (SD: 21.6) in 2011/2013. A detailed distribution of four age groups across the years was presented in figure 1. There were increased proportions over the time of patients aged over 55 years, patients never married or divorced/separated, patients born in a non-English speaking country, patients with a more advantageous SES and patients living in metropolitan area (table 1).

Unadjusted patient outcomes stratified by age groups and the study years

We present the crude rates of six patient outcomes, stratified by age groups and the study years in table 2. We found significant increased risks with increased age for IHCA, IHCA-related mortality, 1-year post-discharge mortality after surviving an IHCA, DLMDRG and hospital mortality. There was also a decreased chance of surviving an IHCA to discharge with increased age. These significant age effects were consistent across the study years (2007–2013). There was significant improvement of patient outcomes between 2013 and 2007 with the magnitude of the improvement having a clear age gradient effect, but no improvement on DLMDRG among those aged less than 55 years old. For example, the reduction of IHCA incidence was a 3.8% in those aged 18–34 years, 41.3% in 35–54 years; 45.1% in 55–74 years and 56.1% in those 75 years and older.

The patient outcomes trends and its changes after the introduction of BTF (results from the interrupted time series segmented regression analysis)

We presented historical trend estimates and the changes of the trend and levels after the implementation of BTF based on segmented regression modelling results (tables 3 and 4). Before the BTF system (2007–2009), for the female patients as a whole, there was a progressive decrease in rates of IHCA, IHCA-related mortality and hospital mortality, but no changes in DLMDRGs, IHCA survival to discharge and 1-year post-discharge mortality after surviving an IHCA. The female patients aged 55 years and older and the female patients as a whole showed the same results patterns for above outcomes. After BTF programme (2010–2013), the same trends (except for DLMDRG) continued for female patients as a whole and for those aged 55 years or older. However, post BTF implementation, there was a new reduction in DLMDRG among patients aged 35–54 years (p<0.001), patients aged 75 years and over (p<0.05) and patients as a whole (p<0.05) after the BTF. The decreasing trend (p<0.05) of surviving an IHCA to hospital discharge before the BTF system among patients aged 18–34 years was reversed after the BTF implementation (p<0.01). An ITS graph

Table 3 Interrupted time series segmented regression results for clinical outcomes of female patients before and after the implementation of the BTF programme (T1: 2007–2009; T2: 2010–2013)

	18–34 years		35–54 years		55–74 years		≥75 years		Total	
Clinical outcomes	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**
IHCA incidence: /1000 admissions										
Trend since baseline (T1)	0.988	(0.974 to 1.003)	0.998	(0.987 to 1.008)	0.990*	(0.982 to 0.998)	0.982†	(0.974 to 0.989)	0.986†	(0.981 to 0.992)
Change of trend since BTF (ΔT)	1.016	(0.997 to 1.036)	0.999	(0.986 to 1.012)	0.998	(0.989 to 1.007)	1.009	(0.999 to 1.019)	1.005	(0.997 to 1.013)
Intercept (BTF: yes/no)	1.236	(0.804 to 1.903)	0.863	(0.643 to 1.160)	1.305‡	(1.073 to 1.586)	1.104	(0.954 to 1.277)	1.132*	(1.002 to 1.279)
IHCA survival to discharge: %										
Trend since baseline (T1)	0.969*	(0.946 to 0.993)	1.000	(0.991 to 1.008)	1.005	(0.995 to 1.014)	1.010	(0.998 to 1.022)	1.005	(0.997 to 1.013)
Change of trend since BTF (ΔT)	1.044‡	(1.016 to 1.073)	1.003	(0.992 to 1.015)	1.001	(0.990 to 1.012)	0.993	(0.977 to 1.009)	0.999	(0.989 to 1.009)
Intercept (BTF: yes/no)	1.653	(0.806 to 3.390)	1.203	(0.908 to 1.593)	0.929	(0.745 to 1.160)	1.037	(0.785 to 1.371)	1.026	(0.864 to 1.217)
1-year post-discharge mortality after surviving an IHCA: %										
Trend since baseline (T1)	2.913	(0.004 to 2365)	1.029	(0.981 to 1.080)	1.001	(0.982 to 1.020)	0.993	(0.978 to 1.008)	0.999	(0.990 to 1.008)
Change of trend since BTF (ΔT)	0.348	(0.004 to 30.21)	0.979	(0.928 to 1.032)	1.006	(0.977 to 1.036)	0.997	(0.978 to 1.015)	1.001	(0.987 to 1.015)
Intercept (BTF: yes/no)	0	(-)	0.567	(0.173 to 1.864)	0.763	(0.438 to 1.331)	1.181	(0.728 to 1.916)	0.900	(0.646 to 1.254)
IHCA mortality: /1000 admissions										
Trend since baseline (T1)	1.005	(0.987 to 1.022)	0.998	(0.985 to 1.010)	0.987*	(0.976 to 0.998)	0.979†	(0.970 to 0.989)	0.984†	(0.976 to 0.992)
Change of trend since BTF (ΔT)	0.990	(0.968 to 1.012)	0.995	(0.977 to 1.013)	0.997	(0.983 to 1.010)	1.011	(0.997 to 1.025)	1.005	(0.993 to 1.016)
Intercept (BTF: yes/no)	0.972	(0.518 to 1.824)	0.755	(0.495 to 1.151)	1.386*	(1.065 to 1.804)	1.081	(0.894 to 1.306)	1.119	(0.958 to 1.308)
DLMDRG: /1000 admissions										
Trend since baseline (T1)	0.976	(0.929 to 1.025)	1.039‡	(1.015 to 1.063)	0.994	(0.983 to 1.006)	1.002	(0.995 to 1.009)	1.002	(0.996 to 1.008)
Change of trend since BTF (ΔT)	1.036	(0.986 to 1.087)	0.951†	(0.926 to 0.977)	0.999	(0.985 to 1.014)	0.992*	(0.984 to 0.999)	0.992*	(0.986 to 0.998)
Intercept (BTF: yes/no)	1.522	(0.319 to 7.265)	0.592	(0.335 to 1.046)	1.074	(0.746 to 1.544)	0.929	(0.779 to 1.107)	0.928	(0.782 to 1.101)
Hospital mortality: /1000 admissions										
Trend since baseline (T1)	0.999	(0.986 to 1.012)	1.000	(0.995 to 1.005)	0.996*	(0.993 to 0.999)	0.997‡	(0.995 to 0.999)	0.997†	(0.995 to 0.998)
Change of trend since BTF (ΔT)	1.000	(0.986 to 1.015)	0.997	(0.990 to 1.003)	1.000	(0.996 to 1.003)	1.000	(0.997 to 1.003)	1.000	(0.998 to 1.002)
Intercept (BTF: yes/no)	1.049	(0.778 to 1.415)	1.017	(0.886 to 1.167)	1.092*	(1.021 to 1.169)	0.989	(0.934 to 1.047)	1.016	(0.971 to 1.064)

The full Poisson model marital status, country of birth, socio-economic status, calendar month (January–December), residential area (urban vs rural and regional), private health insurance status (full vs basic vs none) and hospital peer group (A–D and F) as; A: Principal Referral Group: acute hospitals, treating 25 000 or more acute casemix weighted separations per annum, with an average cost weight greater than 1; B: Major hospitals: acute hospitals, treating 10 000 or more acute casemix weighted separations per annum, but having less than 25 000 acute casemix weighted separations or an average casemix weight of less than 1; or acute hospitals treating 10 000 or more acute casemix weighted separations per annum that are located in rural areas providing acute specialist and referral services for a catchment population from a large geographical area; C: District Group: acute hospitals, treating 2000 or more, but less than 10 000 acute casemix weighted separations per annum; D: Hospitals treating less than 2000 acute casemix weighted separations per annum. F: All other public health facility including the subacute and residential care facilities.
*p<0.05.
†p<0.001.
‡p<0.01.
BTF, Between the Flags; DLMDRG, deaths in low-mortality diagnostic-related group; IHCA, in-hospital cardiopulmonary arrest; ITS, interrupted time series.

Table 4 The outcome trends before the BTF and the trend changes after the BTF

Clinical outcomes	18–34 years	35–54 years	55–74 years	≥75 years	Total
IHCA incidence: /1000 admissions					
Trend since baseline (T1)	–	–	↓	↓	↓
Change of trend since BTF (ΔT)	–	–	–	–	–
IHCA survival to discharge: %					
Trend since baseline (T1)	↓	–	–	–	–
Change of trend since BTF (ΔT)	↑	–	–	–	–
Died within 1 year of surviving an IHCA: %					
Trend since baseline (T1)	–	–	–	–	–
Change of trend since BTF (ΔT)	–	–	–	–	–
IHCA mortality: /1000 admissions					
Trend since baseline (T1)	–	–	↓	↓	↓
Change of trend since BTF (ΔT)	–	–	–	–	–
Death in low mortality DRG: /1000 admissions					
Trend since baseline (T1)	–	↑	–	–	–
Change of trend since BTF (ΔT)	–	↓	–	↓	↓
Hospital mortality: /1000 admissions					
Trend since baseline (T1)	–	–	↓	↓	↓
Change of trend since BTF (ΔT)	–	–	–	–	–

↑: upward trend; ↓: downward trend; –: no change of trend.
BTF, Between the Flags; DRG, diagnostic-related group; IHCA, in-hospital cardiopulmonary arrest.

(figure 2) of predicted trends based on the modelling results for three significant outcomes were also presented that included pre-BTF trend, post-BTF trend and counterfactual trend (ie, what would have happened if the pre-BTF trend had continued).

Estimated lives saved between 2011 and 2013 due to reduced DLMDRG and increased IHCA survival to discharge after the BTF implementation

Overall, there were 1 736 469 LMDRG admissions between 2007 and 2013. The crude numbers and denominators of DLMDRG across age groups were presented in two supplementary tables (online supplemental tables S1,S2). The numbers of IHCA across age groups were presented in online supplemental appendix table S3. Between 2011 and 2013, the extra lives saved were 327 (27% of 1197 deaths of DLMDRG in 75 years and older, online supplemental tables S1-S2), 44 (86% of 51 deaths of DLMDRG in 35–54 years old) and 14 (10% of 140 IHCA deaths in 18–34 years old, online supplemental appendix table S3), respectively. The total extra lives saved amounted to 385 between 2011 and 2013 for the participating hospitals.

DISCUSSION

Key findings

Our study, of female only hospital patients, found significant progressive decreasing rates of IHCA, IHCA-related mortality and hospital mortality and no change in rates of IHCA survival to discharge and 1-year mortality post discharge after surviving an IHCA over the study period. In contrast, there was a reduction of DLMDRG after the implementation of the BTF among the whole female patient sample, in particular those aged 35–54 years old and patients aged 75 years or older. The declining survival in IHCA to hospital discharge before the BTF system among patients aged 18–34 years old was reversed after the BTF implementation. In a conservative estimate, 385 lives were saved due to reduction in DLMDRG and increased IHCA survival to hospital discharge between 2011 and 2013 among participating hospitals.

Comparison with previous studies

Our study results are consistent with the previous study that evaluated the BTF effectiveness on all adult patients,[3] that is, the previous significant improvement of patient outcomes such as the rates of IHCA, IHCA-related mortality and overall hospital mortality had continued after universally adopting the BTF system in 2010 with a background of voluntary uptake an RRS from 31.7% (in 2002) to 74.4% (in 2009)[25] among all public hospitals in NSW. At the end of the study period, the incidence rate of IHCA (ie, 0.98 per 1000 admissions) among female patients were among the lowest reported (most reported between 1 and 6 per 1000 admissions[26 27]). The incidence rates of IHCA survival to discharge (39.8%) were higher than the reported one-quarter in Australia and New Zealand[27] and 1-year post discharge survival after IHCA in our study (ie, 34.8%=39.8%×87.5%) was also much

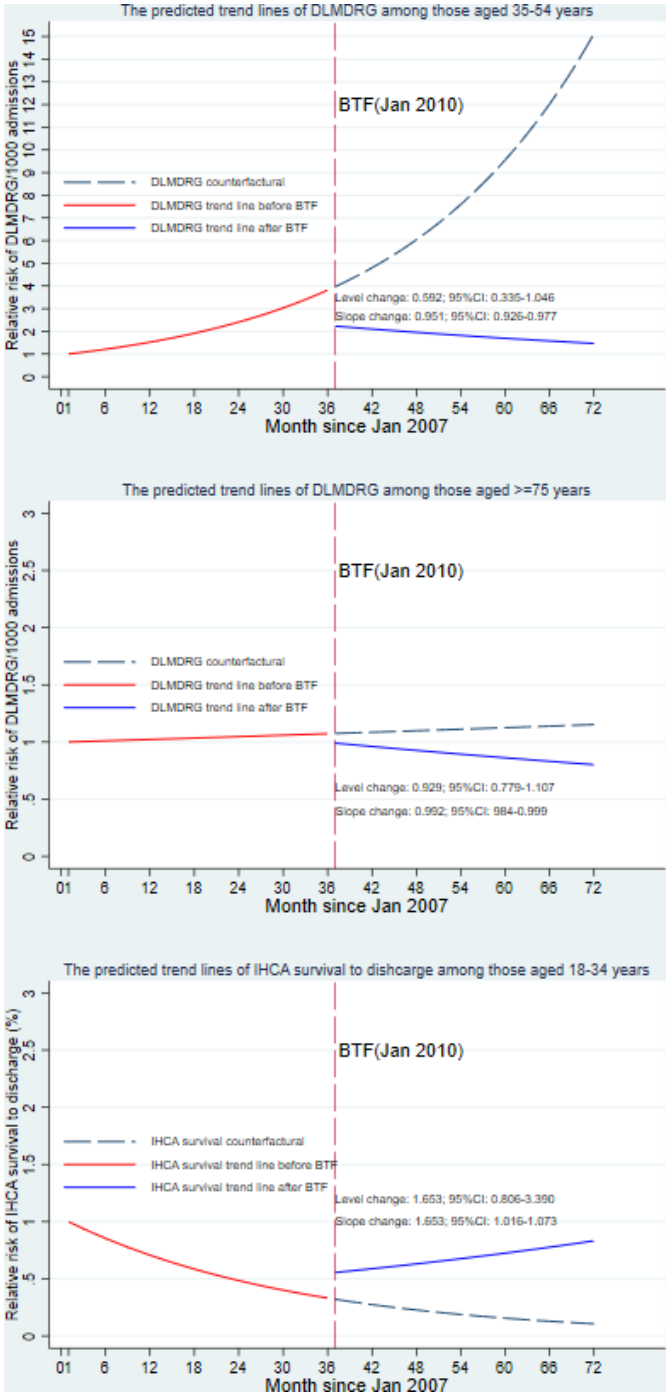

Figure 2 Predicted ITS trends (pre-BTF and post-BTF and counterfactual trends) for three significant patient outcomes. BTF, Between the Flags; DLMDRG, deaths in low-mortality diagnostic-related group; IHCA, in-hospital cardiopulmonary arrest.

higher than that (ie, 13.4%) reported in a recent systematic review including 40 studies.[26] Our study showed that the before–after differences of these outcomes had an age gradient effect with the older age groups have larger magnitude of improvement. For example, our study has showed that the IHCA-related mortality has decreased by 25% in patients aged 18–34 years and by 62% in those aged 75 years and over. Our study has also provided detailed epidemiology on all these patient outcomes before and after implementation of an RRS and could be compared with other individual study or system reviews.[1 2]

The life-saving impact on DLMDRG among those patients aged 35–54 years and patients aged 75 years and over have not been reported anywhere else. The rates of DLMDRG are potentially important as they represent a group of patients having simple diagnostics or procedures where serious adverse events would not be expected. Australian maternal deaths[28] which are part of the DLMDRG were 8.5 per 100 000 for women having live births in 2016. Most of the leading causes of these deaths included non-obstetric haemorrhage, cardiovascular, thromboembolism and sepsis where deterioration would have most likely been preceded by deterioration of vital signs. Our study results have shown the positive reduction of the DLMDRG among one of the higher risk maternal death age group (ie, 35–54 years). In contrast, in a recent systematic review which included 17 studies examining 16 different early warning systems in obstetrics, only 1 before–after study[29], which included 200 women who underwent emergency caesarean section in a developing country, assessed the impact on maternal deaths after implementing a National Early Warning Score (NEWS) system. The study recorded no maternal deaths both before and after the NEWS implementation given its relatively small sample size and short study period. The significantly improved IHCA hospital survival rate for those aged 18–34 years old female patients is also unique. This result may be due to the proactive nature of BTF that enabled earlier identification and treatment of potential deterioration of the female patients among this age group.

Study implications

Our study has shown a continuing improvement of the leading patient outcome indicators among female patients after the implementation of a standardised RRS at scale across a large health jurisdiction. Our study also showed significant differential age group effects both for the incidences of the patient outcomes and the treatment effects of BTF. The detailed epidemiology of these outcomes across the different age groups before and after the implementation of BTF provides important benchmarks for other large health jurisdictions. Moreover, our study finding of reduced unexpected deaths (ie, DLMDRG) raises important policy implications. The WHO estimated 303 000 maternal deaths occurred globally in 2015 at the end of the Millennium Development Goals year.[30] Good quality care including timely identification and management of obstetrical complications can contribute to reducing the burden of material deaths and associated complications.[31] As a result, modified early warning systems for the obstetric population have been recommended and implemented across the world.[4 32–35] However, despite recommendations in implementing an obstetric early warning system (OEWS), there were no published studies demonstrating any effectiveness on

reducing maternal deaths while most of the published studies focused on the evaluation of the different OEWSs for their predictive accuracies on different patient subpopulations.[4] Interestingly, our study showed that a standardised non-obstetrics specific and two-tiered RRS has saved patient lives in a higher risk maternal death age group. Similar to other general RRSs, the OEWSs lack agreement on which vital signs, or combination of vital signs, are predictive of material deterioration during and after pregnancy.[1] It is worth noting that the BTF programme released the NSW SMOC (for women over 20 weeks gestation) during 2012 but the exact implementation time for each participating hospital is yet to be confirmed. There is also a paucity of understanding regarding the normal maternal vital signs ranges for each stage of pregnancy, labour and the postpartum period.[36] No prior study explored the incremental values of any OEWSs over the widely adopted RRSs.[37] Rather than more complex scoring systems this study used a simple single criterion for triggering a response. Other RRSs need to be rigorously tested for their effectiveness.

Our study findings that the BTF had also reduced risk of DLMDRG among those 75 years or older women patients were worth further investigation. It was well-known that older female patients were at higher risk of frailty[38] and other comorbidities such as diabetes, hypertension or arthritis than men. Older women were also more likely to suffer from Alzheimer's disease, depression, urinary tract infections[39] and falls that may lend themselves more susceptible to further complications and mortality if their deteriorations were not identified and responded to earlier. Future studies may need to provide in-depth understanding on this group of patients.

Strengths and limitations

Our study employed the linked databases from a large health jurisdiction that was the first to implement a standardised rapid response system. To the best of our knowledge, this is the first large study of its kind to evaluate the impact of the rapid response system on women across a 7-year time span. Given the lack of other evidence on the differential effect of implementing an RRS on female patients, our study provides critical information on both the epidemiology and potential BTF impact on patient outcome indicators across different age groups. Our study also included a set of comprehensive patient outcome indicators including DLMDRG that capture deaths that were mostly likely to be unexpected thus reflecting potential benefits of an RRS. Our study finding of BTF being able to save female patient lives in the 35–54 years group may have important policy implications not only for developed countries but also for developing countries as 99% of maternal deaths occur in the low-income countries.[4 30] Our study included 5 114 170 female patient admissions aged 18 years or older that enabled us to explore the age group differential effects in detail and increased precision for the patient outcome indicators based on rare events such as IHCA and DLMDRG.

Our study has its limitations. First, the study data were derived from the NSW administrative data sets, and despite the use of professional and certified coders to extract chart data, the accuracy of the data extraction cannot be guaranteed. However, the administrative data, which were extracted by certified professional coders based on standardised guidelines at each hospital should minimise potential investigator biases. Second, the cardiopulmonary arrest codes employed in the current study were restrictive and specific but may miss some 'cases' in comparison to other broader range but less specific codes adopted by some studies based on ICD-9 codes and in other settings. Thus, the caution should be exercised when making strict point estimate comparisons between current study endpoints and other studies.[40] However, the fact that our analyses were based on interrupted time series trends with total six endpoints including more reliable mortality-based outcomes may enhance the validity of our findings. Third, the current study is based on data from the state of NSW and might not be generalisable to other healthcare jurisdictions, however, we adopted a segmented regression approach using an interrupted time series design with the analyses and methodology repeatable in the future for both national and international level, offering a means for evaluating an RRS adjusted for the historical secular trend. Another limitation is that our data included only the patients between 2007 and 2013 and further study may be needed to include more up-to-date data to understand the most recent results. Our study set the significance level of p value at <0.05. Given the multiple tests conducted, some of the significant results should only be considered as preliminary and need confirmation from other studies.

CONCLUSIONS

The BTF programme was associated with progressive decrease in the rates of IHCA-related mortality and hospital mortality. In addition, it found a new and significant post-intervention reduction in DLMDRG among female 35–54 years old patients and those patients aged 75 years and older. The BTF reversed previous decreasing cardiac arrest survival rates among 18–34 years female patients. Conservatively estimated, the total extra lives saved between 2011 and 2013 for reduction in DLMDRG and increased IHCA survival amounted to 385 among participating hospitals. However, our study results were based on observational data and should be confirmed by other large and experimental studies.

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Contributors JC, LO, KH, MP, AF and MG conceived and designed the study. JC and LO conceptualised the analytical framework, conducted data management and statistical analysis. JC provided the first draft of the manuscript and produced all the final tables and figures as well as the final draft for review. All contributed to final revised manuscript. All authors read and approved the final manuscript. JC is the guarantor of this work, has full access to all the data in the study and takes responsibility for its integrity and the accuracy of the data analysis.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by The study was approved by the New South Wales (Australia) Population & Health Services Research Ethics Committee (HREC/13/CIPHS/12). The study used retrospective routinely collected administrative data.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. As stipulated by the ethical requirement for the confidentiality of the data, the individual patient data are not available but data are available in the aggregated form upon reasonable request.

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NSW GOVERNMENT Health

STANDARD ADULT GENERAL OBSERVATION CHART

☐ Altered Calling Criteria

ALL OBSERVATIONS MUST BE GRAPHED

FAMILY NAME | MRN
GIVEN NAME | ☐ MALE ☐ FEMALE
D.O.B. ____/____/____ | M.O.
ADDRESS
LOCATION
COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

Date Time

AIRWAY/BREATHING

Respiratory Rate: 35 30 25 20 15 10 5

SpO_2%: 100 95 90 85

Oxygen: O_2Lpm; Device / mode

Key: RA = Room Air, NP = Nasal Prongs, FM = Simple facemask, NRB = Non Re-breather, VM = Venturi Mask

CIRCULATION

Blood Pressure (mmHg) SBP: v 230 220; ^ 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 — SBP is trigger

Heart Rate •: Rhythm; 160 150 140 130 120 110 100 90 80 70 60 50 40

DISABILITY

Neurological: A C V P U

A= Alert, C= new confusion/change in behaviour, V= Rousable by voice (conduct GCS). P= Rousable only by pain (conduct GCS). U= Unresponsive

Initials

NSW GOVERNMENT Health

STANDARD ADULT GENERAL OBSERVATION CHART

☐ Altered Calling Criteria

ALL OBSERVATIONS MUST BE GRAPHED

FAMILY NAME | MRN
GIVEN NAME | ☐ MALE ☐ FEMALE
D.O.B. ____/____/____ | M.O.
ADDRESS
LOCATION
COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

Date Time

EXPOSURE

Temperature (°C) •: 41 40.5 40 39.5 39 38.5 38 37.5 37 36.5 36 35.5 35 34.5 34

Pain

Assess pain level at rest and with movement. Enter R for at rest, M for movement

Severe (7-10) | Moderate (4-6) | Mild (1-3) | Nil

Initials

Blood Glucose: Date; Time; BGL

Bowels: Date

Weight: Date; ☐ Daily

Urinalysis: Date; Time; SG; pH; Leuk; Blood; Nitrite; Ketones; Bilirubin; U/Bil; Protein; Glucose

NSW GOVERNMENT Health

STANDARD ADULT GENERAL OBSERVATION CHART

☐ Altered Calling Criteria

ALL OBSERVATIONS MUST BE GRAPHED

FAMILY NAME	MRN
GIVEN NAME	☐ MALE ☐ FEMALE
D.O.B. _____/_____/_____	M.O.
ADDRESS	
LOCATION	
COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE	

OTHER CHARTS IN USE

☐ **Neurological Observation** ☐ **Insulin Infusion** ☐ **Alcohol Withdrawal**
☐ **Fluid Balance** ☐ **Pain / Epidural / Patient Control Analgesia** ☐ **Resuscitation Plan**
☐ **Anticoagulant** ☐ **Neurovascular** ☐ **Other** _____

PRESCRIBED FREQUENCY OF OBSERVATIONS

Observations must be performed routinely at least 6th hourly, unless advised below

DATE:	dd/MM/yy					
Time:	hh:mm					
Frequency Required	Twice daily					
Medical Officer Name (BLOCK letters)	P. SMITH					
Medical Officer Signature	P. SMITH					
Attending Medical Officer Signature	R.Bloggs					

Alterations to calling criteria (ACC)
Acute ACC changes can be set for up to 8 hours. Chronic ACC changes apply for episode of care
Any alterations MUST be signed by a Medical Officer and confirmed by Attending Medical Officer
Document rationale for altering CALLING CRITERIA in the patient's health care record

DATE:	dd/MM/yy					
TIME:	hh:mm					
Next review due Date & Time	dd/MM/yy hh:mm					
ACUTE / CHRONIC	**ACUTE**					
Yellow Zone	XXX-XXX					
Red Zone	<= or >=XXX					
Yellow Zone						
Red Zone						
Yellow Zone						
Red Zone						
Yellow Zone						
Red Zone						
Yellow Zone						
Red Zone						
Medical Officer Name (BLOCK letters)	P. SMITH					
Medical Officer Signature	P. SMITH					
Attending Medical Officer Signature	R.Bloggs					

INTERVENTIONS / COMMENTS / ACTIONS

	Date	Time	
1.			
2.			
3.			
4.			

STANDARD ADULT GENERAL OBSERVATION CHART SMR110.010

REFER TO YOUR LOCAL CLINICAL EMERGENCY RESPONSE SYSTEM (CERS) PROTOCOL FOR INSTRUCTIONS ON HOW TO MAKE A CALL TO ESCALATE CARE FOR YOUR PATIENT

CHECK THE HEALTH CARE RECORD FOR AN END OF LIFE CARE PLAN WHICH MAY ALTER THE MANAGEMENT OF YOUR PATIENT

Yellow Zone Response

IF YOUR PATIENT HAS ANY YELLOW ZONE OBSERVATIONS OR ADDITIONAL CRITERIA* YOU MUST

1. Initiate appropriate clinical care
2. Repeat and increase the frequency of observations, as indicated by your patient's condition
3. Consult promptly with the **NURSE IN CHARGE** to decide whether a **CLINICAL REVIEW** (or other CERS) call should be made

Consider the following:

- What is usual for your patient and are there documented 'ALTERATIONS TO CALLING CRITERIA'?
- Does the trend in observations suggest deterioration?
- Is there more than one Yellow Zone observation or additional criterion?
- Are you concerned about your patient?

IF A CLINICAL REVIEW IS CALLED:

1. Reassess your patient and escalate according to your local CERS if the call is not attended within 30 minutes or you are becoming more concerned
2. Document an A-G assessment, reason for escalation, treatment and outcome in your patient's health care record
3. Inform the Attending Medical Officer that a call was made as soon as it is practicable

***Additional YELLOW ZONE Criteria**

- Increasing oxygen requirement
- Poor peripheral circulation
- Excess or increasing blood loss
- Decrease in Level of Consciousness or new onset of confusion
- Low urine output persistent for 4 hours (< 100mLs over 4 hours or < 0.5mL/kg/hr via an IDC)
- Polyuria, in the absence of diuretics (urine output > 200mL/hr for 2 hours)
- Greater than expected fluid loss from a drain
- New, increasing or uncontrolled pain (including chest pain)
- Blood Glucose Level < 4mmol/L or > 20mmol/L with no decrease in Level of Consciousness
- Ketonaemia > 1.5mmol/L or Ketonuria 2 + or more
- **Concern by patient or family member**
- **Concern by you or any staff member**

CONSIDER IF YOUR PATIENT'S DETERIORATION COULD BE DUE TO SEPSIS, A NEW ARRHYTHMIA, HYPOVOLAEMIA/HAEMORRHAGE, PULMONARY EMBOLUS/DVT. PNEUMONIA/ATELECTASIS, AN AMI, STROKE, OR AN OVERDOSE/OVER SEDATION

Red Zone Response

IF YOUR PATIENT HAS ANY RED ZONE OBSERVATIONS OR ADDITIONAL CRITERIA# YOU MUST CALL FOR A RAPID RESPONSE (as per local CERS) AND

1. Initiate appropriate clinical care
2. Inform the **NURSE IN CHARGE** that you have called for a **RAPID RESPONSE**
3. Repeat and increase the frequency of observations, as indicated by your patient's condition
4. Document an A-G assessment, reason for escalation, treatment and outcome in your patient's health care record
5. Inform the Attending Medical Officer that a call was made as soon as it is practicable

#Additional RED ZONE Criteria

- **Cardiac or respiratory arrest**
- **Airway obstruction or stridor**
- **Patient unresponsive**
- Deterioration not reversed within 1 hour of Clinical Review
- Increasing oxygen requirements to maintain oxygen saturation > 90%
- Arterial Blood Gas: PaO_2 < 60 or $PaCO_2$ > 60 or pH < 7.2 or BE < -5
- Venous Blood Gas: $PvCO_2$ > 65 or pH < 7.2
- Only responds to Pain (P) on the AVPU scale
- Sudden decrease in Level of Consciousness (a drop of 2 or more points on the GCS)
- Seizures
- Low urine output persistent for 8 hours (< 200mLs over 8 hours or < 0.5mL/kg/hr via an IDC)
- Blood Glucose Level < 4mmol/L or > 20mmol/L with a decreased Level of Consciousness
- Lactate ≥ 4mmol/L
- **Serious concern by any patient or family member**
- **Serious concern by you or any staff member**

Holes punched as per AS2828.1:2019
BINDING MARGIN - NO WRITING

SMR110010

NSW GOVERNMENT Health

STANDARD MATERNITY OBSERVATION CHART

☐ Altered Calling Criteria

ALL OBSERVATIONS MUST BE GRAPHED

FAMILY NAME | MRN

GIVEN NAME | ☐ MALE ☐ FEMALE

D.O.B. _____/_____/_____ | M.O.

ADDRESS

LOCATION / WARD

COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

OTHER CHARTS IN USE

- ☐ Neurological Observation
- ☐ Fluid Balance
- ☐ Anticoagulant
- ☐ Vaginal loss/pad chart
- ☐ Pain / Epidural / Patient Controlled Analgesia
- ☐ Diabetes Record
- ☐ Clinical Pathway
- ☐ Alcohol Withdrawal
- ☐ Antenatal FHR Sticker
- ☐ Intrapartum FHR Sticker
- ☐ Other _____
- ☐ Other _____

MATERNAL RISK FACTORS
Is the woman at risk of any of the following?

☐ **Sepsis or risk of infection** ☐ **Bleeding or risk of bleeding** ☐ **Hypertension**

If a woman has any risk factors present continue to document observations on this chart.
The chart does not replace the use of the partogram for women during the intrapartum period.

PRESCRIBED FREQUENCY OF OBSERVATIONS

Observations must be performed routinely at least 6th hourly for at risk women, unless advised below

DATE:	dd/MM/yy					
TIME:	hh:mm					
Frequency Required	Twice daily					
Name (BLOCK letters)	P. SMITH					
Signature	P.Smith					
Designation	Midwife					
Attending Medical Officer Signature	R. Blogge					

Alterations to calling criteria (ACC)
Acute ACC changes can be set for up to 8 hours. Chronic ACC changes apply for episode of care
Any alterations MUST be signed by a Medical Officer and Confirmed by the Attending Medical Officer
Document rationale for altering CALLING CRITERIA in the woman's health care record

DATE:		dd/MM/yy				
TIME:		hh:mm				
Next review due Date & Time		dd/MM/yy hh:mm				
ACUTE / CHRONIC		ACUTE				
	Yellow Zone					
	Red Zone					
	Yellow Zone	XXX – XXX				
	Red Zone	≤ or ≥XXX				
	Yellow Zone					
	Red Zone					
	Yellow Zone					
	Red Zone					
Medical Officer Name (BLOCK letters)		P. SMITH				
Medical Officer Signature		P. SMITH				
Attending Medical Officer Signature		R. Blogge				

	Date	Time	INTERVENTIONS / COMMENTS / ACTIONS
1.			
2.			
3.			
4.			
5.			
6.			

STANDARD MATERNITY OBSERVATION CHART SMR110.013

NO WRITING

REFER TO YOUR LOCAL CLINICAL EMERGENCY RESPONSE SYSTEM (CERS) PROTOCOL FOR INSTRUCTIONS ON HOW TO MAKE A CALL TO ESCALATE CARE FOR YOUR PATIENT

CHECK THE HEALTH CARE RECORD FOR AN END OF LIFE CARE PLAN WHICH MAY ALTER THE MANAGEMENT OF THE WOMAN

Blue Zone Response to Cumulative Blood Loss

IF A WOMAN IN YOUR CARE HAS A BLUE ZONE OBSERVATION YOU MUST

1. Call for assistance and initiate appropriate clinical care
2. Increase the frequency of observations/assessment as clinically appropriate
3. Commence basic measure as per Guideline GL2017_018 Maternity – Prevention, Detection, Escalation and Management of Postpartum Haemorrhage
4. If cumulative blood loss enters the Yellow Zone or if bleeding continues despite commencement of basic measures escalate and commence full resuscitation measures

Yellow Zone Response

IF A WOMAN IN YOUR CARE HAS ANY YELLOW ZONE OBSERVATIONS OR ADDITIONAL CRITERIA* YOU MUST

1. Initiate appropriate clinical care
2. Escalate cumulative blood loss in the Yellow Zone immediately to a Medical Officer (as per local CERS)
3. Repeat and increase the frequency of observations, as indicated by the woman's condition
4. Consult promptly with the **MIDWIFE / NURSE IN CHARGE** to determine if a **CLINICAL REVIEW** (or other CERS) call should be made

Consider the following

- What is usual for the woman and are there documented 'ALTERATIONS TO CALLING CRITERIA'?
- Does the trend in observations suggest deterioration?
- Is there more than one Yellow Zone observation or additional criterion?
- Are you concerned about the woman?

IF A CLINICAL REVIEW IS CALLED:

1. Reassess the woman and escalate according to your local CERS if the call is not attended within 30 minutes or you are becoming more concerned
2. Document an A-G assessment, reason for escalation, treatment and outcome in the woman's health care record
3. Inform the Attending Medical Officer that a call was made as soon as it is practicable

***Additional YELLOW ZONE Criteria**

- Increasing oxygen requirement
- Poor peripheral circulation
- Altered mental state: agitation, confusion or unexpectedly uncooperative
- Decreasing or absent deep tendon reflexes
- Greater than expected fluid and/or blood loss
- Anuria or urine output < 80mLs total over 4 consecutive hours
- Blood Glucose Level 2-4 mmol/L
- New, increasing or uncontrolled pain (including headache and chest pain)
- Any risk factors, signs or symptoms of SEPSIS
- New Proteinuria (≥ +)
- **Concern by the woman or family member**
- **Concern by you or any staff member**

CONSIDER IF THE WOMAN'S DETERIORATION COULD BE DUE TO SEPSIS, HYPOVOLAEMIA, CONCEALED ABRUPTION, PRE-ECLAMPSIA OR PULMONARY EMBOLUS/DVT

Red Zone Response

IF A WOMAN IN YOUR CARE HAS ANY RED ZONE OBSERVATIONS OR ADDITIONAL CRITERIA# YOU MUST CALL FOR A RAPID RESPONSE (as per local CERS) AND

1. Initiate appropriate clinical care
2. Inform the **MIDWIFE / NURSE IN CHARGE** that you have called for a **RAPID RESPONSE**
3. Repeat and increase the frequency of observations, as indicated by the woman's condition
4. Document an A-G assessment, reason for escalation, treatment and outcome in the woman's health care record
5. Inform the Attending Medical Officer that a call was made as soon as it is practicable

#Additional RED ZONE Criteria

- Cardiac or respiratory arrest
- Airway obstruction or stridor
- Woman unresponsive
- Seizures
- Increasing oxygen requirements to maintain oxygen saturation > 90%
- Sudden decrease in Level of Consciousness (drop of 2 or more points on the GCS)
- Arterial Blood Gas: PaO_2 <60, or $PaCO_2$>60, or pH <7.2, or BE<-5
- Venous Blood Gas $PvCO_2$ >65 or pH <7.2
- Blood Glucose Level < 2 mmol/L
- Deterioration not reversed within 1 hour of Clinical Review
- Persistent low urine output < 160mLs over 8 hours
- **Serious concern by the woman or family member**
- **Serious concern by any staff member**

NO WRITING

Holes Punched as per AS2828.1: 2012

BINDING MARGIN - NO WRITING

SMR110013

NSW GOVERNMENT Health

FAMILY NAME | MRN
GIVEN NAME | ☐ MALE ☐ FEMALE
D.O.B. _____/_____/_____ | M.O.
ADDRESS
LOCATION / WARD

STANDARD MATERNITY OBSERVATION CHART

☐ Altered Calling Criteria

ALL OBSERVATIONS MUST BE GRAPHED

COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

Date / Time

AIRWAY / BREATHING

Respiratory Rate: 35, 30, 25, 20, 15, 10, 5

SpO_2 %: 100, 95, 90, 85

Oxygen: O_2 Lpm; Device / mode

Key: RA = Room Air, NP = Nasal Prongs, FM = Simple facemask, NRB = Non Re-breather, VM = Venturi Mask

CIRCULATION

Systolic Blood Pressure (mmHg) V: 200, 190, 180, 170, 160, 150, 140, 130, 120, 110, 100, 90, 80, 70, 60

Diastolic Blood Pressure (mmHg) ^: 130, 120, 110, 100, 90, 80, 70, 60, 50, 40

Heart Rate: 180, 170, 160, 150, 140, 130, 120, 110, 100, 90, 80, 70, 60, 50, 40

DISABILITY

Neurological: A, C, V, P, U

A= Alert, C= new confusion/change in behaviour, V= Rousable by voice (conduct GCS). P= Rousable only by pain (conduct GCS). U= Unresponsive

Deep tendon reflexes A=Absent N=Normal D=Decreasing: L, R

Initials

NSW GOVERNMENT Health

FAMILY NAME | MRN
GIVEN NAME | ☐ MALE ☐ FEMALE
D.O.B. _____/_____/_____ | M.O.
ADDRESS
LOCATION / WARD

STANDARD MATERNITY OBSERVATION CHART

☐ Altered Calling Criteria

ALL OBSERVATIONS MUST BE GRAPHED

COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

Date / Time

EXPOSURE

Temperature (°C) ●: 40, 39.5, 39, 38.5, 38, 37.5, 37, 36.5, 36, 35.5, 35

Pain

Assess pain level at rest and with movement. Enter R for at rest, M for movement

Severe (7-10) | Moderate (4-6) | Mild (1-3) | No Pain

Measured Cumulative Blood Loss (mL)

Total Blood loss at Birth

3000, 2500, 2000, 1900, 1800, 1700, 1600, 1500, 1400, 1300, 1200, 1100, 1000, 900, 800, 700, 600, 500, 400, 300, 200, 100

Instructions: Total Blood Loss at Birth should be documented on commencement of the SMOC post birth.
Cumulative blood loss in the Yellow Zone requires immediate escalation to a Medical Officer (as per local CERS).
Refer to GL2017_018 Maternity – Prevention, Detection, Escalation and Management of Postpartum Haemorrhage.
Total Blood Loss at Birth = antepartum + intrapartum + blood loss associated with birth.
NB: The observed blood loss may not reflect the total blood loss i.e. some of the loss may be concealed in the uterus.
Antepartum haemorrhage or bleeding needs to be assessed in the context of the period of gestation, the presence or absence of pain and the location of the placenta.

Date | Time | Blood Glucose Level | Urinalysis: Protein | Initials

Appendix 2. The supplementary tables and the estimation of lives saved

Given the increasing trend of DLMDRG in 35-54 years old and decreasing survival of IHCA to discharge in 18-34 years before BTF, we conservatively used the respective 2009 year incidence rate as the baseline rate (i.e, 0.43/1000 admission for DLMDRG and 41.18% for IHCA survival). We used the rate of DLMDRG between 2007-2009 among 75 years and older as the baseline rate (i.e, 9.5/1000 admissions) as our modelling results showed no significant change of rates over the period. The overall numbers of lives save were derived through the summary of potential lives saved at each year (i.e, 2011-2013) which in term was calculated through subtracting the baseline rate from the annual rate and time the denominator of that year.

Table S1: The number of DLMDRG across age groups by year

Year	18 - 34yr	35 – 54yr	55 - 74yr	>=75yr	Total
2007	8	12	81	388	489
2008	8	25	83	475	591
2009	4	30	77	433	544
2010	7	26	84	411	528
2011	7	13	67	421	508
2012	8	22	81	402	513
2013	11	16	68	375	470
Total	**53**	**144**	**541**	**2,905**	**3,643**

Table S2: The number of LMDRG admissions across age groups by year

Year	18 - 34yr	35 – 54yr	55 - 74yr	>=75yr	Total
2007	65,240	67,517	53,263	43,040	229,060
2008	64,708	68,823	55,899	45,742	235,172
2009	63,124	69,200	58,109	47,524	237,957
2010	64,119	71,066	61,340	51,132	247,657
2011	66,278	71,745	63,730	52,473	254,226
2012	68,579	74,150	65,176	53,157	261,062
2013	71,030	76,978	68,497	54,839	271,344
Total	**463,078**	**499,479**	**426,014**	**347,907**	**1,736,478**

Table S3: The number of IHCA events across age groups by year

Year	18 - 34yr	35 – 54yr	55 - 74yr	>=75yr	Total
2007	43	139	364	725	1271
2008	44	126	327	601	1098
2009	34	139	290	510	973
2010	35	128	331	468	962
2011	45	112	312	475	944
2012	52	118	281	409	860
2013	43	94	250	399	786
Total	**296**	**856**	**2155**	**3587**	**6894**

Appendix 3: The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Title page (line 2); Pg1, 3	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	P3 (ln9-12) P3 (ln7-12) P3(ln7-23)
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	Pg5, Pg6(ln1-9)		
Objectives	3	State specific objectives, including any prespecified hypotheses	Pg6(ln5-9).		
Methods					
Study Design	4	Present key elements of study design early in the paper	Pg7(ln10-24), Pg8(ln1-5)		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Pg7-Pg8		

Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	Pg7	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	Pg7(ln10-24); Pg8(ln1-5) N/A Pg7 (ln23-24)All patients in APDC were linked to population-based RBDM meaning that all deaths were captured after discharge)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Pg8(ln11-24) Pg9(ln1-8)	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Pg9(ln2-8) Pg9-Pg10
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Pg8 Pg9		

Bias	9	Describe any efforts to address potential sources of bias	Pg8(ln22-24) Pg9(ln1-8)		
Study size	10	Explain how the study size was arrived at	Pg7(ln10-24) Pg8(ln1-5)		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	Pg 9- Pg10		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	Pg7; Pg8		
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.	Pg8 – Pg9

				RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	Pg8- Pg9 Pg10
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	Pg9 Pg10
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	Pg11-12 (Table 1) Pg12: Figure 1 Pg13-14 (Table 2)	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Pg11-12 (Table 1) Pg13-14 (Table 2)
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	Pg11-12 (Table 1) Pg12 (Figure 1) Pg11-12(Table 1)		
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure	Pg13 (ln3-12) Pg14-15 (Table 2)		

		category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Pg14-14 5(Table 2) Pg16-Pg17 Pg17 (Table 3) Pg18(Table 4) N/A Pg14-15 (Table 2)		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	Pg19 (ln1-10)		
Discussion					
Key results	18	Summarise key results with reference to study objectives	Pg19 (13-22)		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Pg23(ln19-25) Pg24(ln1-13)	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Pg23(ln19-25) Pg24(ln1-13)
Interpretation	20	Give a cautious overall interpretation of results	Pg21 (ln14-25) Pg22 (ln1-24)		

		considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			
Generalisability	21	Discuss the generalisability (external validity) of the study results	Pg23(ln19-25) Pg24(ln1-11)		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Pg2 (ln23-26)		
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Given the restriction imposed by the ethic approval, no data could be shared. However, all the programming code could be available upon to request.

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.