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Short paper

The frequency and nature of clinician identified medication-related rapid response system calls

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Abstract

Aim: The contribution of adverse medication events to clinical deterioration is unknown. This study aimed to determine the frequency and nature of rapid response system (RRS) calls that clinicians perceived were medication-related using RRS quality arm data.

Methods: Analysis of routine data prospectively collected by clinicians responding to RRS calls in an Australian acute tertiary academic hospital.

Results: Between January 2013 and June 2017, 12,221 adult patients triggered the RRS for 25,906 medical emergency team (MET) and 512 code blue calls. Clinicians identified 433 medication-related RRS calls (1.6%) involving 406 patients (3.3%). These included 418 MET calls (1.3 medication-related MET calls per 1000 admissions) and 15 code blue calls (0.045 medication-related code blue calls per 1000 admissions). Medication-related calls occurred earlier in the admission ($p = 0.002$) and were more common for patients triggering multiple calls during the same admission ($p < 0.001$), compared to non-medication-related calls. Medication-related calls most commonly were triggered by low blood pressure (38.3%) and involved cardiovascular (43.0%) and nervous system medications (36.0%). Dose-related toxicity ($n = 178$) was the most frequent adverse medication event contributing to medication-related calls.

Conclusion: One in 30 patients triggering a RRS call experienced medication-related clinical deterioration, most often due to dose related toxicity of cardiovascular system medications. The perceived frequency and potential preventability of this medication-related harm suggest further research is required to increase recognition of medication-related RRS calls by responding clinicians and to reduce the incidence.

Keywords: Hospital rapid response team, Patient safety, Medication safety, Drug therapy, Medication error, Drug-related side effects and adverse reactions, Pharmaceutical preparations

Introduction

Hospital rapid response systems (RRSs) have been widely accepted as a reliable mechanism for recognition and response to clinical deterioration.[1] Preventing clinical deterioration is an increasing priority, with the wealth of epidemiological data from RRS quality arms vital to understanding the causes and contributors, including medical errors.[1,2]

RRSs have been used to detect adverse medication events, also called adverse drug events, including medication errors[2] and adverse medication reactions.[3] However, an accurate estimate of the contribution of medications to RRS calls has not been determined.[4]

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The aim of this study was to use RRS quality arm data to assess the frequency and nature of RRS calls that responding clinicians prospectively identified as medication-related. Specifically, to define the incidence of medication-related RRS calls, to identify differences to non-medication-related calls and the types of medications and adverse medication events involved.

Methods

Ethics

This study received institutional ethical approval and the need for consent was waived (Alfred Ethics Committee 467/17, Monash University Human Research Ethics Committee 11821).

Setting

The study was undertaken in an acute tertiary academic hospital in Melbourne, Australia which had approximately 35,000 multiday admissions per year. The mature two-tier RRS was triggered by standardised single parameter calling criteria.[5]

RRS clinicians routinely recorded data for all MET and code blue calls, in a local database (Riskman, Melbourne, Australia). From 2007 a "medication-related" field was available when clinicians perceived medications contributed to triggering the call.[3] This was a clinical judgement; no standard criteria or definitions of "medication-related" were available to clinicians. The data was used to supplement the hospital's adverse medication reaction monitoring system.[3] To date, it was not used to contribute to RRS quality improvement.

Data collection and analysis

All RRS calls in the hospital for adult (aged 18 years and over) inpatients between 1 January 2013 and 30 June 2017 were included. Just prior to this period, significant changes were made to the structure of clinical service delivery across the hospital, which included after hours medical support and clinical pharmacy models. The primary outcome was the frequency of medication-related RRS calls, MET and code blue, per 1000 admissions. Secondary outcomes included differences in characteristics between calls with and without a perceived medication-related cause and descriptions of the call triggers, medications and adverse medication events.

Data were extracted (Microsoft Excel, Microsoft Corporation, 2019) for cleaning and coding and verified by two researchers. Where multiple call triggers were entered, the trigger most relevant to the patient's clinical condition at the call was analysed. Medications were coded using the World Health Organisation Anatomical Therapeutic Chemical classification (https://www.whocc.no/atc_ddd_index/ Accessed November 21, 2018). More than one medication could contribute to a single call. Categorisations of adverse medication events were selected to be meaningful to clinicians and applied post hoc using clinicians' descriptions of the calls. Adverse medication reactions were classified according to Edwards and Aronson[6] and medication errors were classified using the local adaption of the nursing six rights of medication safety.[7] An additional category of "other medication adverse event" included patient-initiated actions such as self-medication or declining a dose. Statistical analyses were completed using IBM SPSS Statistics 23 (IBM Corporation, Armonk, United States of America). Categorical data were presented as counts (%) and distributed data as median (IQR or range). Differences were assessed with the chi-squared test for proportions and Mann–Whitney U tests for distributed data. A two-sided p-value <0.05 was considered statistically significant.

Results

There were 26,418 RRS calls during 14,732 admissions for 12,221 patients during the study period, including 25,906 MET calls (98.1%) and 512 code blue calls (1.9%). The MET call incidence was 79.6 per 1000 admissions. There were 1.5 code blue calls per 1000 admissions with a true cardiac arrest rate of 1.1 per 1000 admissions.

Medication-related calls

Clinicians identified 433 medication-related RRS calls (1.6%) during 412 admissions (2.8%) for 406 patients (3.3%). Thus, clinicians perceived one in every 30 patients triggering the RRS to have experienced a medication-related call. This included 418 MET calls (96.5%) and 15 (3.5%) code blue calls. The frequency of medication-related MET calls was 1.3 per 1000 admissions and 0.045 medication-related code blue calls per 1000 admissions. These rates were consistent year on year during the study period.

The most common triggers for medication-related RRS calls were low blood pressure (n = 166, 38%) and decreased conscious state (n = 98, 23%) (Fig. 1). Patients experiencing medication-related calls, compared to those who did not, were more likely to be female ($p = 0.019$), have repeat RRS calls during the same admission ($p < 0.001$) and trigger a code blue call ($p = 0.032$) (Supplementary Table 1). Medication-related calls occurred nine hours earlier in the hospital admission ($p = 0.002$).

Medications contributing to RRS calls

Clinicians identified 472 medications as contributing to the 433 medication-related RRS calls (median medications/call 1, range 1–4). Cardiovascular (ATC C) (n = 203, 43%) and nervous system (ATC N) (n = 170, 36%) medications were identified most frequently (Fig. 1). Cardiovascular system medications (ATC C), predominantly agents with anti-hypertensive or heart rate lowering effects, were frequently implicated in calls for cardiovascular triggers (Fig. 1 & Supplementary Fig. 1). Conversely, nervous system agents (ATC N) were identified to contribute to calls for all triggers, except bleeding. These findings suggested some medication types may have an association with specific calling criteria.

Dose-related toxicity (Type A) adverse reactions (n = 178, 41.1%) were the most common adverse medication event identified to contribute to RRS calls (Fig. 2). Omission was the most common medication error (n = 60, 13.9%). There appeared to be a relationship between some call triggers and specific adverse medication events (Supplementary file 2). For example, cumulative toxicity (Type C) was observed more commonly for triggers indicating physiological depression: decreased conscious state and blood pressure. Treatment failures including withdrawal and errors of omission were identified more frequently when calls were triggered for high blood pressure, high heart rate or uncontrolled pain.

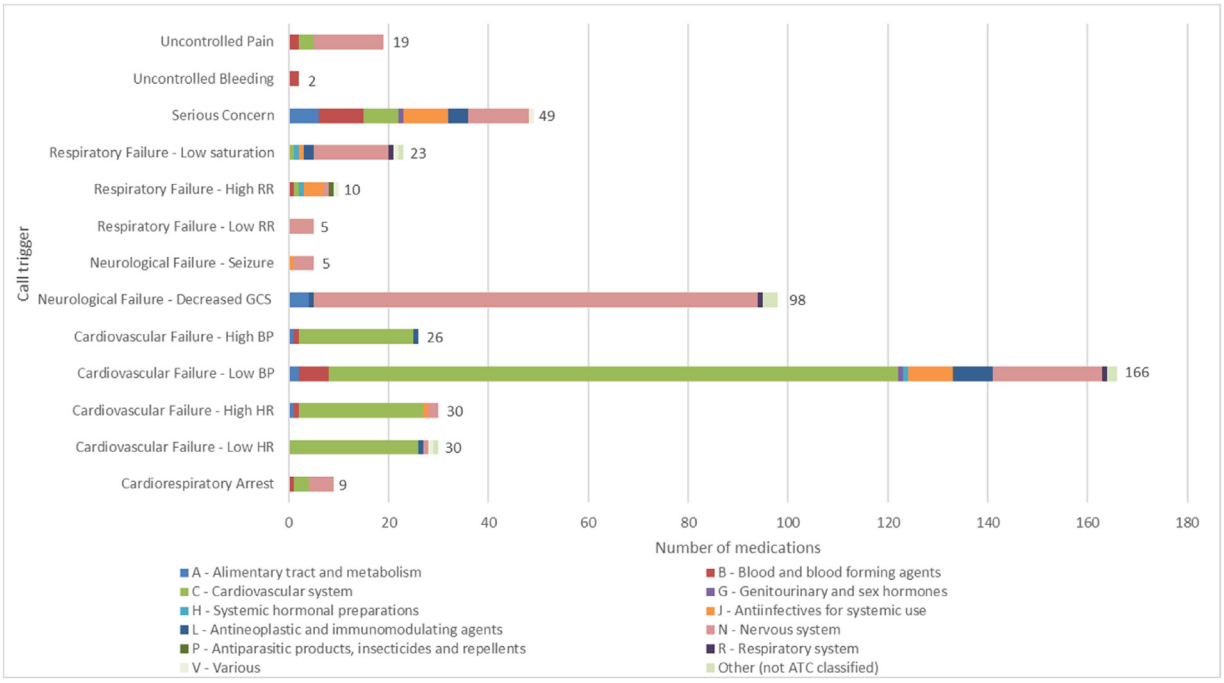

Fig. 1 – Count[a] of medications identified by clinicians as contributing to medication-related rapid response system calls (n = 472) categorised by call triggers, with a secondary analysis of medications classified at ATC[b] level 1. [a]Count = number at end of bar; [b]ATC: World Health Organisation Anatomic Therapeutic Chemical classification; RR: respiratory rate; GCS: Glasgow coma scale; BP: blood pressure: HR: heart rate.

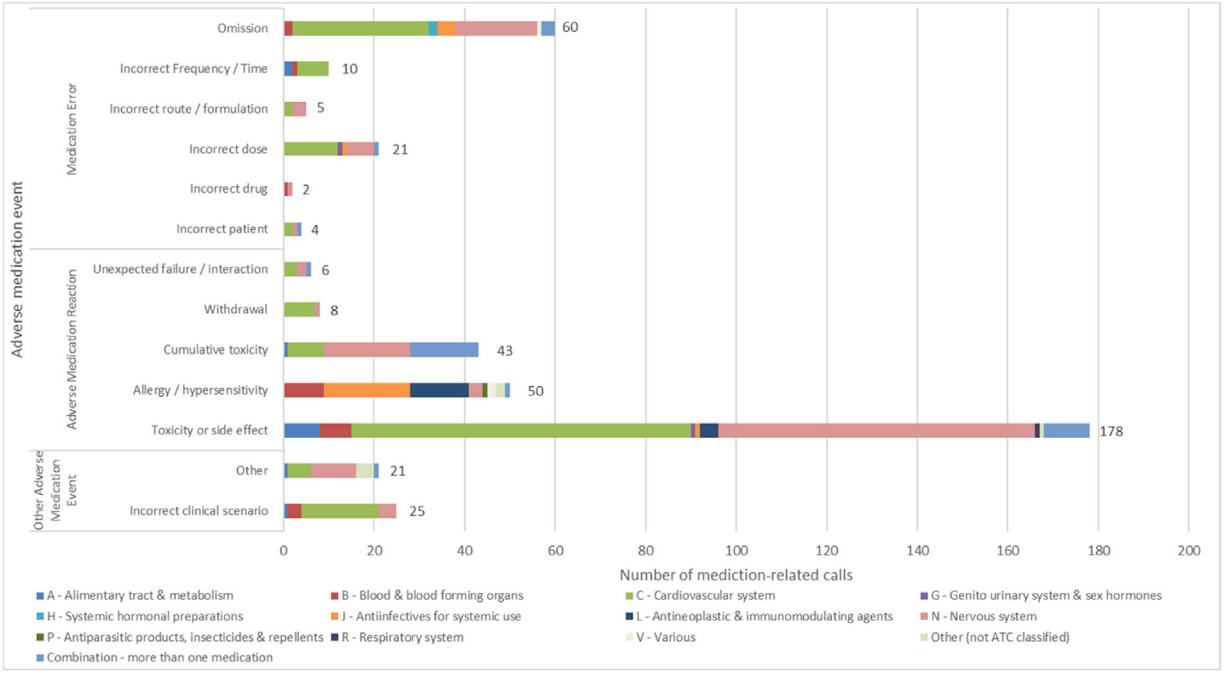

Fig. 2 – Count[a] of medication-related rapid response system calls (n = 433) categorised by adverse medication event (number at end of bar) with secondary analysis of medications identified by clinicians as contributing classified at ATC[b] level 1. [a]Count = number at end of bar; [b]ATC: World Health Organisation Anatomic Therapeutic Chemical classification.

Discussion

In this single centre study using data collected but not previously analysed to support RRS quality improvement, clinicians perceived that medications contributed to calls for one in every 30 patients triggering the RRS. These patients were more likely to experience repeat calls during their admission, therefore prevention of even some calls would relieve a considerable burden. Dose-related toxicity of cardiovascular medications leading to calls for cardiovascular triggers

relatively early in an admission appeared the predominant medication-related issue identified by RRS clinicians.

We were aware of only one previous report of prospectively identified medication-related RRS calls. In 5.9% of 795 MET calls clinicians identified "medication adverse effects" as the underlying clinical condition.[8] Using the reported MET incidence for that study, we estimated the medication-related MET call incidence for their cohort to be between 1.7 and 2.6 calls per 1000 admissions: comparable to our finding of 1.3 medication-related MET calls per 1000 admissions. Expression in the same format as MET dose aids comparison by accounting for differences in call volumes. The modesty of these estimates compared to the proportions of medication-related calls identified in retrospective case reviews[4] suggested medication-related RRS calls identified by clinicians represented the "tip of the iceberg".

We believe ours was the first study to explicitly examine the medication-related causes of RRS calls. One previous report investigating medication contributions to unplanned intensive care unit admissions and RRS calls found antibacterials (ATC J01) and antithrombotics (ATC B01) were commonly involved and that preventable adverse drug events, principally incorrect dose and omission, were more common than adverse medication reactions.[9] Our finding of toxicity as very common may represent some classification bias as we relied on clinicians' description of the call rather than retrospective case review which may permit closer scrutiny and detection of medication errors. For RRS clinicians, differentiating adverse medication event types likely was challenging and deprioritised during the calls.

This study's reliance on analysis of clinician collected RRS quality data has inherent limitations. The lack of objective criteria for identification and categorisation of medication-related calls based on clinician opinion likely introduced subjectivity. Similarly, clinicians may have failed to identify all medication-related RRS calls but likely captured the most clinically significant events. The results should be considered descriptive and exploratory in the setting of little exiting literature. The strengths of this approach included the reliability of the very large prospective cohort of consecutive RRS calls from a mature system and the validity of international, standardised classifications for medications and medication adverse reactions.

This study highlighted the practice intersection of medication safety and RRSs and the burden of medication-related RRS calls to patients and hospitals. Clinicians appeared to need support to detect medication-related RRS calls. As data were previously lacking, this study provided the best available description of medication-related RRS calls to inform practice. Medication-related calls occurred one nursing shift earlier in a patient's admission than other RRS calls, suggesting that medication optimisation is not always occurring in the most unstable patients, despite proactive clinical pharmacist intervention. While we did not measure preventability, adverse medication events in similar clinical settings were found to have high preventability.[9,10] Locally, the results have raised awareness of the clinical scenarios where medications may contribute to clinical deterioration and have informed the design of prospective investigations to more fully evaluate the nature, extent, and potential preventability of this clinical problem.

Conclusion

Clinicians perceived one in 30 patients triggering a RRS call had experienced medication-related clinical deterioration. This appeared only the tip of the iceberg. Such medication-related harm has high potential preventability. Further work should define the true incidence, increase real-time detection by clinicians and develop and test interventions to prevent medication-related RRS calls.

Conflict of interest

None.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.resuscitation.2019.09.033.

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