

Original Research Article

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4 **Title: : A Comparative Analysis of Electronic Prescribing Near Misses in King Saud**
5 **Medical City, Riyadh, Saudi Arabia**

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7 **Running header:** Electronic Prescribing Near Misses
8

9 **Abstract**

10 **Background:** A “near miss” or close call is a medication error that happened but did not
11 result in injury or damage to the patient. These medication errors (MEs) are captured and
12 corrected before affecting the patient either fortuitously or purposefully by designed
13 system controls imbedded in electronic health record (EHR) as well as electronic
14 prescribing systems (EPS). **Objective:** This study analyzed the reported electronic
15 prescribing near misses (NMs) in King Saud Medical City (KSMC) in Riyadh city.
16 **Methods:** The ME report forms were consecutively collected over a period of one year,
17 from 1 January to 31 December, 2012. These forms were evaluated for data abstraction
18 and a comparative analysis of NMs of first 6-month (n=1025, timeline 1) versus second
19 6-month (n=2398, timeline 2) was carried out. No systematic intervention prior to
20 timeline 2 was used in this study. **Results:** The total number of MEs/NMs report forms
21 was 3423 and total number of reported NMs was 7415, as each form could contain more
22 than one NM. Drug prescription items, medication dispensing stages, NM makers and
23 identifiers, underlying causes, sites of errors, prescribed drugs and suggested actions to
24 avoid NM errors all differed significantly between the two timelines, which could be
25 attributed to natural, real world practices in KSMC. **Conclusion:** This prospective study
26 found significant differences in factors related to NMs between two six month periods in
27 a single year. Reasons for these differences between two timeframes remain poorly
28 understood. NMs comparative studies using systematic interventions are warranted in the
29 Kingdom of Saudi Arabia.

30 **Keywords:** Electronic prescribing near miss, medication errors, e-prescribing, electronic
31 health records, electronic prescribing system, Saudi Arabia.

32

33 Introduction

34 A near miss is a medication error that happened but did not reach the patient. Near miss
35 may also be defined as an error that reached the patient but did not result in harm.¹
36 According to the Agency for Healthcare Research and Quality (AHRQ), a near miss is an
37 event or situation that did not produce patient injury only because of chance.² However,
38 the Institute for Safe Medication Practices (ISMP) has criticized this definition.¹ ISMP
39 considers a near miss as a close call, which is an event, situation, or error that took place
40 but was captured before reaching the patient. Kessels-Habraken and colleagues
41 extensively reviewed the literature on the definition of NM and defined three near miss
42 incidents (Type 1-3).³ These were based on a combination of “patient reached” and
43 “patient harmed”, and focused on error handling processes in terms of detection,
44 explanation, countermeasures and their combinations. As a result, they developed a near
45 miss incident matrix. Near misses and medication errors are considered medical incidents
46 (MIs).⁴ Electronic health records (EHRs) embedded with electronic prescribing system
47 (EPS) considerably reduces medication incidents.³⁻¹³

48 There is much less literature on electronic prescribing (EP), and medical incidents
49 in the Eastern world.¹⁴⁻¹⁷ Recently, one descriptive study has explored electronic
50 prescribing near misses (NMs) in King Saud Medical City (KSMC), Riyadh, Saudi
51 Arabia.¹⁸ However, this paper comparatively examines electronic prescribing near misses
52 voluntarily reported over one year and attempts to elucidate factors that impact
53 electronic prescribing NMs in KSMC, Riyadh, Kingdom of Saudi Arabia (KSA).

54

55 Objective

56 This study seeks to estimate the monthly rate of NMs during the year 2012 in KSMC,
57 Riyadh, and compare factors influencing NMs between the first and second [T1 and T2]
58 six months of the year, building on our previous work.¹⁸ This study attempts to determine
59 the personal, ecological and system influences at KSMC that affected the occurrence of
60 NMs during the two timeframes. The main assessment involves electronic prescribing
61 NMs recorded in ME report forms during the year 2012.

62 Material and methods

63 The study was conducted between 1 January to 31 December 2012 at KSMC,
64 which is a major 1400-bed tertiary care hospital. In 2006, KSMC became the first
65 Ministry of Health (MOH) hospital to implement an electronic prescribing system (EPS).
66 This tertiary care hospital serves a wide range of patients drawn from a large population
67 in and around Riyadh, many of whom present with complex medical problems and are
68 referred from different regions of KSA. The hospital's MEDI system, i.e., electronic
69 health record system, has been upgraded regularly since 2006. The EPS is connected to
70 the MEDI system. The number of daily e-prescriptions at KSMC varies and does not
71 include paper prescription or medication orders written on patients' charts.

72 Medical incidents (MIs) are reported voluntarily to the medication safety unit of
73 KSMC. All healthcare providers and consumers can report medication errors (MEs) to
74 this unit. Two coordinators, one from pharmacy and the other from Drug Poisoning
75 Information Center (DPIC) work on electronic MEs data collection, its entry into the
76 computer, and statistical analysis. They also produce quarterly ME reports. All MEs
77 reporters are required to complete an ME reporting form. The completed ME forms are
78 screened and reviewed by the pharmacy designee in the medication safety unit for
79 deciding whether or not the reported ME is a near miss. Thereafter, this ME form is sent
80 to DPIC for further review and statistical analysis. Sentinel errors are investigated by a
81 committee using root cause analysis (to be reported in a forthcoming paper). Two other
82 methods for reporting electronic prescribing NMs not used in this study are web and
83 telephone.

84 NMs in the present report were examined during the two consecutive six-month
85 timeframes [T1 & T2]. No systematic intervention, such as a randomized clinical trial,
86 was implemented between T1 and T2 to influence NMs in this study. We examine here
87 the role of real world practice factors that could have affected NMs between the two time
88 periods. KSMC setting factors that may have had an influence included the
89 implementation of a medication safety unit in mid-year 2012; organization of a
90 medication safety committee; design and distribution of a medication error flow chart in
91 all KSMC departments; assigning an ME pharmacist to all departments of KSMC;
92 implementation of twice-monthly educational and awareness sessions on MEs for all

93 nurses, pharmacists, and physicians, including newly employed staff; adoption of a
94 blame-free culture in reporting and documenting MEs; distribution of posters and
95 brochures on MEs throughout KSMC; and an annual evaluation and competency report
96 of activities to motivate and engage employees in reporting and documenting MEs.
97 Finally, annual vacations taken by staff and time off for Ramadan (fasting) and Hajj
98 (pilgrimage) that occurred during T2 may have influenced near misses occurrence,
99 identification and reporting during that period.

100

101 **Data collection**

102 All medication error report forms were evaluated by the pharmacist and Drug
103 Poisoning Information Center staff. The relevant data were abstracted from these forms.
104 The variables examined were gender, medication-related variables such as drug types,
105 dose, frequency of administration, route of administration, dosage form, concentration,
106 and duration, details on reporters and interveners, types of errors, causes of errors, stages
107 of electronic prescribing NMs made, settings where NMs were made, actions taken to
108 avoid the occurrence of NMs, and suggested recommendations for preventing electronic
109 prescribing NM errors in the future. In addition, real practice MEs safety/prevention
110 programs at KSMC were also identified. For this purpose, key pharmaceutical care
111 managers of KSMC were consulted. This study was approved by the Academic
112 Department of KSMC that gave permission to analyze and publish our findings regarding
113 electronic prescribing NMs.

114

115 **Data analysis**

116 Data were analyzed using the Statistical Package for Social Sciences version 17
117 software (IBM Corporation, Armonk, NY, USA). Descriptive statistics were used to
118 calculate frequencies and percentages. We also calculated rate of NMs for each month
119 during the year 2012. The NM rate was equal to the number of NMs for a particular
120 month X 100 divided by the number of prescriptions made during the month. The NMs
121 data for T1 and T2 were compared using z-test. This test is used to compare two
122 proportions created by two random samples or two subgroups of one random sample.

123 Bar graph for NMs/ME report forms of the year 2012 was plotted, as well as three time-
124 series graphs for NMs during the year 2012 for T1 and T2.

125

126 **Results**

127 A total of 3,423 NM report forms were collected between January 1, 2012 and
128 December 31, 2012. Although the total number of electronic prescribing NM report
129 forms was 3,423, each form could contain more than one near miss. The number of NM
130 report forms in first and second half of the year were 1,025 and 2,398, respectively. The
131 distribution of ME/NM report forms by month (Figure 1-Bar graph) showed that they
132 ranged from 55 to 898 per month. The Table 1 presents the monthly distribution of
133 electronic prescriptions, frequency of NMs and their rates. The number of NM report
134 forms during T1 was more than double those in T2. Males comprised 58.7% (n=602) of
135 NMs during the first 6-months compared to 48.8% (n=1170) during the second 6-months.
136 Gender was missing in 0.6% of forms during T1 and 2.9% during T2. Time-series graphs
137 (Figures 2, 3 & 4) of NMs during 2012 show the different frequency of NMs between T1
138 and T2.

139 Compared to T1, there was significant decrease in incorrect doses, wrong dosage
140 forms, drug-drug monitoring, wrong quantity, and wrong patient ($p<0.05$) during T2,
141 whereas there was a significant increase in wrong strength/concentration and wrong route
142 ($p<0.05$). Other drug related variables did not differ between the two timelines ($p>0.05$)
143 (Table 2). NMs significantly decreased during transcription and entering, monitoring and
144 administration stages of medication processing during T2 compared to T1 ($p<0.05$).
145 However, NMs related to physician orders significantly increased during T2 compared to
146 T1 ($p<0.05$), possibly due to a shortage of staff during the Hajj season. There was no
147 difference in NMs between T1 and T2 for the dispensing and delivery stages (Table 3).

148 Physicians and pharmacists made significantly fewer NMs during T2 compared to
149 T1 ($p<0.05$) and nurses and assistant pharmacists made significantly more NMs during
150 T2 compared to T1 ($p<0.05$) (Table 4). Furthermore, pharmacists were more likely to
151 identify NMs during T1 compared to T2. A significant reverse trend was observed for
152 assistant pharmacists who identified more NMs during T2 compared to T1 ($p<0.05$).
153 There were no significant differences in NM identification between nurses, physicians

154 and clinical pharmacists between two time periods ($p>0.05$), although the latter group
155 does not usually engage in medication dispensing (Table 5). Corrective actions by health
156 professionals in response to NM medication errors significantly decreased between T1
157 and T2 with regard to dose corrections, calls for clarification, cancelled drugs, forwarding
158 orders to health providers, discontinuation of drugs, and occurrence of variance report
159 (OVR) ($p<0.05$). Conversely, actions taken by professionals significantly increased from
160 T1 to T2 with regard to pharmacist noting NM and waiting for response and no drug
161 dispensing ($p<0.05$) (Table 6).

162 According to the perceptions of NM reporters, the main causes for NMs were
163 wide-ranging (Table 7). Notably, lack of education and miscommunication regarding the
164 drug order as causes for NMs increased significantly between T1 and T2 ($p<0.05$). On the
165 other hand, environmental, staffing, or workflow problems, drug information missing,
166 drug name/label/package problems, lack of quality control or independent check system,
167 clinical information missing, drug delivery device problems and drug storage or delivery
168 problems significantly decreased between T1 and T2 ($p<0.05$). However, patient
169 education problems as a cause for NMs did not differ significantly between the two time
170 periods ($p>0.05$) (Table 7).

171 Regarding locations where NM medication errors were reported and made, NMs
172 significantly decreased between T1 and T2 for the inpatient-pharmacy and other settings
173 ($p<0.05$). Conversely, NMs increased significantly between T1 and T2 at the OR-
174 pediatric hospital ($p<0.05$), possibly because the training programs in this setting did not
175 highlight and emphasize pediatric ME problems (Table 8).

176 The NMs decreased significantly between T1 and T2 in relation to cardiovascular
177 agents, metabolic agents, and miscellaneous drugs. However, NMs significantly
178 increased between T1 and T2 in relation to coagulation modifiers, respiratory agents,
179 psychotherapeutic agents (Table 9). Recommendations by NM reporters decreased
180 significantly between T1 and T2 with regard to double checks and patients counseled,
181 whereas CME, stop nurse drug entry, medication reconciliation, and system upgrade all
182 significantly increased from T1 to T2 ($p<0.05$) (Table 10).

183 Discussion

184 This study estimated the NM rate and compared important aspects of electronic
185 prescribing NMs across two timelines in a tertiary care hospital in Riyadh City. Unlike
186 the female predominance in MEs, males were slightly overrepresented (1772 males vs
187 1651 females) in this and our previous study¹⁸ despite the fact that in ambulatory care
188 females tend to utilize more healthcare services. However, the number of females
189 increased during T2 matching the universal trend.¹⁹ Other factors that also impact
190 healthcare utilization include reproductive biology and age-related mortality.¹⁹
191 Conventional wisdom would suggest that overutilization of healthcare services by
192 females should increase their risk of having more NMs; however, the reverse was the
193 case in this study, at least during T1. In the second half of the year, pressure on
194 prescribers to utilize medication stock before the end of the year may have also
195 contributed to this finding. Our finding that females who utilize more healthcare services
196 paradoxically tend to have fewer NMs diverges from other reports²⁴ and, therefore, needs
197 replication in future studies.

198 For some outpatient departments and the inpatient pharmacy at KSMC, there was
199 significant drop in NMs between T1 and T2 possibly due to the implementation of a
200 medication safety plan, regular training of staff especially pharmacy personnel, and
201 rigorous quality monitoring. Other important sites for NMs were pediatric and adults
202 emergency and maternal ambulatory care services, which is consistent with other
203 studies.^{5-6,12,18,20} In these settings, except for the maternity hospital, the proportion of
204 NMs increased significantly between T1 and T2, possibly due to staff shortages and less
205 rigorous quality monitoring in emergency settings during the Hajj season, when
206 healthcare providers' services are diverted to the two holy sites. While other factors^{16-17,}
207 ²¹ also influence the occurrence of medical incidences (MIs) and reporting, how they
208 affect the occurrence of MIs throughout the year are unknown..

209 In general, factors such as patient's age, weight, diagnosis, prescribed medications,
210 experience of health care providers, practice setting, and the presence or absence of EPS
211 have a strong impact on the prevalence of MEs.^{16-17,21} Interestingly, similar factors predict
212 the occurrence of NMs,²² an important aspect of medication errors. Myers substantiated
213 that the causes of and contributing factors to MEs are similar to those involved in NMs.⁸

214 Addressing the same issue, Tanaka and colleagues examined predictors of NMs and
215 adverse events and found that those for NMs and adverse events are quite similar. Years
216 of experience, frequency of night shifts, ward location, and time pressure were all
217 significantly related to both NMs and adverse events. According to this study, there was
218 little difference between the causes of NMs and those of adverse events.²²

219 According to the present study, the rate of near misses/close calls varied
220 throughout the year and were significantly higher during T2. This finding is consistent
221 with other studies, which also report variable prevalence of electronic prescribing MEs
222 and NMs.^{9,18,23-27} Variations in the prevalence rate of medication errors have been
223 attributed to differences in methodology, definitions of MEs, study settings,
224 classifications of MEs, and sample size²⁵⁻²⁶, which may also help to explain the
225 differences reported regarding electronic prescribing NMs. In a systematic review of
226 medication errors, Lisby and colleagues reported prevalence of MEs ranged from 2% to
227 75%, with no association found between how MEs were defined and their prevalence.
228 However, the majority of studies reported prevalence rates below 10%.²⁶ Approximately
229 35% of MEs are potentially preventable adverse events/near misses.²⁷ Arguably, NMs
230 that are not checked and corrected will lead to a significant rise in MEs with
231 consequences that range from mild to serious to fatal. Therefore, the primary reason for
232 identifying and correcting NMs is to improve the management of health care systems so
233 that health risks are reduced and patient safety is improved. However, both MEs and
234 NMs are frequently underreported,^{4,12,28} as we found in the present study. The monthly
235 NM rate here ranged from 0.48 % to 1.57%, with an overall annual rate of 0.72%.

236 A variety of clinical factors related to NMs decreased significantly between T1 and
237 T2, whereas others increased. However, some factors, including the wrong time of drug
238 administration, did not change between T1 and T2. Though no straightforward
239 explanations can be offered, medication safety programs and related training courses on
240 medical incidents may have contributed. However, these variables have been reported as
241 causes for medical incidents in previous studies.^{18,29-31} These findings argue for the
242 presence of electronic checks in the process of prescribing and dispensing medications
243 throughout the year in order to prevent these medical incidents and the adverse health
244 consequences and economic losses involved.³²⁻³³ The correct and complete documentation

245 of medication-related variables in electronic prescriptions is mandatory and strongly
246 recommended in clinical and pharmaceutical practice worldwide. Only when this is
247 accomplished will patient safety, quality care, cost reductions and decreased morbidity
248 and mortality be ensured across the healthcare system.¹⁶⁻¹⁷ This has been substantiated in
249 at least one study of NM events on labor and delivery, in which medication and patient
250 identification errors were the most common near miss events.⁵ In another study of
251 perceptions of perioperative nurses, personal factors reflecting “communication between
252 team”, “inconsistent information,” and “incorrect monitoring” were the most frequently
253 identified causes of near misses.⁷

254 Medical incidents (MIs) can occur at any one of the five stages of medication
255 administration, including medication prescribing.^{18,28} To address this issue further, a
256 study found that the phase affected by the most medication errors in all three models was
257 transcription and the least affected phase was administration, but prescription errors were
258 the worst in single-dose systems.³⁴ In another study, nurses reported that medication
259 administration and transcription errors were the most frequent types of NMs caused by
260 personal factors rather than by institutional factors. This study emphasized that education
261 to avoid personal errors, including STAR, i.e., stop, think, act, review, and verification of
262 proper procedures, was imperative for nurses to avoid NMs.¹⁰ In psychiatric settings,
263 medication administration errors are the most common errors, and distraction, poor
264 communication and being unfamiliar with the ward are common contributory factors.¹¹
265 These results underscore the importance of double checking, training of health
266 professionals, and focusing on physician entry in reducing near misses.^{10-11,18} The present
267 study found that NMs significantly decreased between T1 and T2 during transcription
268 and entering, monitoring and administration stages of medication processing. However,
269 NMs related to physician ordering significantly increased from T1 to T2. The fact that
270 annual vacations of most physicians and the pilgrimage season falls during T2 may
271 explain this increase in near misses related to physician ordering. During the second six
272 months of the year, hospitals in KSA are usually short of physicians and those who
273 remain tend to overwork and develop fatigue, which is associated with more medication
274 errors and near misses.³⁵

275 Physicians and nurses tend to make the most near misses, whereas pharmacists
276 and nurses are those most likely to identify and report NMs. Furthermore, pharmacists
277 are most likely to intervene in order to prevent medication errors.^{18, 29-31} Pharmacist
278 interventions result in the prevention of up to 89% of medication errors.^{30, 31, 36} We found
279 that physicians and pharmacists but not nurses made significantly fewer NMs during T2.
280 While pharmacists identified significantly more NMs during T1 than during T2, this
281 finding was reversed for assistant pharmacists who identified more NMs during T2 than
282 during T1. Making, identifying, reporting and intervening in NMs are closely shared by a
283 triad that is comprised of physicians, nurses and pharmacists. In light of the Eindhoven
284 model, Henneman and Gawlinski proposed that nurses manage medical errors by
285 identifying and correcting them.³⁷ Evidently, health professionals often do not report near
286 misses for many reasons including fear and blame.³⁸ Other investigators have reported
287 innovative approaches for capturing electronic prescribing near misses in order to
288 develop a patient safety culture.²⁷

289 According to our previous study¹⁸, antibiotics, cardiovascular drugs, CNS agents,
290 nutritional products, GIT agents and coagulator modifiers were the most frequent
291 medications involved in NMs. Globally, antibiotics are prescribed most frequently and
292 are the most common source of adverse drug events.³⁹⁻⁴⁰ Several issues related to
293 prescribing such medications including route of administration and associated near
294 misses have been reported.^{9,18,41-44} IV medications from multiple drug groups have been
295 associated with up to 54% of potential adverse drug events/near misses and 56% of
296 medication errors.⁴¹ In one survey, near misses were identified most frequently (90.3%)
297 by emergency department pharmacists.³⁹ According to the present study, NMs associated
298 with some drugs either significantly decreased or significantly increased from T1 to T2 .
299 We feel that near misses associated with medications should ideally decrease not only
300 during T2 but also throughout the year.

301 It has been emphasized that the counseling of patients regarding medication use
302 and the documenting of details in e-prescriptions by physicians are key to preventing
303 medication errors⁴⁵ including near misses. The advantages and techniques of patient
304 counseling have been discussed.^{18, 46-47} Furthermore, patients and their family members
305 are important source of identifying medical incidents affecting their health care.⁴⁸ Besides

306 counseling of patients and caregivers, their appropriate training and engagement in
307 identification of medication errors in emergency departments may further boost health
308 care safety.⁴⁸ We found that NM medication error reporters recommended significantly
309 less double checking and patient counseling during T2. Patient counseling is clearly
310 underused in this tertiary care setting. Counseling of patients regarding medication use
311 needs to be mandatory as it tends to reduce medical incidents and facilitates patient safety
312 and improves quality of life.

313 A number of limitations affect the generalizability of this study's results.
314 Although several variables related to NMs were influenced by natural real world practice
315 factors in KSMC, this study was not designed to fully explain the time trends in near
316 misses discovered here. However, factors related to healthcare providers and healthcare
317 consumers (personal), the healthcare institution (institutional), and healthcare informatics
318 (EP system) clearly influence the occurrence, identification, reporting, and prevention of
319 NMs.

320 **Conclusion**

321 We report here the rate of NMs and other important insights into electronic prescribing
322 near misses between two consecutive six-month periods during 2012, with findings that
323 are consistent with results from other investigators internationally. Based on our brief
324 literature review, our research findings, opinions of near miss reporters, and the recent
325 initiation of several real practice operational programs, we make several
326 recommendations for further mitigating NMs at KSMC and other similar tertiary care
327 hospitals. NM prevention interventions such as double checking, rigorous quality
328 monitoring, and regular training of staff in prescribing, providing incentives for reporting
329 NMs, ensuring system updates, and patient counseling should be implemented in all
330 tertiary care hospitals across the nation. Although electronic prescribing NMs do not
331 result in injury or damage to the patient, they need to be identified and corrected.
332 Otherwise MEs will increase significantly with a range of adverse consequences.
333 Electronic prescribing systems/electronic health record systems need to be updated for
334 capturing and correcting NMs, which will help to prevent real MEs associated with
335 increased economic costs, poor health outcomes and compromised quality of life.

336 **Disclosure:**

337 All authors except AMAB and NAQ are affiliated to the tertiary care hospital
338 where this study was conducted. Abdullah Mohammed Al-Bedah and Naseem Akhtar
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340

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345

346 **References**

- 347 1. Institute for Safe Medication Practices. ISMP survey helps define near miss and close
348 call. ISMP Medication safety Alert-Acute care. September 24. 2009.
- 349 2. www.psnet.ahrq.gov/glossary.aspx. Accessed on 15 July 2013.
- 350 3. Kessels-Habraken M, Van der Schaaf T, De Jonge J, Rutte C. Defining near misses:
351 Towards a sharpened definition based on empirical data about error handling processes.
352 *Social Science & Medicine* xxx, 2010: 1–8.
- 353 4. Boyle TA, Mahaffey T, Mackinnon NJ, Deal H, Hallstrom LK, Morgan H.
354 Determinants of medication incident reporting, recovery, and learning in community
355 pharmacies: a conceptual model. *Res Social Adm Pharm* 2011;7:93-107.
- 356 5. Clark SL, Meyers JA, Frye DR, McManus K, Perlin JB. A systematic approach to the
357 identification and classification of near-miss events on labor and delivery in a large,
358 national health care system. *Am J ObstetGynecol* 2012; 207: 441-445.
- 359 6. Tuncalp O, Hindin MJ, Souza JP, Chou D, Say L. The prevalence of maternal near
360 miss: a systematic review. *BJOG* 2012;119:653-661.
- 361 7. Cohoon B. Cause of near misses: perceptions of perioperative nurses. *AORN J* 2011;93:
362 551-565.
- 363 8. Myers JA, Dominici F, Morlock L. Learning from near misses in medication errors: a
364 Bayesian approach, 2008. John Hopkins University, dept. of Biostatistics Working
365 Papers. Working Paper 178.
- 366 9. Kaplan HS. Getting the right blood to the right patient. The contribution of near-miss

- 367 event reporting and barrier analysis. *TransfusClinBiol* 2005;12:380-384.
- 368 10. Speroni KG, Fisher J, Dennis M, Daniel M. What causes near misses and how they
369 are mitigated? *Nursing* 2013;43:19-24.
- 370 11. Haw C, Cahill C. A computerized system for reporting medication events in
371 psychiatry: the first two years of operation. *J PsychiatrMent Health Nurs* 2011; 18: 308-
372 315.
- 373 12.Cushman JT, Fairbanks RJ, O’Gara KG, et al. Ambulance personnel perceptions of
374 near misses and adverse events in pediatric patients. *PrehospEmerg Care* 2010 Oct-
375 Dec;14(4):477-484.
- 376 13.Habraken MM, van der Schaaf TW. If only..... : failed, missed, and absent error
377 recovery opportunities in medication errors. *QualSaf Health Care* 2010; 19: 37-41
- 378 14. Altuwaijri MM. Electronic-health in Saudi Arabia: just around the corner? *Saudi Med*
379 *J.*2008;29(2):171–178.
- 380 15. Altuwaijri MM, Bahanshal A, Almehaid M. Implementation of computerized
381 physician order entry in National Guard Hospitals: assessment of critical success factors.
382 *J Family Community Med.* 2011;18(3):143–151.
- 383 16. Qureshi NA. Handwritten to Electronic Prescriptions: Emerging Views and Practices,
384 Saudi Arabia. *EMHJ* (under publication).
- 385 17. Qureshi NA. Electronic Prescribing: a brief review of literature. *EMHJ* (under
386 publication).
- 387 18. Al-Zaagi IA, AlDhwaihi KA, Al-Dossari DS, Salem SO, Qureshi NA. Analysis of
388 reported e-prescribing near misses in King Saud Medical City, Riyadh. *Integrated*
389 *Pharmacy Research and Practice* 2013; Volume 2013: 17-24.
- 390 19.Mustard CA, Kaufert P, Kozyrskyj A, Mayer T. Sex differences in the use of health
391 care services. *N Engl J Med.* 1998 Jun 4;338(23):1678-1683.
- 392 20. Camargo CA Jr, Tsai CL, Sullivan AF, Cleary PD, Gordon JA, Guadagnoli
393 E, Kaushal R, Magid DJ, Rao SR, Blumenthal D. Safety climate and medical errors in 62
394 US emergency departments. *Ann Emerg Med* 2012; 60(5):555-563.
- 395 21. Evans RS, Lloyd JF, Stoddard GJ, Nebeker JR, Samore MH. Risk factors for adverse
396 drug events: a 10-year analysis. *Ann Pharmacother.* 2005; 39(7–8):1161–1168.
- 397 22. Tanaka K, Otsubo T, Tanaka M, Kaku A et al. Similarity in predictors between near

- 398 miss and adverse event among Japanese nurses working at teaching hospitals. *Ind Health*
399 2010; 48: 775-782.
- 400 23. Barach P, Small SD. Reporting and preventing medical mishaps: lessons from non-
401 medical near-miss reporting system. *BMJ* 2000; 320:759–763.
- 402 24. Nanji KC, Rothschild JM, Salzberg C, et al. Errors associated with outpatient
403 computerized prescribing systems. *J Am Med Inform Assoc.* 2011;18(6):767–773.
- 404 25. Aronson JK. Medication errors: definitions and classification. *Br J*
405 *ClinPharmacol*2009; 67: 599-604.
- 406 26. Lisby M, Nielsen LP, Brock B, Mainz J. How are medication errors defined? A
407 systematic literature review of definitions and characteristics. *Int. Journal for Quality in*
408 *Health Care* 2010; 22: 6: 507-518.
- 409 27. MacPhee E, Sherrard H. An Innovative Approach to ‘Near Miss’ Capture for
410 Improvement of Patient Safety. A Canadian Patient Safety Institute Studentship Project
411 July 6, 2007 (Available at: [http://www. Patient safety institute.](http://www.PatientSafetyInstitute.ca/English/research/studentships/CPSI%20Studentship%20Project%20Summaries/Heather%20Sherrard,%20University%20of%20Ottawa%20Heart%20Institute.pdf)
412 [ca/English/research/studentships/CPSI% 20](http://www.PatientSafetyInstitute.ca/English/research/studentships/CPSI%20Studentship%20Project%20Summaries/Heather%20Sherrard,%20University%20of%20Ottawa%20Heart%20Institute.pdf)
413 [Studentship%20Project%20Summaries/Heather%20Sherrard,%20University%20 of%20](http://www.PatientSafetyInstitute.ca/English/research/studentships/CPSI%20Studentship%20Project%20Summaries/Heather%20Sherrard,%20University%20of%20Ottawa%20Heart%20Institute.pdf)
414 [Ottawa%20Heart%20Institute.pdf](http://www.PatientSafetyInstitute.ca/English/research/studentships/CPSI%20Studentship%20Project%20Summaries/Heather%20Sherrard,%20University%20of%20Ottawa%20Heart%20Institute.pdf).
- 415 28. Williamson S. Reporting medication errors and near misses. In: Medication Safety:
416 An Essential Guide, ed. Molly Courtenay and Matt Griffiths. Published by Cambridge
417 University Press. © M. Courtenay and M. Griffiths 2009. Available at: [https://dspace.](https://dspace.stir.ac.uk/bitstream/1893/2044/1/9780521721639c10_p155-172.pdf)
418 [stir. ac. Uk/bitstream/1893/2044/1/9780521721639c10_p155-172.pdf](https://dspace.stir.ac.uk/bitstream/1893/2044/1/9780521721639c10_p155-172.pdf) Accessed on July
419 13, 2013.
- 420 29. Fertleman M, Barnette N, Patel T. Improving medication management for patients:
421 the effect of a pharmacist on post-admission ward rounds. *QualSaf Health Care.*
422 2005;14(3):207–211.
- 423 30. Buurma H, De Smet PA, Leufkens HG, Egberts AC. Evaluation of the clinical value
424 of pharmacists’ modifications of prescription errors. *Br J ClinPharmacol.*
425 2004;58(5):503–511.
- 426 31. Qureshi NA, Al-Habeeb TA, Al-Ghamdy YS, Magzoub MMA, Schmidt HG.
427 Psychotropic drug prescriptions in primary care and general hospitals, in Saudi Arabia.
428 *Saudi Pharm J.* 2001;9:193–200.

- 429 32. Koppel R, Metlay JP, Cohen A, et al. Role of computerized physician order entry
430 systems in facilitating medication errors. *JAMA*. 2005; 293(10):1197–1203.
- 431 33. Scott JT, Rundall TG, Vogt TM, Hsu J. Kaiser Permanente’s experience of
432 implementing an electronic medical record: a qualitative study. *BMJ*.
433 2005;331(7528):1313–1316.
- 434 34. Jiménez Muñoz AB, MuiñoMiguez A, Rodriguez Pérez MP, Durán Garcia ME,
435 SanjurjoSaez M. Comparison of medication error rates and clinical effects in three
436 medication prescription-dispensation systems. *Int J Health Care QualAssur*.
437 2011;24(3):238–248.
- 438 35. Rogers AE. The Effects of Fatigue and Sleepiness on Nurse Performance and Patient
439 Safety. In: *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Edited
440 by Ronda G Hughes. Rockville (MD): Agency for Healthcare Research and Quality
441 (US); April 2008. Publication No.: 08-0043).
- 442 36. Astrand B, Montelius E, Petersson G, Ekedahl A. Assessment of eprescription
443 quality: an observational study at three mail-order pharmacies. *BMC Med Inform*
444 *DecisMak*. 2009;9:8.
- 445 37. Henneman EA, Gawlinski A. A “near-miss” model for describing the nurse’s role in
446 the recovery of medical errors. *J Professional Nursing* 2004; 20: 196-201.
- 447 38. Richardson, W. Innovations in patient safety management: Bedside nurses’
448 assessment of near misses. *Topics in Emergency Medicine* 2006; 28(2):154-160.
- 449 39. Rothschild JM, Churchill W, Erickson A, Munz K, Schuur JD, Salzberg CA et al.
450 Medication errors recovered by emergency department pharmacists. *Ann Emerg Med*.
451 2010 Jun; 55(6): 513-521.
- 452 40. Vlahovic-Palcevski V, Morovic M, Palcevski G. Antibiotic utilization at the
453 university hospital after introducing an antibiotic policy. *Eur J ClinPharmacol* 2000;
454 56(1):97-101.
- 455 41. Crass R. Improving intravenous (IV) medication safety at the point of care:
456 Retrospective analysis of pooled data using an innovative IV Harm Assessment Index.
457 Available at: [http://www.carefusion.com/pdf/Infusion/clinical_](http://www.carefusion.com/pdf/Infusion/clinical_documentation/white_papers/Improving_IV_Med_Safety_whitepaperIF2707.pdf)
458 [documentation/white_papers/Improving_IV_Med_Safety_whitepaperIF2707.pdf](http://www.carefusion.com/pdf/Infusion/clinical_documentation/white_papers/Improving_IV_Med_Safety_whitepaperIF2707.pdf)
459 (accessed on 19 July 2013).

- 460 42. Ardenghi D, Martinengo M, Bocciardo L, Nardi P, Tripodi G. Near miss errors in
461 transfusion medicine: the experience of the G. Gaslini Transfusion Medicine Service.
462 *Blood Transfusion* 2007; 5(4): 210–216.
- 463 43. Wu A. Near Miss with Bedside Medications (Spotlight Case); available at:
464 [http://webmm.ahrq.gov/case.aspx? Case ID =254](http://webmm.ahrq.gov/case.aspx?CaseID=254) [Accessed on July 19, 2013].
- 465 44. Lefkovitz A, Zarowitz B. Top 10 lists - medications associated with adverse events
466 and medications involved with errors. *Geriatr Nurs* 2007 Sep-Oct;28(5):276-279.
- 467 45. Kuyper AR. Patient counseling detects prescription errors. *Hosp Pharm.*
468 1993;28(12):1180–1181, 1184–1189.
- 469 46. Awad A, Abahussain E. Health promotion and education activities of community
470 pharmacists in Kuwait. *Pharm World Sci.* 2010;32(2):146–153.
- 471 47. Benjamin DM. Reducing medication errors and increasing patient safety: case studies
472 in clinical pharmacology. *J ClinPharmacol.* 2003;43(7):768–783.
- 473 48. Friedman SM, Provan D, Moore S, Hanneman K. Errors, near misses and adverse
474 events in the emergency department: what can patients tell us? *CJEM* 2008;10:421-427.
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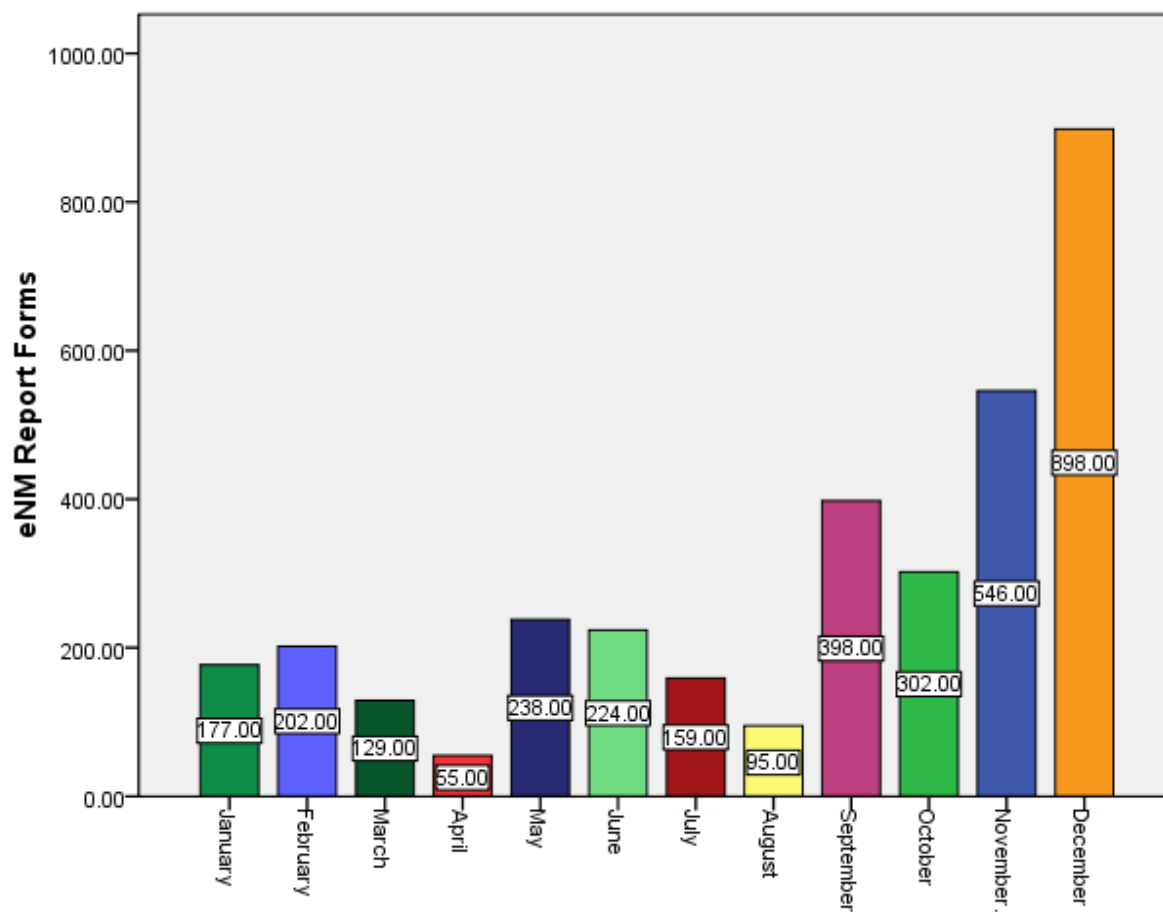


Figure 1: eNM Report Forms by Months

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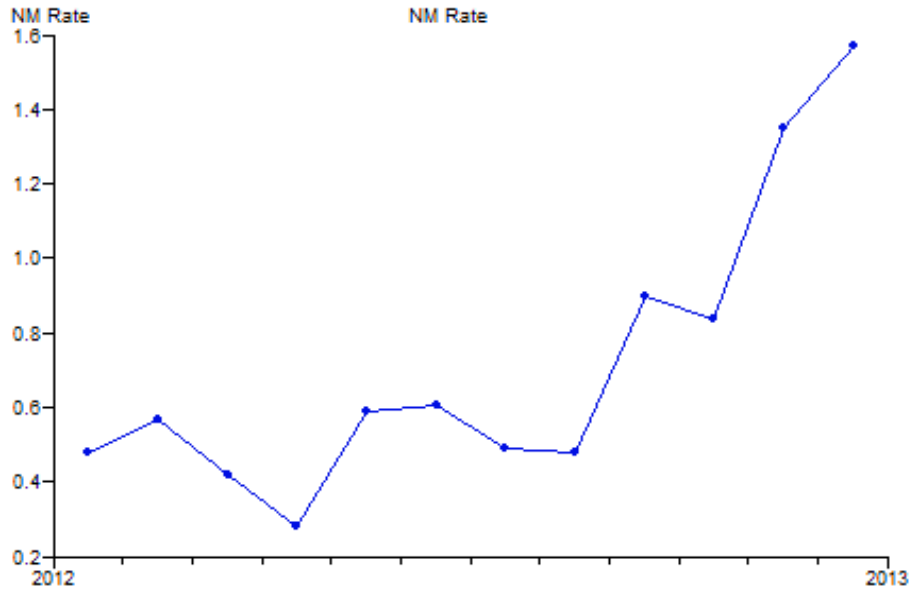
Table 1. NMs by month in 2012

Month / Variable	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
No. of prescription	96321	92000	86012	88829	97548	88821	83644	65163	86819	78053	77154	95718	1036082
No. of NMs	459	527	361	252	572	545	406	315	785	657	1038	1498	7415
Rate of NMs%	0.48	0.57	0.42	0.28	0.59	0.61	0.49	0.48	0.90	0.84	1.35	1.57	0.72

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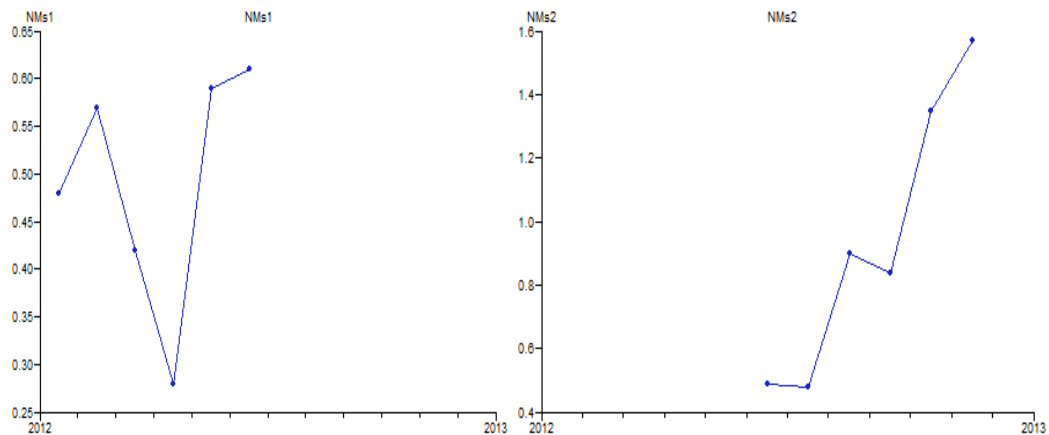
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Figure 2. Time-series graph of month-wise NMs rate for the year 2012.



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Figure 3 & 4. Time-series graphs for NMs during the first 6-months (NMs1) and second 6-months (NMs2) during 2012



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Table 2. Distribution of drug-related variables in NMs medication errors

Medication variables in NMs	First 6-months		Second 6-months		Z value	P value
	No. of Cases	%	No. of Cases	%		
Wrong Frequency	266	25.95	633	26.27	0.42	0.67
Incorrect Dose	250	24.39	415	16.57	5.39	0.00007
Wrong Drug	126	12.29	343	13.69	1.11	0.26
Wrong Duration	97	9.46	242	9.66	0.18	0.85
Wrong Strength/ Concentration	92	8.98	529	21.12	8.60	0.00001
Wrong Dosage Form	57	5.56	94	3.75	2.41	0.01
Monitoring Error-Drug- Drug	53	5.17	70	2.79	3.49	0.0005
Wrong Quantity	28	2.73	9	0.36	6.28	0.00001
Wrong Patient	21	2.05	22	0.88	2.87	0.004
Omission Error	14	1.37	21	0.84	1.43	0.15
Wrong Documentation	12	1.18	28	1.12	0.13	0.89
Wrong Route	4	0.39	74	2.95	4.70	0.00003
Wrong Rate	3	0.29	14	0.56	1.03	0.29
Wrong Time of Administration	2	0.19	11	0.44	1.08	0.27
Total	1025	100%	2505	100%		

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Table 3. Stages during which near miss medication errors were discovered

Stages Involved	First 6-months		Second 6-months		Z value	P value
	No. of Cases	%	No. of Cases	%		
Transcription & Entering	676	55.32	1074	43.93	6.51	0.000001
Physician Ordering	397	32.49	1150	47.03	8.40	0.000001
Dispensing & Delivery	115	9.41	210	8.59	0.82	0.41
Monitoring	24	1.96	8	0.33	5.02	0.000005
Administration	10	0.82	3	0.12	3.34	0.0008
Total	1222	100%	2445	100%		

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523 Table 4. Health professionals who committed near miss medication errors

Health professionals	First 6-months		Second 6-months		Z value	P value
	No. of Cases	%	No. of Cases	%		
Physicians	493	47.27	282	10.42	24.96	0.000001
Nurses	436	41.80	2197	81.18	23.63	0.000001
Pharmacists	66	6.33	29	1.07	9.1	0.000001
Asst. Pharmacists	48	4.60	198	7.33	3.0	0.002
Total	1043	100%	2706	100%		

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526 Table 5. Health professionals who identified near miss medication errors

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Error Identifiers	First 6-months		Second 6-months		Z value	P value
	No. of Cases	%	No. of Cases	%		
Pharmacist	1002	97.28	2251	93.83	4.19	0.00003
Nurse	14	1.36	24	1.00	0.92	0.35
Asst. Pharmacist	10	0.97	119	4.96	5.62	0.00002
Clinical Pharmacist	2	0.19	1	0.04	1.38	0.166
Physicians	2	0.19	4	0.17	0.17	0.86
Total	1030	100%	2399	100%		

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529 Table 6. Actions taken by pharmaceutical staff in response to near miss medication
530 errors

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Action	First 6-months		Second 6-months		Z value	P value
	No. of Cases	%	No. of Cases	%		
Change to correct dose/drug/duration/frequency/rate/route/dosage form/patient/strength/quantity	710	34.97	1025	19.03	14.45	0.000001
Pharmacist note & wait for response	358	17.64	1880	34.91	14.45	0.000001
Call reporter for clarification	471	23.20	322	5.98	21.39	0.000001
No Dispensing	331	16.31	1900	35.28	15.88	0.000001
Educational Session	48	2.36	156	2.89	1.24	0.21
Cancelled drug	28	1.38	16	0.29	5.41	0.000006
Forward order to nurse/physician/pharmacist	28	1.38	27	0.79	3.92	0.00009
D/C Drug	24	1.18	17	0.32	4.48	0.000007
Informed Nurse/Physician to change the order	12	0.59	22	0.41	1.03	0.29
OVAR	11	0.54	8	0.15	2.98	0.0028
Supervise the Asst. Pharmacist/Pharmacist during dispensing	9	0.44	12	0.22	1.59	0.111
Total	2030	100%	5385	100%		

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544 Table 7. Causes of near miss medication errors

Cause of Error	First 6-months		Second 6-months		Z value	P value
	No. of Case	%	No. of Case	%		
Lack of Staff Education	419	34.12	2127	49.95	9.80	0.000001
Miscommunication of Drug Order	387	31.51	1865	43.79	7.71	0.000001
Environmental, Staffing, or Workflow Problem	199	16.21	89	2.09	19.53	0.000001
Drug Information Missing	121	9.85	99	2.33	11.84	0.000001
Drug Name, Label, Package Problem	40	3.26	50	1.17	5.06	0.000004
Lack of Quality Control or Independent Check System	39	3.18	11	0.26	9.47	0.000001
Clinical Information Missing	15	1.22	12	0.28	4.14	0.000003
Drug Delivery Device Problem	4	0.33	2	0.04	2.60	0.009
Drug Storage or Delivery Problem	3	0.24	1	0.02	2.52	0.011
Patient Education Problem	1	0.08	2	0.04	0.45	0.64
Total	1228	100%	4258	100%		

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546 Table 8. Locations where near miss medication errors were made

Site of Errors	First 6-months		Second 6-months		Z value	P value
	No. of Case	%	No. of Case	%		
OPD-General Hospital	453	44.67	841	34.88	5.39	0.000007
ER-General Hospital	237	23.37	767	31.81	4.95	0.000007
OPD Maternity Hospital	203	20.02	326	13.52	4.80	0.000002
In-Patient Pharmacy	53	5.23	33	1.37	6.58	0.000001
OPD-Pediatric Hospital	23	2.27	136	5.64	4.28	0.000002
Out-Patient Pharmacy	22	2.17	42	1.74	0.84	0.39
ER-Pediatric Hospital	12	1.18	169	7.01	6.95	0.000001
OR-Pediatric Hospital	7	0.69	47	1.95	2.70	0.006
Others	4	0.39	50	2.07	3.8	0.0001
Total	1014	100%	2411	100%		

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548 Table 9. Medications involved in near miss medication errors

Medications	First 6-months		Second 6-months		Z value	P value
	No. of Cases	%	No. of Case	%		
Anti-infective	239	22.61	512	20.61	1.33	0.18
Cardiovascular agents	207	19.58	354	14.25	3.97	0.00007
CNS Agents	154	14.57	367	14.77	0.15	0.87
Nutritional products	69	6.53	130	5.23	1.53	0.12
Gastrointestinal Agents	67	6.34	145	5.84	0.57	0.56
Coagulation modifiers	64	6.05	837	33.69	17.28	0.000001
Metabolic agents	46	4.35	76	3.06	1.92	0.05
Hormones	39	3.69	79	3.18	0.77	0.43
Respiratory agents	37	3.50	412	16.59	10.71	0.000001
Topical agents	29	2.74	56	2.25	0.87	0.38
Genitourinary Tract Agents	19	1.81	36	1.45	0.76	0.44
Psychotherapeutic Agents	17	0.95	92	3.70	3.30	0.001
Antineoplastics	13	1.23	21	0.85	1.07	0.28
Miscellaneous agents	57	5.39	98	3.95	1.92	0.05
Total	1057	100%	2484	100%		

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550 Table 10. Recommendations to avoid near miss medication errors

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Recommendation	First 6-months		Second 6-months		Z value	P value
	No. of Cases	%	No. of Cases	%		
Double Check	822	50.09	426	12.59	28.84	0.000001
CME	511	31.14	1276	37.72	4.56	0.000005
Physician Entry/stop nurse medication entry	303	18.46	1484	43.87	17.63	0.000001
Medication Reconciliation	3	0.18	96	2.84	6.35	0.000002
Patient Counseling	2	0.12	--	--	2.03	0.042
System Upgrade	--	--	101	2.98	7.07	0.000001
Total	1641	100%	3383	100%		

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