Absent, missed and failed error recovery in medication errors

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Abstract. Systematic analysis and understanding of error recovery can provide hospitals with the necessary information to improve their resilience. Because errors will always crop up and 100% safety can never be achieved, health care systems should be able to prevent patient harm by timely and effective error recovery. In this paper we identified absent, missed and failed recovery opportunities in 56 medication errors, of which 52 resulted in severe patient harm or patient death. At least one recovery opportunity was present in nearly all of the medication errors. In the set of 52 full-blown accidents 127 recovery opportunities were identified. Of these, 94 recovery opportunities were *planned* recovery opportunities; 33 recovery opportunities were *unplanned* recovery opportunities. For these recovery opportunities the underlying failure factors were identified and classified according to the Eindhoven Classification Model. The majority of the failure factors underlying the planned recovery opportunities were organisational failure factors; the majority of the failure factors underlying the unplanned recovery opportunities were human failure factors. From this study it can be concluded that accidents can be used as an alternative data source to near misses for the analysis and understanding of error recovery.

1 INTRODUCTION

Patient safety is an important issue in health care. Between 44,000 and 98,000 people in the United States die in hospitals each year because of medical errors. The implementation of a safety management system consisting of predictive risk analysis and retrospective incident analysis is recommended as a solution to this huge problem [Aspden et al., 2004]. The importance of retrospective incident analysis is already widely recognized in health care. Incidents are analysed in a more or less systematic way to identify the factors underlying the failure. Subsequently, countermeasures are determined to prevent the incidents from recurring. Until recently however, retrospective incident analysis particularly concentrated on the identification of failure factors. Nowadays, the importance of the analysis of error recovery is more and more recognized in the health care domain. In case of a near miss timely and effective error recovery did prevent patient harm [Van der Schaaf, 1991]. Systematic analysis and registration of near misses is rather important because, in comparison with accidents, near misses provide supplementary information to hospitals. Near misses can be used to identify recovery factors in addition to failure factors. Recovery factors explain why developing incidents did not result in a real accident or in other words, why safety related consequences were pre-

vented [Kanse, 2004; Van der Schaaf and Kanse, 2000]. These factors provide us with an insight into the extent to which health care systems are capable of detecting and correcting initial failures. Such information about error recovery provides hospital management with an additional strategy to improve patient safety; that is, enhancing their resilience [Van der Schaaf and Wright, 2005].

Information about error recovery can be obtained in two ways. Usually, near misses are collected and analysed in order to find out why patient harm was prevented. This approach concentrates on successful recovery. However, missed or failed recovery opportunities can also provide us with important safety related information. In a recent field study on near misses in a hospital pharmacy Kanse et al. (2006) demonstrated that often multiple recovery opportunities are missed or fail before successful recovery takes place. Kanse et al. classified the factors that contributed to missing or failing error recovery into the Eindhoven Classification Model for failure factors. Subsequently, the hospital pharmacy has been recommended to reduce these negative influences on error recovery. However, one might assume that, in addition to near misses, accidents could also provide us with information about negative influences on error recovery. In case of accidents recovery actions might have failed, recovery opportunities might have been missed, or recovery opportunities might have been absent at all. In this explorative study we identified and categorised recovery opportunities in full-blown medication errors to find out whether or not it is useful to identify recovery opportunities that have not been utilized or that have failed. Moreover, we try to answer the question whether real accidents can be used as an alternative data source to near misses for the analysis and understanding of error recovery.

2 METHODS

2.1 Data collection

In an earlier study we collected 56 medication errors in hospitals as reported to the Dutch Health Care Inspectorate. Except for 4 near misses, these medication errors all resulted in severe patient harm or patient death. In-depth causal analysis of the 56 medication errors identified on average 7.1 failure factors per incident. These failure factors have subsequently been classified according to the Eindhoven Classification Model that consists of five main categories of failure factors: technical, organisational, human, patient related and other failure factors [Habraken, 2005; Habraken and Van der Schaaf, 2005]. In this study we made use of the causal trees of those medication errors.

2.2 Procedure

To determine the procedure for the identification and categorisation of the recovery opportunities, we selected 10 medication errors out of the total set of 56 medication errors. This sample was representative for the complete data set in terms of type of medication error (i.e. the stage of the medication process in which the initial failure occurred) and

complexity. We independently identified possible recovery situations in the causal trees of the ten selected medication errors. During a consensus meeting the results were compared and finally we agreed upon the identified recovery opportunities. Subsequently, we categorised the identified recovery opportunities. Initially, we used existing categories for error recovery. We distinguished between planned and unplanned error recovery and between missed and failed recovery opportunities [Kanse et al., 2006; Van der Schaaf and Kanse, 2000]. *Planned* recovery opportunities involve defences and barriers that are built into the health care system to avoid safety related consequences [Hollnagel, 1999; Svenson, 2001]. *Unplanned* recovery opportunities are ad hoc solutions and largely depend on the problem solving abilities of the people involved [Kanse et al., 2006]. When categorising the identified recovery opportunities, we decided to add several categories. Finally, we distinguished six categories. Three categories for planned recovery opportunities: planned-absent, planned-missed, and planned-failed. And three categories for unplanned recovery opportunities: unplanned-absent, unplanned-missed, and unplanned-failed.

The categories for planned recovery opportunities were used in case of formalized barriers that were utilized, but that failed (planned-failed), barriers that could have been utilized, but that were not utilized (planned-missed), or barriers that could not be utilized because they were absent, but that should have been in place according to the state-of-the-art or expert opinion (planned-absent). Examples of planned recovery opportunities are upper limits for medication dosage in a Computerized Physician Order Entry (CPOE) system and a double check procedure before medication administration. If a double check is performed, but the person who performs the double check does not detect the initial failure, the category planned-failed is used. If a double check is not performed, but a double check should be performed according to existing procedures, the category planned-missed is used. If a double check is not performed because there is no procedure, but such a procedure should have been present, the category planned-absent is used.

The categories for unplanned recovery opportunities were used in case the people involved might have been able to correct the initial failure by using their knowledge, experience and problem solving abilities. If a person is aware of the initial failure, but does not (successfully) correct it, the category unplanned-failed is used. If a person does not detect the failure, but should have detected the failure because the failure was very obvious or because the person should have detected the failure according to their professional qualities, the category unplanned-missed is used. If a person should have detected the failure, but the person was lacking the necessary resources or abilities, the category unplanned-absent is used.

After we agreed upon those categories, we independently identified and categorised the recovery opportunities in the total set of 56 medication errors. If we could not determine which category should be assigned to a particular recovery opportunity, we decided to assign two categories that counted half each. We discussed the categorisations until a consensus was reached.

Finally, we linked the six categories for recovery opportunities to the failure factors underlying the recovery opportunities to determine the negative influences on error recovery. All failure factors had already been identified and classified according to the Eindhoven Classification Model. For each recovery opportunity we registered the underlying failure factors and the accompanying classification codes. Then, we were able to create a profile of underlying failure factors for each category of recovery opportunities.

3 RESULTS

In the 52 medication errors that resulted in severe patient harm or patient death, 127 recovery opportunities were identified that had been absent, missed, or that had failed. In the 4 near misses we identified 8 recovery opportunities that had been absent, missed, or that had failed before successful recovery took place. The number of recovery opportunities per medication error ranged from 0 to 11. On average 2.4 recovery opportunities were present in the set of accidents; for the near misses on average 2.0 recovery opportunities were identified. Only in 4 accidents no recovery opportunities were identified at all.

Table 1 shows the distribution of the recovery opportunities over the six categories. Of the 127 recovery opportunities that were identified in the set of accidents, 94 were planned recovery opportunities and 33 unplanned recovery opportunities. All 8 recovery opportunities that were identified in the set of near misses were planned recovery opportunities. The planned recovery opportunities that were identified in the set of accidents were equally distributed among the categories planned-absent (32.5), planned-missed (29.5), and planned-failed (32). The majority of the unplanned recovery opportunities were categorised as unplanned-failed (17). Note that the frequency of some categories is not a whole number because in a few cases two categories were assigned to a single recovery opportunity.

Table 1. Distribution of recovery opportunities over categories. A distinction is made between accidents and near misses

Category for recovery opportunities	Accidents (n = 52)	Near misses (n = 4)
Planned-absent	32,5	2
Planned-missed	29,5	3
Planned-failed	32	3
Unplanned-absent	5,5	0
Unplanned-missed	10,5	0
Unplanned-failed	17	0
Total	*127*	*8*

Table 2 shows the number of times various failure factors contributed to the absent, missed and failed *planned* recovery opportunities. It should be noted that multiple failure factors can underlie a single recovery opportunity. Hence, the total number of failure factors (134) exceeds the total number of planned recovery opportunities (94). The dominant failure factor that contributed to absent, missed and failed planned recovery is organisational protocols. This means that absent, incomplete or unclear protocols hindered the health care employees from successful error recovery. In many cases these protocols were related to double checks after medication preparation or just before medication administration. Failure to recover from the medication errors was also due to incorrect or incomplete assessment and verification of the materials and the patient before starting the intervention. Other failure factors that made it impossible for the health care employees to recover from the initial failures are management priorities and an organisational culture in which compliance with safety related procedures and agreements is low. Regarding the main categories of failure factors the organisational failure factors contributed the most to absent, missed and failed planned recovery opportunities.

Table 2. Failure factors and main categories of failure factors underlying absent, missed and failed planned recovery opportunities.

Failure factor	Number of times failure factor was underlying an absent, missed or failed recovery opportunity	Number of times main category of failure factors was underlying an absent, missed or failed recovery opportunity
Technical – External	1	11
Technical – Design	7	
Technical – Construction	2	
Technical – Materials	1	
Organisational – Knowledge transfer	1	74
Organisational – Protocols	42	
Organisational – Management priorities	16	
Organisational – Culture	15	
Human – External	1	45
Human – Knowledge	5	
Human – Qualifications	1	
Human – Coordination	6	
Human – Verification	25	
Human – Intervention	6	
Human – Monitoring	1	
Patient Related Factor	3	4
Unclassifiable	1	
Total	*134*	*134*

Table 3 shows how often particular failure factors were underlying the absent, missed and failed *unplanned* recovery opportunities. Again, the total number of failure factors (49) exceeds the total number of unplanned recovery opportunities (33). No dominant failure factor has been identified. Several failure factors to some extent contribute to unsuccessful recovery. In several full-blown medication errors suspicion was present. In these cases a health care employee, the patient or a visitor was more or less aware of the initial failure, but lack of verification, coordination or in-depth knowledge hindered them from successful error recovery. In other cases the persons involved were not able to solve the problem because of absent, erroneous, incomplete or unclear protocols and procedures. In contrast with unsuccessful planned error recovery, human failure factors contributed the most to absent, missed and failed unplanned recovery opportunities.

Table 2. Failure factors and main categories of failure factors underlying absent, missed and failed unplanned recovery opportunities.

Failure factor	Number of times failure factor was underlying an absent, missed or failed recovery opportunity	Number of times main category of failure factors was underlying an absent, missed or failed recovery opportunity
Technical – Design	1	1
Organisational – Knowledge transfer	4	17
Organisational – Protocols	7	
Organisational – Management priorities	5	
Organisational – Culture	1	
Human – Knowledge	6	28
Human – Coordination	6	
Human – Verification	10	
Human – Intervention	4	
Human – Monitoring	2	
Patient Related Factor	2	3
Unclassifiable	1	
Total	*49*	*49*

These results imply that hospitals can reduce the negative influences on *planned* error recovery by improving organisational protocols that health care employees need to be able to detect and correct medication errors, by giving top priority to safety, and by reflecting on the existing organisational culture and the attendant modes of behaviour. On the other hand, focussed training and instructions can reduce the negative influences on *unplanned* error recovery. Hospital management should be sure that the knowledge and skills of the health care employees is up-to-date to enable them to detect and correct medication errors.

4 DISCUSSION

In this study we demonstrated that information about error recovery can also be obtained from full-blown accidents such as medication errors that resulted in severe pa-

tient harm or patient death. At least one recovery opportunity was present in nearly all of the medication errors that have been analysed in this study. Because these recovery opportunities did not result in successful error recovery, the underlying failure factors can provide us with relevant information about negative influences on error recovery. Together with information about positive influences on error recovery that can be obtained by analysing near misses, this information provides hospitals with the necessary information to enhance their resilience. Hospitals should not only reinforce the positive influences on error recovery, but they should also reduce the negative influences on error recovery.

Regarding the analysis of accidents and near misses one should therefore perform two steps in order to obtain as much information as possible about error recovery. In case of near misses the steps that led up to the successful recovery should be identified and categorised. In case of both near misses and accidents one should identify and categorise the absent, missed and failed recovery opportunities that arose after the occurrence of the initial failure.

Because of the fact that this study is explorative in nature, no formal interrater reliability checks have been performed. In future studies we will determine the extent to which multiple raters assign the same category to a particular recovery opportunity. A potential bias of the approach that is advocated in this paper is hindsight bias. One should prevent to identify absent and missed recovery opportunities, which in fact can not be expected to be present according to the state-of-the-art or expert opinion. In this study we prevented this kind of bias by only using information that was agreed upon by inspectors of the Dutch Health Care Inspectorate, being experts in the field of medical error investigation.

5 CONCLUSION

Because accidents can provide us with information about absent, missed and failed recovery opportunities and the underlying failure factors, information about negative influences on error recovery can be obtained from full-blown accidents. Accidents can thus be used as an alternative data source to near misses for the analysis and understanding of error recovery. This insight in error recovery is rather important because errors will always crop up. Health care systems should therefore be resilient; they should be able to prevent patient harm by timely and effective error recovery.

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