Rapid response systems. Recognition and management of the deteriorating patient
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Chapter 10

Epilogue
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Clinical futile cycles

The Swiss Cheese model described by James Reason is a very useful model to describe factors underlying adverse events (AE) in hospital environments.\(^1\) Whenever "the wholes within the cheese do lineup" AEs are likely to occur and also multiple factors have to be precisely in line in order for the AE to occur. However, it isn’t always applicable for every case and more complex adverse events such as described by Dr. Michael Buist, a practicing internist and intensivist at the University of Tasmania. As a patient, he nearly died wasn’t it for the actions of the Rapid Response Team (RRT) after nearly bleeding out after an episode of acute appendicitis. After this episode, he focused on describing this term ‘clinical futile cycles’. It refers to a situation in which clinical staff, presented with a patient, just goes round and round the problem without solving the entire problem and moving the problem to another person, area, or space and not towards resolution. This has been further elucidated and described as ‘professional silos’ in which the needs of patients are not the center of care but dictated by the rigid practice of medicine with its own tribal boundaries including discrete geographical sites of care and specialized teams.\(^2\) If fluent and efficient care is to be provided, these functional barriers should be overcome and broken down.\(^3;4\)

Clinically deteriorating patients on nursing wards may find themselves ‘stuck’ in these situations. Multi-organ involvement is present in the majority of clinical deterioration and requires a more holistic view. Organ specialists don’t always appreciate the patient as an entire system and therefore additional delay may be present, resembling the silo concept.\(^5;6\)

Because clinically deteriorating patients on the nursing wards show in up to 80% of times abnormal vital signs in the 24 hours prior an AE, these patients should be readily recognized and triggered.\(^7;10\) In light of these findings, the concept of Medical Emergency Teams (MET) or Rapid Response Systems (RRS) was already developed as early as 1995.\(^11\)

Many attempt have been made in the recent two decades to evaluate and analyze the effectiveness of RRSs. Studies performed in the late nineties and early 2000s, demonstrated great benefit after introduction of RRSs especially on cardiac arrest rates.\(^12;14\) The largest cluster randomized trial held to date, the MERIT study, was underpowered and showed no improvements in the rates of cardiopulmonary arrest, intensive care unit ICU) admission or death with do-not-attempt-resuscitation (DNAR) decision.\(^15\) The main reason why no improvement was observed, was the lack of statistical power due to significant variation between outcomes of the participating hospitals. A post hoc analysis of the MERIT study identified a significant inverse relationship between the proportion of the early RRT calls and the number of unexpected deaths and cardiac arrest rates in both the intervention and control hospitals.\(^16\) Also,
the cardiac arrest teams in the control hospitals were acting in a more pro-active manner and were called more often to deteriorating patients instead of strictly codes. Through media attention, control hospitals were “polluted” and this may also have contributed to the results of the MERIT trial. (Personal communication Hillman) Despite the absence of irrefutable evidence regarding effectiveness of RRSs, recent meta-analyses show a significant trend in reduction of cardiac arrest rates and a declining trend in other outcomes. By some, these findings are difficult to explain as attributable to other single interventions in acute hospitals with potential similar impact. Irrespective of these findings, RRSs are implemented around the world including large parts of Europa, United States of America and Australia.

Afferent limb

The primary component of the afferent limb is a Track and Trigger (TT) system. This system relies on the measurement of vital signs. Measurement of individual vital signs does not have high predictive power and it seems that a combination of vital signs shows a different profile. Track and Trigger systems assign a score or at least define a threshold to warrant immediate assistance. There are largely two different systems in place, single parameter and aggregated weighted multi-parameter systems. These systems have imperfections where to date, a balance needs to be created between excessive workload and increased triggering with more false positives (lower specificity) and reduced workload and increased false negatives (lower sensitivity). There is no evidence supporting a superior role for either of the two systems and therefore it seems regional differences reflect local preference. Recently, groups in the UK are working on perfecting the aggregated weighted systems. A national early warning score (NEWS) is now implemented in the UK with better discriminative capabilities then previous multi-parameter system, with Areas Under the Receiver Operating Curve between 0.722 and 0.873 for the different endpoints. These systems are truly bedside tools and can be applied to the patient without additional delay. The same group also identified additional benefit regarding predicting capabilities after adding blood test parameters.

Despite these systems being present, measurement of the vital signs remains paramount in order for the system to operate. Accumulating evidence suggests that institutions do not reliably measure vital signs on patients in a systematic and relevant manner even in the days after complex surgery. Respiratory rate has even been named “the neglected vital sign” and remains difficult to measure by nurses. Direct influence of RRSs or just (one of) its components did show an increased surveillance and measurement of vital signs.

Afferent limb failure or delayed triggering in case of deteriorating patients is directly correlated with unplanned ICU admissions and even mortality. Besides RRT activation rate, it is also associated with the level of maturity of the system within an institution. Compliance to measuring vital signs and to the escalation protocol is difficult...
to measure and data indicate that there is ample room for improvement. In a study performed in an academic hospital in the Netherlands using a quasi-experimental approach, wards were randomized to measure vital signs and the Modified Early Warning Score (MEWS, an aggregated weighted TT) three times daily on each patient compared to on clinical indication. Frequent measurements resulted in enhanced implementation, increased compliance to protocol and less doctor delay after reaching the trigger threshold. (Ludikhuize et al. Submitted for publication).

Possible solutions for these problems may lie in the automation of these processes. The VITAL Care study, was an international multi center before-after study, employing electronic advisory vital signs monitoring at the bedside. Implementation of this system resulted in improved RRT calls triggered by abnormal respiratory rates, increased survival of patients receiving a RRT call and decreased time spend by nurses measuring and recording these parameters. Other non-invasive measuring equipment relies on trend analysis and are very precise at predicting deterioration. In another study performed in Australia, electronic recording of vital signs linked to a computer system was able to calculate risk scores and issue an alert resulting in earlier attendance at unstable patients on general medical wards. On the contrary, in a small randomized study performed in the UK, full five-channel monitoring at the request of ward staff did not have any effect on adverse events or mortality within the medical or surgical patient population. Due to lack of real randomization, selection bias may have contributed to these findings and the very small population that was studied makes this study very likely to be underpowered. But why does not anyone call for help when a patient triggers? There are likely many cultural and psychosocial factors at play determining RRS activation which aren’t at this moment fully (scientifically) appreciated. In a provocative paper from 1998, this question was addressed in cases of suboptimal care. Failure to appreciate clinical urgency, lack of supervision and failure to seek advice were the main causes for delay. As possible solutions, RRSs and more general debate about structure and the process in acute care was advocated.

Efferent limb

To date, little scientific literature is present specifically investigating the efferent component. Regarding RRT composition, no (randomized) comparative trials have been held investigating the differential effect on clinical outcome. In general, physician led teams tend to show greater effectiveness. Interestingly, there are largely two systems in place on how the RRT can be activated. From the start of RRS literature and in the majority of countries except the Netherlands, the RRT is called directly by the nurses in charge of a deteriorating patient. Within the Netherlands, the “home team” otherwise known as the primary responsible physician, is called to the patient and are
able to assess and manage the patient in a set time frame. Recently, through personal communication with Professors Hillman and Jones (Universities of Sydney and Melbourne respectively), Australia is at the brink of changing to a more Dutch system due to concerns about excessive workloads and deskilling of ward staff. Interestingly, some institutions (primarily in the USA) have experience and also described data regarding family activation of the RRT. As described above, a RRT has to be called when a certain threshold is reached. Perhaps due to professional boundaries and freedom, mandatory activation of RRTs is only debated in few editorials whereas this almost seems an unnecessary question.

**Administration and educational limb**

The ‘Chain of Prevention’ postulated by Professor Smith from the UK, explains that five rings may assist hospitals in structuring their care processes and prevent cardiac arrest and patient deterioration in general. The five rings of the chain of prevention represent ‘staff education’, ‘monitoring’, ‘recognition’, the ‘call for help’ and the ‘response’. It is a general believe that (continuous) education is paramount in the working life of health care providers. Some data are available describing specific courses, teaching specific knowledge and skills to nurses and (junior) doctors to assess and treat the deteriorating patient. Impact of these courses is only tested at a small scale and not in clinical practice. As part of the COMET study, basic knowledge regarding normal boundaries and thresholds of vital signs was measured on nurses and physician. Surprisingly, many care-providers have a skewed perception of these normal boundaries and this might explain (to some degree) the delays in recognition and management of these patients. Providing feedback to the wards in respect to specific cases may offer one form of direct and applied knowledge transfer to assist in implementation of RRSs.

**Clinical implications and future research**

The COMET study is a provoking and elaborate study which has taken place in the Netherlands at the moment the hospitals were mandated to implement RRSs. In this situation, the most appropriate trial design was chosen which was deemed feasible. Because of its multicenter character, correction for multiple patient and hospital confounders, we found a significant reduction in the composite endpoint of either experiencing a cardiopulmonary arrest, unplanned ICU admission or death by roughly 15%. The COMET study has its imperfections but contributes greatly to the body of knowledge regarding RRSs and should provoke political debate regarding mandatory implementation and regulation. In accordance with the literature and experiences from abroad, the RRS within the COMET study was not fully implemented as seen by the low number of registered RRT activations within the COMET study. This holds true for many other situations as not only described in this thesis. Compliance to MEWS/SBAR, as
shown in chapter 6 was marginal and only improved on those wards were three times daily measurement was imposed. (Chapter 7)

Further analysis of data from the COMET study may elucidate these problems further and analyze dose-response curves similar to the MERIT trial. As part of the COMET study, data on knowledge and exams taken after introduction of the MEWS/SBAR and RRT was gathered. In preliminary analyses, large discrepancies are present in respect to population of nurses who have limited knowledge regarding normal vital parameters and recognition of a deteriorating patient. Through informal meetings with (nursing) heads of departments, unwillingness and lack of urgency also seems to be present among nurses (and physicians) comparable to findings of McQuillan et al almost 20 years ago. At this point, we only have data regarding perception of care-providers of their abilities and skills in the pre-RRS era and it would be interesting to repeat this in the future (chapter 3). In relation to the COMET study, satisfaction with the system and compliance related questions were also administered at a large scale throughout the study (chapter 8). Future analyses will investigate correlations in time and also clustered differences between hospitals in respect to outcome.

Although the COMET study has its limitations in respect to methodology, the absolute numbers of included patients, the pragmatic nature of the study, its elaborative statistical analysis and it’s in line with current evidence, should warrant mandatory implementation and strict compliance with the imposed guidelines. But how can the care for those patients still at risk be improved at this moment in light of imperfect and difficult system interventions like RRSes? This is a very difficult question to answer as more information on the precise nature of the problem is still lacking but is likely to lie in psychosocial factors and difficulty reviewing these clinical pathways in real time. Therefore, I postulate some form of contact culture with penalties imposed for non-compliance. This is very innovative and “not done” in health care, but non-compliance to set guidelines in respect to measuring MEWS, calling a physician when a threshold is reached etcetera isn’t that difficult. The same holds true for physicians because the fall into the same protocol and should be able to hold accountable for non-compliance. What kind of penalties should be imposed is outside of the scope of this thesis and should be left at the management of the institutions as they are directly accountable for the quality of care of their institutions.

Measuring non-compliance is an intensive and time-consuming investment but can be implemented straight away on a sample basis. To really gain insight into this clinical process, real time monitoring of the system is required. Automation of the institutions is happening at this very moment. Electronic patient charts are already present in a large part of hospitals in the Netherlands. This may lead to a “perfect world” as this makes life easier for researchers, managers but also the care-provider and is likely to further decrease adverse events. Much research has gone into perfecting Track and Trigger
systems and combining vital signs data with recent laboratory data almost makes it a perfect screening instrument with very high sensitivity and specificity. The industry has many potential interesting “gadgets” that enable non-invasive vital signs monitoring. Through personal communication with some of the manufactures, hospitals are using these instruments and linking them to their electronic management systems. It would be very interesting to set-up a cluster-randomized trial in which hospitals having a RRS are randomized for receiving these non-invasive instruments versus way of measuring and dealing with vital signs. Patient outcome, but also early clinical deterioration and system performance can be investigated and further elucidated. 69 (Ludikhuize et al, submitted)

Concluding, implementation of RRSs in the Netherlands should be mandated by the inspectorate of healthcare based on our findings. Deteriorating patients are a normal and everyday life occurrence and should be dealt with in swift, systematic and appropriate manner. Some form of accountability in regards to actions of care-providers may improve the effectiveness of the system directly and immediately. In order to further enhance patient safety in regards to RRSs, more research should be performed into ways to optimize utilization, compliance and effectiveness of the system.
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