A REVIEW OF RISK MATRICES USED IN ACUTE HOSPITALS IN ENGLAND

ABSTRACT

In healthcare, patient safety has received substantial attention and, in turn, a number of approaches to managing safety have been adopted from other high-risk industries. One of these has been risk assessment, predominantly through the use of risk matrices. However, whilst other industries have criticised the design and use of these risk matrices, the applicability of such criticism has not been investigated formally in healthcare. This study examines risk matrices, as used in acute hospitals in England, and the guidance provided for their use. It investigates the applicability of criticisms of risk matrices from outside healthcare through a document analysis of the risk assessment policies, procedures and strategies used in English hospitals. The findings reveal that there is a large variety of risk matrices used, where the design of some might increase the chance of risk misprioritisation. Additionally, findings show that hospitals may provide insufficient guidance on how to use risk matrices as well as what to do in response to the existing criticisms of risk matrices. Consequently, this is likely to lead to variation in the quality of risk assessment and in the subsequent deployment of resources to manage the assessed risk. Finally, the paper outlines ways in which hospitals could use risk matrices more effectively.

KEY WORDS: Patient safety; safety risk assessment; risk matrix

1. INTRODUCTION

The healthcare industry has paid substantial attention to the improvement of patient safety.[1] To this end, a number of leading reports have been published[2,3] and a range of approaches have been adopted from other high risk industries.[4,5] Risk assessment is one such approach, where the aim is to prevent harm before it occurs by addressing three questions: "*What could go wrong?*", "*How bad and how often?*", and *"Is there any need for action, and if so, what?*".[6,7] However, organisation-wide risk assessment in healthcare is predominantly conducted by the use of risk matrices, and risk matrices have inherent challenges that limit the effectiveness of the risk assessment.[7–10]

A risk matrix is a tool to visualise and prioritise risks and to guide resource allocations.[9,11,12] It consists of likelihood (or probability or frequency) and consequence (or severity or impact) axes to estimate a risk rating. Risk prioritisation and resource allocations are determined depending on where the risk rating falls on the risk matrix.[9,13,14] Figure 1 shows a generic example of a 5 x 5 risk matrix, where both axes are categorised by using nominal descriptors (e.g. rare and negligible) and the risk matrix is divided into 3 bands. A lower band, which may often be coloured green, represents low risks, which are tolerable and, therefore, no risk treatment measures are needed. A middle band, which may be coloured orange, represents moderate risks to be reduced to *As Low As Reasonably Practicable* (ALARP). An upper band, which may be coloured red, represents high risks, which are typically intolerable and, therefore, risk treatment is essential.[14,15] Depending on which coloured band the risk rating is assigned to, the assessor decides whether or not to treat the risk and what actions are needed.[9]

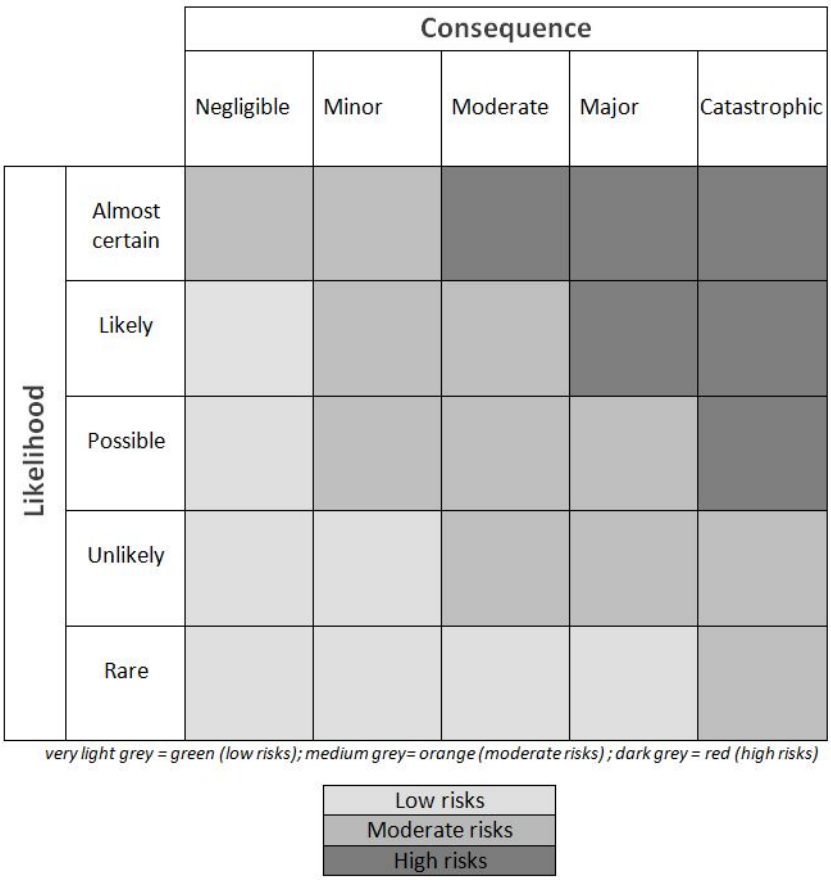


Fig. 1. A 5 x 5 risk matrix

In England, each hospital defines its own risk matrix to be used in risk assessment, which includes the assessment of clinical, organisational, health and safety and financial risks.[12] Risk matrices are embedded into the organisational risk register system that each hospital member can access the system and register a risk. A risk matrix can help to visualise and prioritise a range of risks that are reported by different individuals (e.g. clinicians, nurses, managers) across different units.[16] The simplicity of a risk matrix and its convenience in representing risks make it a frequently used tool.[17,18] However, anecdotal evidence shows that practical risk management in hospitals might misuse or overuse the risk matrices by using the matrices as an assessment, measurement and control tool rather than a simple visualisation tool. However, there have also been criticisms in the safety research literature regarding the effectiveness of risk matrices even with its feature of being a visualisation

tool.[9,10,13,18–22] Some researchers have focused on technical problems,[13,21] while some have focused on the subjectivity of the risk ratings.[18] In addition, the traditional risk description that the risk matrices were built on it was found to be insufficient.[23,24] Cox has even warned that risk matrices may be "*worse than useless"*.[9] These authors suggest that there are challenges to using risk matrices that should be overcome in order to achieve more reliable results. Yet, there is little research that demonstrates how risk assessment practice in healthcare has been taking these criticisms into account. One study, which does aim to assess this, is Card et al (2013), which evaluated risk assessment and risk control guidance provided in 25 Trusts in East of England. They found that there is insufficient guidance provided to support risk evaluation and risk control.[10] Here, we build on this work by extending the scale of the investigation and the analysis.

This study examines the risk matrices used in acute hospitals in England and identifies potential problems that result in light of existing criticisms. It also makes a number of recommendations for improving the risk matrices and their use in hospitals.

2. METHODS

Document analysis was conducted by collecting relevant data from acute hospitals in the English National Health Service (NHS). Acute hospitals provide consultation with specialist clinicians, emergency treatment, surgery and specialist care.[25] To obtain data, a Freedom of Information Act (FOI) request was sent to all acute hospitals in the English NHS (160) on July 11, 2016, by e-mail. The hospitals were asked to provide their current risk assessment procedure and policy (or nearest equivalent documents, e.g. risk management policy, strategy, procedure or guidance).

Collected documents were reviewed to examine the risk matrix used by each hospital. Variables for examining risk matrices used in hospitals included the characteristics of risk

matrices, and guidance on likelihood and consequence ratings. The characteristics of risk matrices were defined by identifying the risk matrix size (e.g. a 3x3 or 5x5 matrix), matrix type (as being symmetrical or asymmetrical), the number of bands on the risk matrix and the risk ratings for each band. The variables of guidance on likelihood and consequence rating included whether each consequence domain (e.g. impact on safety or finance) and each likelihood scale (e.g. nominal, time-framed, probability-based) were defined, and whether further guidance was provided for risk rating.

3. RESULTS

3.1. Response Rate

There is a legal obligation for hospitals to aim to respond to a FOI request within 20 working days of receipt.[26] 100 (out of 160) hospitals responded within 35 working days following the FOI request. From the collected responses, 142 documents (4190 pages) were collated.

3.2. Risk Matrices

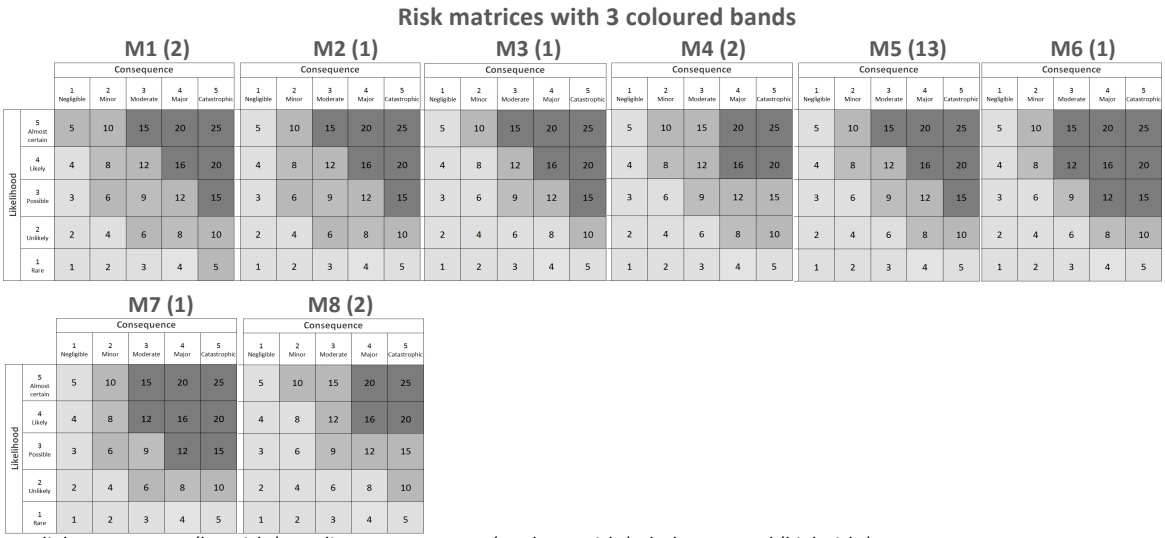
The reviews of the data showed that all hospitals except one estimated their clinical or non-clinical (e.g. financial, health and safety, and organisational) risk ratings by multiplying likelihood and consequence. A single hospital used a different calculation for risk rating *(Risk rating = Likelihood + Impact + Control measure)*. Due to the uniqueness of this approach, this hospital's documents were not included in the study.

All remaining hospitals (99) used a 5x5 risk matrix. Typically, the consequence (C) axis was categorised with nominal descriptors (e.g. negligible and minor), and a score from 1 to 5 was assigned for each descriptor as follows: *negligible=1, minor=2, moderate=3, major=4 and catastrophic=5*. Likewise, the likelihood (L) axis most often used was: *rare=1, unlikely=2, possible=3, likely=4 and almost certain=5*. Since scores are assigned to both consequence

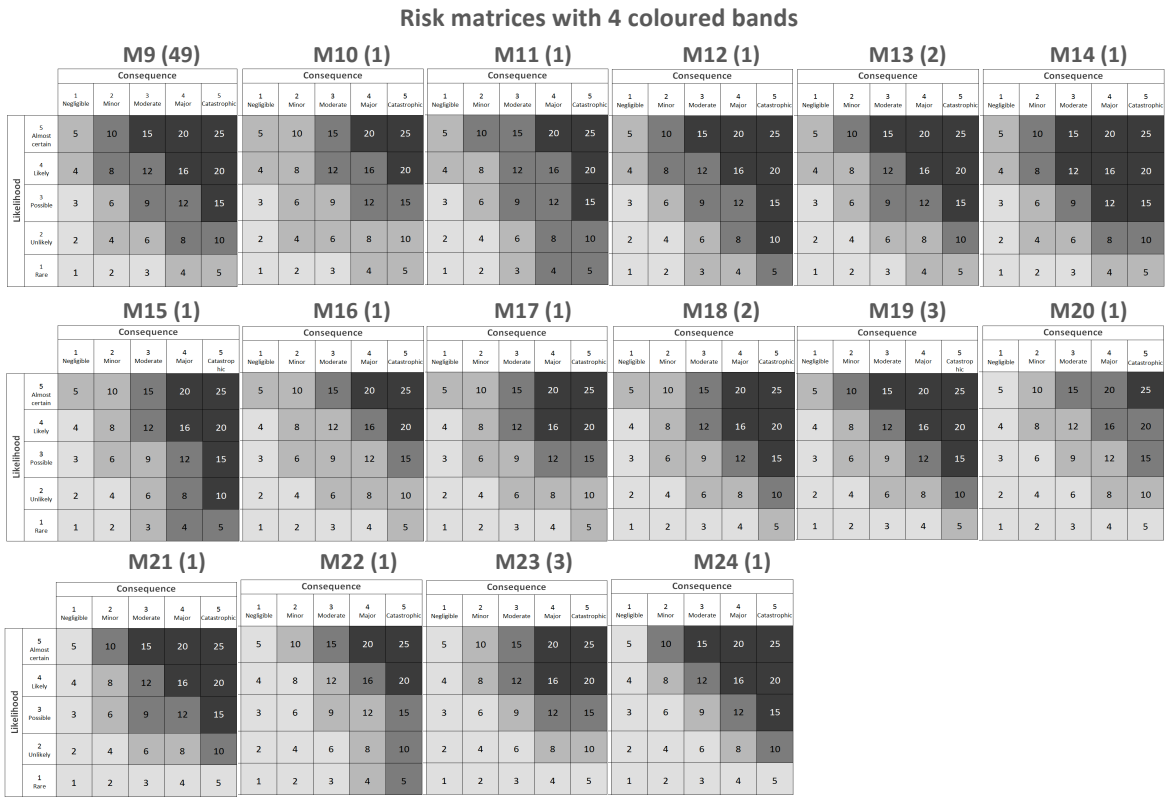
and likelihood categories, the risk rating is represented by a risk score. Therefore, the risk score is estimated by multiplying the two scores.

3.2.1. Characteristics of Risk Matrices

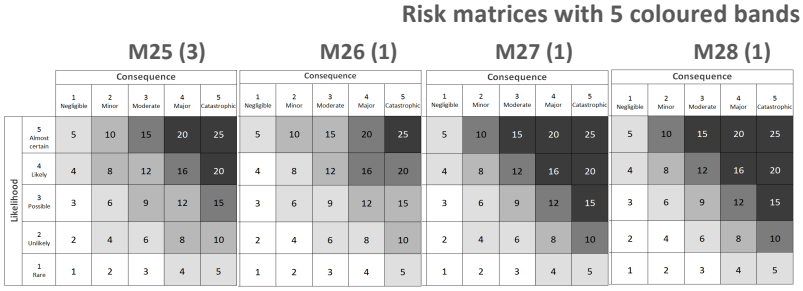
The characteristics of risk matrices include their size, consideration of risk matrix types, the number of coloured risk bands, and their meanings. Figure 2 illustrates every type of risk matrix identified from the data obtained and by how many hospitals. Each unique risk matrix type is identified with a code from M1 to M28, and risk matrices are grouped by determining the number of coloured bands.



very light grey= green (low risks); medium grey = orange (moderate risks); dark grey = red (high risks)



very light grey= green (low risks); light grey= yellow (moderate risk); medium grey = orange (high risks); dark grey = red (extreme risks)



white= dark green (very low risks); very light grey= green (low risks); light grey= yellow (moderate risk); medium grey = orange (high risks); dark grey = red (extreme risks)

Fig. 2. Types of risk matrix used in different acute hospitals in England (the number of hospitals used)

Between them, the 99 hospitals identified 28 different risk matrices in their policies and procedures. Of these, 23 use a risk matrix with 3 coloured bands, 70 use one with 4 coloured bands and 6 use one with 5 coloured bands. Coloured bands were defined by the hospitals to categorise the risk ratings, to determine the tolerability of a risk, and the level of management action needed. For example, a green (very light grey in Figure 2) band *(a risk score of 1-3)* on the risk matrix of M9 represents low risk, a yellow (light grey) band *(a risk score of 4-6)* represents moderate risk, an orange (medium grey) band *(a risk score of 8-12)* represents high risk, and a red (dark grey) band *(a risk score of 15-25)* represents extreme risks. Similarly, a risk matrix with 3 coloured bands categorises risk ratings as low, moderate and high; and one with 5 coloured bands categorises risk ratings as very low, low, moderate, high and extreme.

Although coloured bands determine the tolerability of a risk, only 28 hospitals explained the link between the coloured bands and the level of tolerability on their documents. Risk tolerability refers to the willingness to live with risk, but not necessarily accepting the risk.[27] However, only a few of these 28 hospitals set a tolerability level aligned each coloured band. For instance, a hospital using the M9 described tolerability levels as: a green band represents acceptable risks, a yellow band and an orange band represent tolerable risks, and a red band represents intolerable risks. Remaining hospitals either only described acceptable or unacceptable risks, such as *"below a score of 12 is acceptable"*, and "*risks being lead to death is unacceptable*".

To determine the level of management action, hospitals provided guidance based on the coloured bands. The level of management attention comprises the distribution of responsibilities, the level of prioritisation for actions, and the assignment of risk review

frequency. Table I provides examples of this from 3 randomly selected hospitals. However, it should be noted that the specific management actions can vary from hospital to hospital.

Table I. Examples of the level of management attention for each coloured band

Coloured bands	Management responsibility	Action prioritisation	Review frequency
3 Coloured bands			
Green band (Low risk)	Ward/ departmental level	No immediate action required	Annually
Orange band (Moderate risk)	Divisional/ directorate level	Action required	Quarterly
Red band (High risk)	Board level	Immediate action required	Monthly
4 Coloured bands			
Green band (Low risk)	Ward/ departmental level	No immediate action required	Annually
Yellow band (Moderate risk)	Divisional level	Action required	Quarterly
Orange band (High risk)	Directorate level	Action required	Monthly
Red band (Extreme risk)	Board level	Immediate action required	Monthly
5 Coloured bands			
Dark green band (Very low risk)	Ward/ departmental level	No action required	Annually
Green band (Low risk)	Ward/ departmental level	No immediate action required	Bi-annually
Yellow band (Moderate risk)	Divisional level	Action required	Quarterly
Orange band (High risk)	Directorate level	Action required	Monthly
Red band (Extreme risk)	Board level	Immediate action required	Monthly

In seven risk matrices, the product of the scores does not establish the coloured bands. These are M11, M12, M13 M15, M18, M22 and M28, which we refer to as asymmetrical risk matrices. In an asymmetrical risk matrix, the same risk score can be assigned to different risk rating categories. As an illustration of this point, a hospital may be faced at all times *(giving a likelihood score of 5)* with a risk of incomplete orders of intraocular lenses. However, they are various ways in which this risk could be managed to minimise the consequences *(giving a consequence score of 1)*. Alternatively, the risk of contamination during the manual handling process of infectious blood samples might be something, which is not expected (*giving a likelihood score of 1*), but it could ultimately lead to death *(giving a consequence score of 5)*.

While both risks are scored as 5 (*L:5 x C:1* and *L:1 x C:5*), an asymmetrical risk matrix of M22 assigns the former as a low risk and the latter as a high risk.

3.2.2. Consequence and Likelihood Scoring Guidance

All hospitals provided nominal descriptors for scoring consequence and likelihood (e.g. *negligible* and *minor*; *rare* and *unlikely*). However, although the majority of hospitals provided further guidance for scoring consequence and some for likelihood, none provided any justification for their recommended guidance.

85 hospitals (out of 99) offered detailed guidance for scoring consequence, all of which were based on a single report, *"A risk matrix for risk managers"*.[12] These hospitals provided explanations for each nominal descriptor by considering each consequence domain (i.e. impact on safety, quality, human resources, statutory requirements, reputation, business objectives, finance, service interruption and the environment).[12] Table II provides an example of such guidance for the consequence domain of '*impact on safety'*.

Table II. Consequence scoring guidance for impact on safety[12]

Consequence Score	**Nominal descriptor**	**Explanation (impact on safety)**
1	Negligible	Minimal injury requiring no/minimal intervention or treatment
2	Minor	Minor injury or illness requiring minor intervention
3	Moderate	Moderate injury requiring professional intervention
4	Major	Major injury leading to long term incapacity/disability
5	Catastrophic	Death or multiple permanent injuries or irreversible health effects

40 hospitals provided a time-framed scale *(i.e. L:1=not expected to occur for years, L:2=at least annually, L:3=at least monthly, L:4=at least weekly and L:5=at least daily)* to score likelihood; slightly more (44) hospitals provided probability scales (e.g. *L:1= <0.1% and*

L:5= >50%); and 25 hospitals provided both. While all hospitals provided the same time-framed scale to score likelihood, there were two particularly commonly used probability scales out of a total of 12 probability scales. This is likely to mean that even if two hospitals have the same risk matrix, the assessors in these two hospitals would score the same risk differently due to their different guidance on likelihood scoring.

Only 16 hospitals provided guidance on scoring a risk where there might be multiple potential consequences in the same consequence category. To illustrate this concept, a risk of a patient falling on a ward could lead to various degrees of harm: no harm *(with a consequence rating of 1 and likelihood rating of 4)*, minor cuts and bruises *(with a consequence rating of 2 and likelihood rating of 3)*, hip fracture *(with a consequence rating of 4 and likelihood rating of 2),* or death *(with a consequence rating of 5 and likelihood rating of 1).* Of those who provided guidance, five advised using *'the worst case scenario'* strategy; four advised using *'the highest risk score'* strategy; one advised using *'the most likely scenario'* strategy; and six advised using *'reasonably foreseeable worst case scenario'* strategy. For example, following the worst case scenario strategy might lead to death, and, therefore, to a risk score of 5 *(with a consequence rating of 5 and likelihood rating of 1);* whereas following the most likely scenario strategy would lead to no harm to be determined, and, therefore, to a risk score of 4 *(with a consequence rating of 1 and likelihood rating of 4)*.

4. DISCUSSION

This paper provides an overview of the risk matrices used in hospitals in England. The findings reveal that hospitals, which responded, use a range of risk matrices as well as different guidelines for scoring consequence and likelihood of the risks. Although one may think that this might be due to a hospital's risk appetite, as some hospitals might accept or tolerate more risks than others, no explanations were found to justify their use of the selected

risk matrix or guideline. In turn, hospitals might reach different decisions on the management of the same risk. However, the main problem identified concerns the adequacy of the guidance provided for their use and the limitations inherent to the risk matrices used. This section therefore examines in more detail the currently used risk matrices and guidelines in the light of the existing criticisms in the literature, and provides a number of recommendations for their potential improvement.

4.1. Analysis of the Existing Guidance on the Use of Risk Matrices

The review of the risk assessment policies and procedures reveals a lack of clarity in the guidance provided in the following areas: the meaning of coloured bands, what to do when a risk could result in different consequences, which likelihood scoring scheme to use and in what circumstances, the strategy of risk scoring, and the strategy of risk prioritisation for the same scored risks.

It is not clear from the results whether or not coloured bands indeed determine the tolerability of a risk (e.g. a green band refers to tolerable risks). In fact, risk scores bear little relation to the real risk ratings. Actually, even if quantitative values were used to estimate risk ratings, the assessors' strength of knowledge on the event, its consequences and probability would impact on the judgments made to estimate the risk ratings.[24,28,29] In addition, the tolerability of a risk might require consideration of multiple other factors in addition to likelihood and consequence. Indeed, when evaluating risks, there are additional factors to determine, including detectability of a risk, the rapidity with which the risk will manifest itself and potentially additional legal requirements.[23,30–32] Thus, it should be acknowledged that the solely reliance on the coloured bands when making risk tolerability decisions might mislead the assessors. Yet, the level of tolerability can be set by providing less precise instructions, such as the green bands refers to '*generally tolerable'* risks, instead of referring to *'tolerable'*

risks despite the fact that this could lead to more inconsistency in the use of the risk matrices and might add more subjectivity to the current risk assessment practice in hospitals.

85 hospitals (out of 99) provided descriptors to score the consequences for different consequence domains (e.g. impact on safety and reputation). However, no guidance was found detailing what to do when a risk could result in different consequences for different consequence domains. For instance, severely delayed cancer treatment might result in unavoidable harm to patients as well as patient complaints and reputational damage. Risk matrices evaluate risks by considering a single consequence domain. This can be considered as a limitation of the use of risk matrices. To address such a problem, we suggest that analysts could aggregate or combine risks. Indeed, Card *et al* have suggested compiling an index of total assessed risks in healthcare.[10] This allows risk assessors to consider all domains of consequence for a risk and to measure the overall risk by taking the sum of the individual risks for each domain. However, no evidence has been found in the literature to support the effectiveness of such a method in healthcare.

There was also a lack of clarity around the guidance provided for scoring likelihood. Hospitals provided different types of likelihood scales (i.e. nominal, time-framed and probability), and yet none of these provided any further guidance on when to use which type of likelihood scoring scale. Intriguingly, there was no reference to time in any of the hospitals' guidance on the use of probabilities. For instance, it was not clear if the probability of 50% refers to a day or a year. Apart from the hospitals' documents, there are exceptions to this. For example, the UK's National Patient Safety Agency has suggested that probability and time can be used concurrently, but provides this guidance only in the context of project management and the management of business objectives.[12] Similarly, Duijm recommends using probability for one-off projects and frequency for continuous operations.[13] This

indicates that hospitals could predominantly use a time-framed likelihood scale to score likelihood of a risk since most of the risks in hospitals are in relation to operations.

It was also not always clear from the collected dataset how to score a risk when it might result in various degrees of severity with different probabilities (as mentioned earlier with the patient fall example). 16 hospitals, however, did provide strategies for such circumstances. These are '*the worst case scenario'*, '*the highest risk score'*, '*the most likely scenario'*, and '*reasonably foreseeable worst case scenario'*. However, all strategies might lead to bias at some point. For instance, '*the worst case scenario'* might lead to an over consideration of the most extreme cases; '*the most likely scenario'* might ignore the extreme cases; '*the reasonably foreseeable worst case scenario'* might lead to most of the risk scores being assigned to intermediate coloured bands; and '*the highest risk score scenario'* might require the measurement of risk scores for all possibilities, which might be considered to be time consuming. Although there is always a possibility of bias in following such strategies, it is advised in the literature to consider *'the worst credible case scenario'* as referring to '*the reasonably foreseeable worst case scenario'*.[31,33–35]

Additionally, there was no evidence found on which of the risks should be given a priority when multiple risks received the same score. For instance, many risks might be scored as the same and, therefore, assigned to the same risk level (if the risk matrix is symmetrical). However, the risk matrix does not help the assessor to decide which one to give priority for risk treatment. For example, is it better to prioritise higher likelihood risks of similar scored (those that are most likely to see), or higher impact risks (those that may cause most harm)? While the quantitative risk rating values might help to decide which one to prioritise, it would be less practical for healthcare staff to consider quantitative risk ratings rather than scores. Yet, they could consider additional factors. In the safety literature, this has been

acknowledged that risk-based decisions should be made by considering beyond the findings of risk analysis.[24,36,37] This involves both professional and subjective judgement. For instance, patient safety is often stated as primary goal in hospitals, and there might be multiple other factors to consider when prioritising risks, including organisational objectives, detectability, legislation, and the resources needed to implement any risk controls.

To address such challenges, providing better guidance would help healthcare staff to use risk matrices more effectively. However, there are a number of other issues in relation to the design and the use of risk matrices that need to be determined to be able to use risk matrices better.

4.2. Analysis of the Currently Used Risk Matrices

Reviews of the results suggest that risk matrices can be used by hospitals inconsistently due to the risk scoring and the selection of risk matrices.

Hospitals use descriptors for consequence (e.g. negligible, minor, moderate, major and catastrophic) and likelihood (rare, unlikely, possible, likely and almost certain) by simultaneously assigning scores to these descriptors. However, the product of scores will bear little relationship to the underlying risk ratings, which might lead to a compound error. For instance, a risk with a score of 25 may not be 25 times as bad as a risk with a score of 1 from the real world descriptions of these scores. Figure 3 demonstrates the significance of the quantitative risk rating between the lower right and upper left corner as being £0 to over £500,000, instead of 1 to 25. Thus, the use of risk scores might mislead assessors in determining the significance of a risk, especially when comparing one risk to another.

While the above discussion concerns the replacement of risk ratings by risk scores, there are also limitations inherent to the use of risk ratings. Cox claims that the qualitative risk rating

categorisation (e.g. low, moderate and high) is a simplification to make risk related decisions; quantitatively different risk ratings can be assigned to identical risk ratings category; and quantitatively lower risk ratings can be assigned to a higher qualitative risk rating category.[9,38] Such limitations are demonstrated in Figure 3 by the use of the M9 risk matrix and guidance provided by a hospital. Since hospitals use scores in line with the descriptions of consequence and likelihood categories, risk scores are also assigned to the risk matrix in Figure 3.

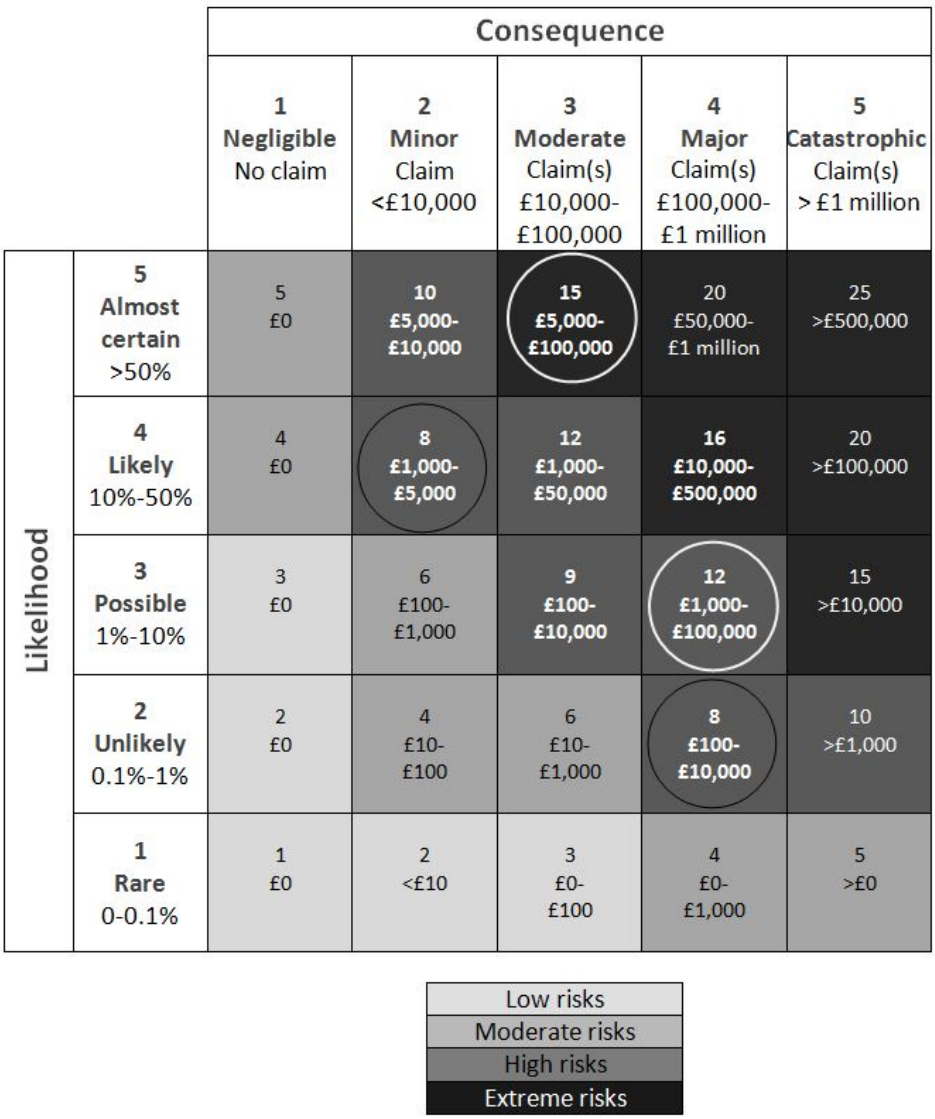


Fig. 3. Quantitative risk matrix for M9

Figure 3 shows that a quantitative risk rating of £10,000 per annual can be assigned to both the high risk and extreme risk rating categories. Similarly, a risk score of 8 is estimated to represent a cost of between £1,000 (L:4 x C:2) and £5,000 or between £100 and £10,000 (L:2 x C:4).

The results of this study also show that 9 hospitals use asymmetrical risk matrices, where a risk score can be assigned to different risk rating categories by the same risk matrix. Such matrices do not just use the product of risk scores to establish coloured bands. While technically this could be considered as an inconsistency, they could have used the descriptions behind the scores to establish the coloured bands. What is more, asymmetrical risk matrices can be deliberately designed due to a hospital's risk appetite. A hospital might not be willing to take the risk with a consequence score of 5 and a likelihood score of 1 whereas the same hospital might be willing to take the risk with a consequence score of 1 and a likelihood score of 5. However, no information was provided on the reviewed documents to explaining how the coloured bands are established.

Additionally, findings showed that two risk matrices (M3 and M6, see Figure 2) share an edge between green and red cells, which increases the possibility of categorising a low risk to a high-risk level. This was criticised by Cox as this increases the risk of incorrectly categorising a risk rating, and it was recommended that there be an intermediate band between green and red. However, Cox also warned that having two or more intermediate bands could also lead to incorrectly categorising risks due to the increased possibility of weak consistency, and 76 of the reviewed risk matrices have at least two intermediate bands, as can be seen in Figure 3.[9] The limitations inherent in risk matrix design, therefore, increase the risk of misprioritisation.

4.3. Further Considerations Regarding the Use of Risk Matrices

There are some inherent limitations in the use of risk matrices, which also apply to the risk matrices currently used in hospitals. These limitations include the simplicity of the consideration of risk rating, the difficulty of linking relevant risks and the subjectivity of risk scoring.

The findings reveal that hospitals replace risk ratings by risk scores, and hospitals recommend estimating the risk score by simply considering likelihood and consequence scores. However, this simplification has recently been criticised and it has been recommended that additional factors are considered.[23,39,40] These factors include the determination of the risk sources, uncertainty about the events and their consequences, and the strength of knowledge of the assessors.[41–43] For example, there might be two situations giving the same place in the risk matrix, but they are completely different from a risk perspective (in one case really poor knowledge supporting the likelihoods, in the other very strong). The strength of knowledge of assessors can be evaluated by considering data used for the assessment, the justification for the likelihood assumptions made, and reaching agreement between the assessors regarding the assessment.[23] Although these factors might add more complexity to current practice in healthcare, risk would better be described by consequence, likelihood of event with that consequence and strength of knowledge supporting the likelihood and consequence judgment. In so doing, Aven and Renn suggested the use of an extended risk matrix that specifies the strength of knowledge used in the risk assumptions by dividing it as strong, medium and poor.[28]

A risk matrix can only assess an individual risk at any one time,[9,19] which limits the understanding of the risk sources as well as the links between different risks. Many of the risks immediately evident are linked to other less visible risks. For instance, a risk to inpatient bed capacity may be linked to delays on surgery, and delays in discharge. However, other

tools and techniques can also be used with risk matrices to address some of this challenge. Failure modes and effects analysis may help to identify undesired events in relation to the system to be assessed, and the bow-tie technique may help in understanding the pathways of a risk from its sources to consequences.[14] However, with the exception of Chatzimichailidou *et al*,[44] there is little evidence to show that such tools, especially the bow-tie, are often used in hospitals.[40–42] More importantly, these tools also assess a single event or failure mode at once.

Subjectivity also impacts the effectiveness of risk matrices. Individual perception might lead to biased judgements about the management of the risks.[18,21] This may stem from job function or seniority, personal experiences and the level of confidence.[21,48,49] Furthermore, individuals might purposefully be subjective. Risks can be deliberately understated or overstated in order to avoid or gain management attention. For instance, a study revealed that the patient risk of metal phosphide poisoning was overstated by hospital staff due to the ethical and legal issues involved.[50] Suggestions to overcome these problems include the use of quantitative data, team assessment, peer review, risk scoring guidance and a separate risk matrix for each consequence domain (e.g. financial and harm related consequences).[10,13,51] Since data in healthcare might not be easily quantified, providing better guidance on scoring risks and encouraging staff to use this guidance may be helpful to overcome bias in decisions. However, anecdotal evidence so far shows that healthcare staff might score risks without consideration of the descriptors behind the scores. As a result, different individuals might score the same risk differently even in the same hospital.

In summary, risk matrices are widely used to assess risks in hospitals. However, there are a number of limitations to using risk matrices that might lead to poor prioritisation of risks and inadequate resource allocation. Nonetheless, there are still some advantages to using the risk

matrix as a tool in assessing risks. A risk matrix helps illustrate risk scores in a table and prioritise risks through the use of coloured cells, and there may be no need for expertise to use this tool.[9,52] These features make the risk matrices the commonly used tool to assess risks in hospitals.

Limitations

The main limitation of this research is that the reviewed risk assessment policies and procedures may not reflect the actual practice of risk assessment and subsequent actions. For example, risk managers and risk leads might use risk matrices differently to add more value to their risk assessment. However, until recently, the National Health Service Litigation Authority (NHS LA) was assessing the risk management practices of acute hospitals by considering the NHS LA risk management standards, which includes the assessment of hospitals' risk management strategies, policies and procedures in terms of its content, practice and performance.[53] We, therefore, believe that such documents should reflect the actual practice.

Furthermore, the non-response rate (37 percent) to the FOI request is likely to have affected this study. However, it is likely that a higher response rate would have led us to collect a higher number of risk matrix types as well as different levels of guidance without significantly affecting the arguments we make here.

What is more, we must note that we could not own all the knowledge of the risk science in our implications. This was due to hospitals unpreparedness to the dramatic changes in their risk management practice. As a result, it is likely that our suggestions might still misguide decision makers to some extent, but would provide better guidance for the use of risk matrices.

5. CONCLUSION

A variety of risk matrices are used across acute hospitals in the English National Health Service and are accompanied by the provision of different levels of guidance by different hospitals. Reviews of the risk assessment policies and procedures reveal that there is insufficient guidance available for the use of risk matrices. Indeed, no matter how well guidance has been provided by hospitals, there are limitations inherent to the use of risk matrices. So, until the time that hospitals are open and prepared to the dramatic changes on the way to use or not to use the risk matrices, we have a number of suggestions for consideration in English acute hospitals:

- Consider risk by not only estimating the likelihood of an event with its potential consequence, but also the strength of knowledge supporting the likelihood and consequence judgment. Perhaps, three dimensional risk matrices can be designed for this purpose.
- Introduce guidance on what to do when a risk has several consequences in multiple domains (e.g. a single risk may lead to personal injury, economic loss or reputational damage).
- Clarify which likelihood scoring scheme (i.e. nominal, time-framed and probability) should be used and in which circumstances.
- Clarify how risk should be scored where a range of consequence could occur with different likelihoods (e.g. a risk of patient fall could lead to no harm, minor cuts and hip fracture with different likelihoods).
- Clarify how risks that have been scored the same should be prioritised.
- Remind risk assessors that a risk matrix is not a tool for them to make decisions directly; but rather is one of several methods designed to support their decisions.

- Remind risk assessors that risk prioritisation require additional factors to be determined such as organisational objectives, detectability legislation, and the resources needed to implement any risk controls.
- Remind risk assessors that risk scores might show little relation to the real risk rating, and, therefore, a balanced and unbiased professional and subjective judgement should be involved when making risk informed decisions.

This study aims to raise more discussions on the use of risk matrices in risk management in hospitals, and it contributes to the current risk assessment practice in hospitals by highlighting the main challenges of the use of risk matrices as well as the guidance provided for their use. Further research is needed to strengthen the evidence behind the practical use of risk matrices in terms of how risks are actually scored and what the actual role of played by risk matrices is in making risk-based decisions.

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