

Review

# Verbal Probability Terms for Communicating Clinical Risk - a Systematic Review

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## Abstract

Verbal probability expressions such as ‘likely’ and ‘possible’ are commonly used to communicate uncertainty in diagnosis, treatment effectiveness as well as the risk of adverse events. Probability terms that are interpreted consistently can be used to standardize risk communication. A systematic review was conducted. Research studies that evaluated numeric meanings of probability terms were reviewed. Terms with consistent numeric interpretation across studies were selected and were used to construct a Visual Risk Scale. Five probability terms showed reliable interpretation by laypersons and healthcare professionals in empirical studies. ‘Very Likely’ was interpreted as 90% chance (range 80 to 95%); ‘Likely/Probable,’ 70% (60 to 80%); ‘Possible,’ 40% (30 to 60%); ‘Unlikely,’ 20% (10 to 30%); and ‘Very Unlikely’ with 10% chance (5% to 15%). The corresponding frequency terms were: Very Frequently, Frequently, Often, Infrequently, and Rarely, respectively. Probability terms should be presented with their corresponding numeric ranges during discussions with patients. Numeric values should be presented as X-in-100 natural frequency statements, even for low values; and not as percentages, X-in-1000, X-in-Y, odds, fractions, 1-in-X, or as number needed to treat (NNT). A Visual Risk Scale was developed for use in clinical shared decision making.

**Keywords:** probability, clinical reasoning, risk communication, medical decision-making

## Introduction

Risk is an inherent part of healthcare that requires communicating the probability of future events in the clinical context.<sup>1</sup> For instance, osteoporosis is associated with a risk of fragility fractures which can be reduced using different treatment options.<sup>2</sup> Verbal expressions of probability such as ‘probably’ and ‘likely’ are commonly used to communicate uncertainty in diagnosis, treatment effectiveness as well as the risk of adverse events with medications and surgical procedures. Patient surveys indicate a high demand for information on the risk of clinical outcomes.<sup>3</sup> Hence, it is critical that physicians and other health professionals communicate risks clearly and unambiguously as discordant interpretations can lead to misunderstanding, undesired decisions and unwanted outcomes. While visual formats such as pictograms have been advocated for

communicating probabilities,<sup>4</sup> verbal expressions are still used predominantly.<sup>3</sup> Plain language words are a natural choice in risk communication.

Previous research has elucidated certain recurring themes in the field of risk communication.<sup>5-7</sup> Probability terms are imprecise or vague by nature, yet people receiving information translate these into numeric values in order to make decisions.<sup>8</sup> There is a general preference for communicating risk to others using (imprecise) verbal terms while receiving risk information in (precise) numeric format.<sup>8</sup> The meanings of these terms are inherently vague and imprecise. Empirical studies with laypersons and health professionals have attempted measure the numeric interpretation of verbal terms. Verbal probability terms may be defined as words that communicate the numeric chance of an event. The aim of this review was to develop a standardized set of probability terms. An additional goal was to provide an overview of recommendations for risk communication in clinical medicine.

## Methods

A systematic review was conducted. Inclusion criteria included original research articles (with empirical data) that studied the interpretation of probability terms by laypersons and health professionals. Review articles and studies that evaluated visual formats such as graphs and pictograms were excluded. PRISMA guidelines (<http://prisma-statement.org/>) were followed. PubMed MEDLINE, PubMed Central, ProQuest PsyArticles, Academic Search Complete, Cochrane Library, ClinicalKey Elsevier, Google Scholar, Education Resources Information Center (ERIC), Nature, and Web of Science were searched (Supplementary File). Search keywords included “probability terms” as well as “communicat\* risk” (separately) using the Best Match (Relevance) sort order.

Terms commonly used in clinical settings for risk

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communication were identified from research studies that evaluated these terms. Numeric probabilities were collated from results of studies conducted with patients and health professionals. Terms with consistent interpretation across studies were selected based on their numeric ranges reported in empirical studies. Consistency was defined as numeric ranges that overlapped across studies. Verbal terms that showed a wide variation in interpretation across studies were excluded. A formal meta-analysis with weights based on sample sizes was not feasible due to heterogeneity of study designs. A visual scale was constructed by combining selected terms and their respective numeric ranges on a linear axis.

## Results

The search yielded 647 studies of which 6 met the inclusion criteria for full-text review (Table 1). Study designs were heterogenous: from psychology experiments to large scale

**Table 1.** Studies evaluating the interpretation of verbal probability terms

Study	Year	Country	Participants	Study design
Reagan et al.	1989	US	115 undergraduate students	Survey: assign numeric estimates to verbal terms, and vice versa
Shaw & Dear	1990	UK	100 mothers; 50 doctors and medical students	Survey: assign numeric estimates to verbal statements with probability terms
Mosteller & Youtz	1990	US	238 science writers	Mailed questionnaire survey: assign numeric probabilities to 52 probability expressions
Ness	1995	US	194 college students	Survey with 3 methods: Percentage Estimation, Successive Interval Transformed, and Rank Order
Fillenbaum et al.	1991	US	23 graduate students	Psychology experiment: comprehension and selection tasks
Wintle et al.	2019	US	924 participants	Online survey: numerical judgements from participants for each of the 7 verbal probability expressions

online surveys. Methodological quality and rigor were generally low (lack of blinding, control groups, randomization or retest validation). There were no randomized trials; hence, weighted meta-analysis, risk of bias, and grading recommendations to assess the quality of evidence could not be conducted. Both patients and health professionals have been surveyed to assign numeric estimates to verbal probability terms.

Patients vary in the numeric values they assign to terms; however, the relative meanings of these terms show stable groupings.<sup>9,10</sup> For example, based on results of 13 patient surveys, numeric probabilities for the word *probable* showed clustering around 70%, with most estimates between 60 and 90%.<sup>11</sup> Similar groupings emerged for other commonly used probability terms such as *possible* and *likely* based on published studies.<sup>12</sup> On the other hand, a wide variation in interpretation occurred with the use of *risk* as a verbal probability expression.<sup>13</sup> Expressions incorporating the term *risk* (as in *low risk*, *standard risk*, *high risk*) were problematic as laypersons tended to confuse frequency with the severity

of a potential adverse event.<sup>13</sup> Phrases such as *negligible risk* were interpreted anomalous to their meaning.<sup>13</sup> Expressions with large modal peaks were the following: *even chance*, *always*, *never*, *impossible*, and *certain*.<sup>14</sup> Terms with wide interquartile ranges included *liable to happen*, *sometimes*, *not infrequent*, *not unreasonable*, *might happen* and *possible*.<sup>14</sup>

There was a preference among patients for using words over numeric estimates.<sup>15</sup> The use of verbal terms led to decisions more congruent with personal aims than numeric presentation of probabilities.<sup>16</sup> Furthermore, there was no association between numeric estimates of terms and respondents' age, educational level or health literacy.<sup>17</sup>

Health professionals' interpretation of verbal probability terms has also been studied using hypothetical clinical cases and assignment of numeric values to each term.<sup>18</sup> Results showed agreement in the interpretation of the probability terms. There was no effect of clinical context or physician

specialty on the interpretation of verbal terms.<sup>18</sup> The term *likely* was interpreted synonymously with *probable*.<sup>19,20</sup> Residents interpreted verbal probability terms in a manner similar to experienced physicians.<sup>18</sup> There was no effect of contextual framing on numeric interpretation between experienced physicians and residents.<sup>18</sup>

Selected terms showing consistent interpretation across studies were compiled with their numeric estimates (Table 2). The numeric evidence suggested that study participants ascribed these terms into discrete identifiable ranges. Based on these findings, five terms with reliable numeric interpretation were selected (Table 3). Frequency terms corresponding to the respective probability terms were also collated. For example, *Often* is interpreted as 35 – 83%; this corresponds to the probability range for *Possible*.<sup>17</sup> A Visual Risk Scale was constructed using these probability terms (Figure 1).

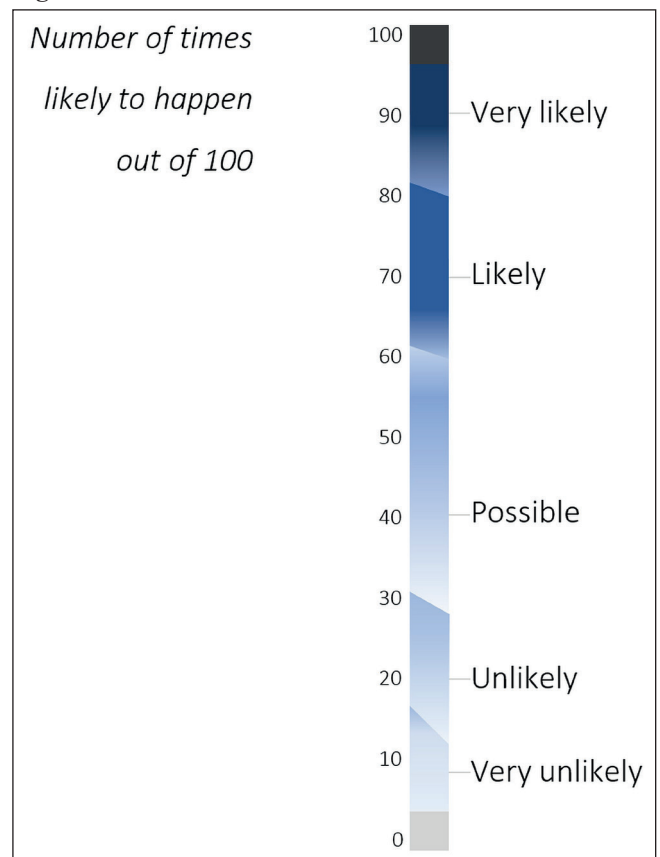


Term	Study	Lower estimate	Central estimate	Upper estimate
Very Likely	Reagan pre-1989		87	
	Reagan 1989	80	85	90
	Shaw 1990, mothers	71	86	100
	Shaw 1990, doctors	86	91	96
	Mosteller pre-1990		82	
	Mosteller 1990	80	88	90
	Ness 1995	75	87	99
	Wintle 2019	77	85	92
	Mean	78	87	95
	Likely	Reagan pre-1989		70
Reagan 1989		65	70	80
Shaw 1990, mothers		49	66	83
Shaw 1990, doctors		64	77	90
Mosteller pre-1990			69	
Mosteller 1990		63	71	78
Fillenbaum 1991			72	
Ness 1995		56	71	87
Wintle 2019		57	67	77
Mean		59	71	82
Possible	Reagan pre-1989		40	
	Reagan 1989	30	40	58
	Shaw 1990, mothers	45	62	79
	Shaw 1990, doctors	27	46	65
	Mosteller pre-1990		42	
	Fillenbaum 1991		43	
	Mean	34	45	67
Unlikely	Reagan pre-1989		17	
	Reagan 1989	10	15	20

**Table 2.** Numeric estimates of verbal probability terms from empirical studies

	Shaw 1990, mothers	9	27	45
	Shaw 1990, doctors	6	16	26
	Mosteller pre-1990		17	
	Mosteller 1990	10	17	23
	Fillenbaum 1991		23	
	Ness 1995	15	27	39
	Wintle 2019	17	30	42
	Mean	11	20	32
Very unlikely	Reagan pre-1989		10	
	Reagan 1989	10	10	20
	Mosteller pre-1990		11	
	Mosteller 1990	3	5	10
	Ness 1995	6	15	24
	Wintle 2019	9	14	18
Mean	7	11	18	

**Figure 1.** Visual Risk Scale



\*All ranges are fuzzy estimates and should be interpreted as approximate with tapering and overlapping ends.



**Table 3.** Standardized terms for expressing probabilities

Probability term*	Frequency term	Probability (per 100 cases)	Range (per 100 cases)	Width of range (precision)
Very likely	Very frequently	90	80 – 95	Narrow (precise)
Likely / Probable	Frequently	70	60 – 80	Moderate
Possible	Often	40	30 – 60	Wide (imprecise)
Unlikely	Infrequently	20	10 – 30	Moderate
Very unlikely	Rarely	10	5 – 15	Narrow (precise)

\* *Probable* can be used interchangeably with *Likely*. The prefix *Very* can be changed to *Highly*. Absolute referents such as *never*, *impossible*, *certain* and *always* should be avoided. Terms such as *high/moderate/low risk*, *negligible*, *uncertain*, *less/more/equally/not likely*, *even chance*, *not often* and *fifty-fifty* should not be used.

### Discussion

Empirical studies involving patients and health professionals indicate that there is agreement in the interpretation of certain terms indicating a potential for standardization. The solution proposed in this article is to select five terms which are interpreted consistently for communicating risk.

Verbal expressions of probability are preferred in risk communication by physicians and patients.<sup>21,22</sup> Most experts agree that the use of verbal terms will continue in clinical settings despite variations in interpretation.<sup>17</sup> Instead of recommending against the use of these terms, a pragmatic solution is to standardize the meanings based on empirical findings. Indeed, Reagan et al, in their now classic paper on quantitative meanings of verbal probability expressions, found that “results agreed highly with others and were highly consistent across methods”.<sup>19</sup> An elegant and eloquent rejoinder has been written in response to objections against using words to express probability, such as contextual factors and variability.<sup>23</sup>

Physicians and patients generally agree on relative ranges of the selected terms. For example, in one study of about 200 subjects, the concordance rates was .975 to .998, with identical ranking of terms in an ordinal sequence.<sup>24</sup> Thus, most terms show an ordered sequence with nominally overlapping ranges. The ordinal ranking of these terms was reliable across studies. For instance, the term *probable* was interpreted to mean a greater mean chance than *possible*. Terms that were distinct (in their numeric ranges) were selected. There was flexibility as certain terms such as *very unlikely* and *highly unlikely* were equivalent.<sup>24</sup> Numeric ranges proposed for these terms are based on empirical findings, as opposed to arbitrary standards by certain organizations.<sup>25</sup> Verbal expressions with ambiguous interpretation such as *negligible*, *uncertain* and *fifty-fifty* were excluded. With the use of standardized meanings of selected terms in the proposed Visual Risk Scale, more widespread concordance may eventually be achieved.

The Visual Risk Scale presented in this study combines high-fidelity standardized probability terms with their empiric numeric ranges. An earlier risk scale was evaluated in a study of Dutch family physicians.<sup>26</sup> However, the scale used in the study contained terms such as *fifty-fifty*, *uncertain*, *certain*, *improbable* and *impossible* which are known to have wide variations in interpretation. The study found that more experienced physicians preferred a scale with verbal terms while their younger colleagues were more comfortable with a numeric scale. A large study of almost one thousand participants found that presenting a scale as opposed to a single term reduced variability in interpretation.<sup>27</sup> Thus, the Visual Risk Scale is a combination of words and numbers, as recommended for risk communication.<sup>28,29</sup>

Since absolute certainty is difficult to achieve and rarely encountered, terms such as *never*, *certain*, *always* and *impossible* should be avoided in clinical conversations. Other alternatives such as *almost certain* and *almost never* are ambiguous and should be substituted by *Very Likely* and *Very Unlikely*, respectively. Other terms to avoid include *confirmed*, *ruled out* and *ruled in*, except when indicated by a gold standard test such as tissue biopsy. The phrase *fifty-fifty chance*, should not be used in discussions with patients as it is interpreted as “uncertainty” rather than a numeric probability of 50%.<sup>30</sup> Comparative terms such as *more* and *less likely* as well as negations like *not often* are also inadvisable.<sup>17</sup> A standardized terminology can reduce incongruent use of verbal probability terms. For example, the term *common* has been used inappropriately to denote a 1 in 100 chance in a patient information guide.<sup>31</sup> Such an arbitrary assignment of numeric values to specific verbal terms may lead to continued ambiguity and miscommunication.

While verbal terms are convenient, numeric estimates should be provided whenever possible. This practice will reinforce the meanings of verbal expressions and is useful for patients with higher numeracy skills. Point estimates using whole numbers are easier to understand than ranges of values.<sup>32</sup> We propose that numeric estimates should be expressed as a





natural frequency statement with a fixed denominator of 100 (for example, 20 out of 100 patients): the X-in-100 format. Chance of a single event is easier to interpret as a natural frequency statement instead of a probability.<sup>33</sup> Hence, the term percentage (or percent) is not recommended.<sup>34</sup> Varying denominators such as 1,000 and 100,000 are also not advisable.<sup>35</sup> For consistency, a denominator of 100 should be used for extreme values as well, such as “less than 1 in 100”, instead of denominators such as 1,000,000.<sup>35</sup>

Other formats of expressing numeric values are not advisable, such as decimal fractions (for example, 0.25), percentages (25%), simple fractions (1/4), simplified fraction expressions (3 out of 7), frequencies with unusual denominators (23 in 500) or odds (one in three).<sup>34</sup> Number needed to treat (NNT) and the 1-in-X format (for example, 1 out of 30 patients) should be avoided as they distort risk perception by patients.<sup>35,36</sup> Stating the absolute risk of outcomes (probability terms) is preferred over relative risk reduction (X% reduction in risk). Since a large proportion of the lay public have limited numeracy skills,<sup>35</sup> numeric estimates can be misinterpreted and should be accompanied by commonly understood verbal terms, as shown in the Visual Risk Scale.

Limitations of this review include variations in contexts and study participants, limited number of studies and heterogenous study designs. The methodological rigor and quality of studies was inconsistent. In particular, online surveys may produce unreliable data. Bias assessment and data synthesis were not conducted due to variations in study designs and outcome measures. The review may have missed studies that have not been indexed in research databases such as doctoral theses and conference abstracts. Many of the studies were conducted over two decades ago and the usage of these verbal terms may have changed.

## Conclusions

The main contribution of this article is to identify five probability terms and codify their numeric meanings. This assignment of numeric estimates is based on empirical studies involving health professionals and laypersons. The resulting Visual Risk Scale follows the recommendation to integrate numeric estimates with verbal probability terms. Presentation of risk in a standardized format may improve comprehension over the long term. When discussing clinical risk with patients, clinicians can express the chances of different outcomes using these five terms. These probability terms should be used preferentially in professional communications such as case presentations, medical documentation and clinical teaching as well as in discussions with patients for informed consent. These terms may be useful in communicating and teaching evidence-based medicine, healthcare risk and safety, shared decision-making and clinical reasoning.

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