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Review article

Visualizing risks in cancer communication: A systematic review of computer-supported visual aids

Jan Stellamanns[a,b,c,*], Dana Ruetters[a], Keshav Dahal[c,d], Zita Schillmoeller[b], Jutta Huebner[e]

[a] Deutsche Krebsgesellschaft (German Cancer Society), Kuno-Fischer-Straße 8, 14057 Berlin, Germany
[b] Department Health Sciences, Hamburg University of Applied Sciences (HAW Hamburg), Ulmenliet 20, 21033 Hamburg, Germany
[c] School of Engineering and Computing, University of the West of Scotland (UWS), Paisley, PA1 2BE Scotland, UK
[d] Nanjing University of Information Science and Technology (NUIST), Nanjing, China
[e] Clinic for Internal Medicine 2, Department for Haematology and Internal Oncology, Jena University Hospital, Bachstraße 18, 07743 Jena, Germany

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ABSTRACT

Objective: Health websites are becoming important sources for cancer information. Lay users, patients and carers seek support for critical decisions, but they are prone to common biases when quantitative information is presented. Graphical representations of risk data can facilitate comprehension, and interactive visualizations are popular. This review summarizes the evidence on computer-supported graphs that present risk data and their effects on various measures.
Methods: The systematic literature search was conducted in several databases, including MEDLINE, EMBASE and CINAHL. Only studies with a controlled design were included. Relevant publications were carefully selected and critically appraised by two reviewers.
Results: Thirteen studies were included. Ten studies evaluated static graphs and three dynamic formats. Most decision scenarios were hypothetical. Static graphs could improve accuracy, comprehension, and behavioural intention. But the results were heterogeneous and inconsistent among the studies. Dynamic formats were not superior or even impaired performance compared to static formats.
Conclusions: Static graphs show promising but inconsistent results, while research on dynamic visualizations is scarce and must be interpreted cautiously due to methodical limitations.
Practice implications: Well-designed and context-specific static graphs can support web-based cancer risk communication in particular populations. The application of dynamic formats cannot be recommended and needs further research.

Contents

* Corresponding author at: Deutsche Krebsgesellschaft e.V. (German Cancer Society), Kuno-Fischer-Straße 8, 14057 Berlin, Germany.
E-mail addresses: stellamanns@krebsgesellschaft.de, J.Stellamanns@gmx.net (J. Stellamanns), ruetters@krebsgesellschaft.de (D. Ruetters), Keshav.Dahal@uws.ac.uk (K. Dahal), zita.schillmoeller@haw-hamburg.de (Z. Schillmoeller), Jutta.Huebner@med.uni-jena.de (J. Huebner).

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1. Introduction

1.1. Informed decision-making and cancer risk communication

Crucial medical decisions arise throughout the cancer continuum and are demanding. Each phase comes with specific challenges: In prevention, the risk of developing cancer may occur in the distant future, while the possible benefits and harms of upcoming treatments are imminent for cancer patients. A full understanding of all benefits, risks, uncertainties and alternative courses is the ideal to make an informed decision [1,2]. Besides the physical and psychosocial burden of the disease, individuals affected by cancer are prone to common interpretation problems and biases. When it comes to comprehension and interpretation of relevant quantitative information, distortions by framing effects, ambiguity aversion, ratio biases, and other kinds of cognitive biases can interfere [3–5]. Cancer patients and their carers must deal with uncertainty in its various conceptualizations: Uncertainty regarding future events, validity of evidence, multiplicity, interdependency and instability of risks, and uncertainty about the personal significance [6–8]. Furthermore, people's numeracy skills, risk knowledge and perception have a major influence on the accurate interpretation of medical data; consequent disadvantages are associated with low numeracy skills [9–13]. Difficulties in the interpretation of quantitative information can occur, for example in regard to breast cancer and prostate cancer screening programs: the majority of respondents overestimate the benefits, while they underestimate the harms [14,15].

These problems in medical risk communication are well known and have been tackled. Recommendations to overcome misinterpretation and to improve informed decision-making are available, e.g. the presentation of absolute rather than relative risk, natural frequencies rather than percentages, and others. One common strategy is the application of visual aids [2,16–20].

1.2. Visual aids and visualizations in cancer communication

Visual aids have a long history in the communication of risks [21,22]. They can facilitate communication of statistical data and enhance comprehension through various modes: By revealing patterns and trends, depicting proportions and part-to-whole relationship, supporting mental processing of information, catching attention with an attractive design, improving the transparency of risk information, attenuating common biases, and increasing accurate data recall [23–26]. Common graphical formats include icon arrays, bar charts, pie charts, risk scales or ladders, and line graphs [27]. Besides risks of a disease, side effects of a therapy, and probabilities of survival, visual aids are also utilized to represent other data formats like patient-reported outcomes or the performance of health care providers [28–30].

Persons with low numeracy skills may benefit from visual aids, although this effect is not consistently observed [31–33]. Further graphic literacy plays a crucial role for the understanding of graphical displays [34–36]. Some reviews criticise the atheoretical approaches of most visual aid research [13,18,23]. Current research in medical decision-making and in visual aid research is focussing on dual-process models like the fuzzy-trace theory [34,37–39]. Albeit the common acceptance of visual data displays, the International Patient Decision Aid Standards (IPDAS) Collaboration and other authors emphasize cautious application because poorly designed and incorrect graphs can still bias risk communication [13,24].

The IPDAS Collaboration also recommends interactive web-based formats, again emphasizing cautious employment because of the preliminary evidence [13]. These formats may include information visualizations, which are defined as interactive visual representation of data on computer-supported tools [40]. Visualizations are supposed to improve communication of quantitative information and to provide insight into data [22,41]. Data visualizations are appraised as innovative Internet measures for cancer communication [42]. While visualizations are applied in a wide range of professional health communication contexts, scarce evidence and contradictory findings prevail in the communication to lay people [43–45].

1.3. Cancer information seeking in the Internet

Health professionals are the main source of information for cancer patients [46,47]. But in the last two decades, the importance of the Internet as a source of information has increased. While the usage differs among countries, there is a steady and consistent rise in European countries [48,49]. About a third of information seekers, which are mostly young women, use Internet information as an aid to decide whether to visit a health professional, and about a quarter for the preparation of an appointment [50]. About 40–50% of breast cancer and other oncology patients turn towards the Internet to find information, mostly those with a better education and higher income [51–54]. Other motives include having easy access, seeking for a second opinion and reassurance [55]. Cancer patients want accurate, comprehensible, comprehensive, and high quality information from online sources. Because trustworthiness regarding the quality of information is an issue, patients like to be referred to them by their physician or healthcare team [54,56]. Searching for and sharing cancer information from the Internet can improve doctor-patient communication, increase active decision-making and is associated with higher satisfaction [57,58]. But

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