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EDUCATION & TRAINING

A Systematic Literature Review of Technologies for Suicidal Behavior Prevention

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Abstract

Suicide is the second cause of death in young people. The use of technologies as tools facilitates the detection of individuals at risk of suicide thus allowing early intervention and efficacy. Suicide can be prevented in many cases. Technology can help people at risk of suicide and their families. It could prevent situations of risk of suicide with the technological evolution that is increasing. This work is a systematic review of research papers published in the last ten years on technology for suicide prevention. In September 2017, the consultation was carried out in the scientific databases PubMed, ScienceDirect, PsycINFO, The Cochrane Library and Google Scholar. A general search was conducted with the terms "prevention" AND "suicide" AND "technology. More specific searches included technologies such as "Web", "mobile", "social networks", and others terms related to technologies. The number of articles found following the methodology proposed was 90, but only 30 are focused on the objective of this work. Most of them were Web technologies (51.61%), mobile solutions (22.58%), social networks (12.90%), machine learning (3.23%) and other technologies (9.68%). According to the results obtained, although there are technological solutions that help the prevention of suicide, much remains to be done in this field. Collaboration among technologists, psychiatrists, patients, and family members is key to advancing the development of new technology-based solutions that can help save lives.

Keywords Suicide prevention · Social networks · mhealth · Smartphone · Web

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Introduction

In developed countries suicide is the most frequent cause of unnatural death most frequent in the world and is the second cause of death in young people [1, 2]. This reality places suicide as one of the main health problems in the world and is a priority of governments in terms of public health policies [3, 4]. Generally, suicidal behaviors are preceded by milder manifestations such as thoughts of death or ideas of suicide, which can often go unnoticed [5]. Suicide attempts are behaviors that often take place prior to consummate suicide and are therefore considered a high risk suicide [6]. There are an extensive number of suicide risk factors that are an early sign of risk and provide a pathway for suicide prevention [7]. Suicide risk factors may be related to the individual, such as mental illness, personality or psychobiological factors, but may also be related to the environment, such as socio-economic factors or socio-cultural factors [8–10]. It should be noted that the presence or history of mental illness is the major risk factor for suicide in the general population and depression is the mental disorder that shows greater association with suicide [11, 12].

In suicide prevention, the use of technologies as tools, like Embodied Conversational Agents (ECAs) to support the detection of symptoms, prevention and treatment of mental health disorders [13], facilitates the detection of individuals at risk of suicide who are not accessed in the usual clinical practice, thus allowing early intervention and efficacy [14]. The ease of access and anonymity offered by individual technologies based on the Web and on mobile devices are two key aspects for their use as suicide prevention tools, especially in the young population [15, 16]. For these reasons, new programs for suicide prevention based on the use of technologies are increasingly being developed [17–21]. This type of preventive interventions using emerging technologies in different studies have shown a reduction in the risk of suicide in patients with suicidal thoughts who have never committed a suicide attempt, such as in patients with previous history of suicide attempts [22–25]. There are different types of technologies useful in the field of suicide prevention [26]. It should be noted that the Internet has allowed the creation or adaptation of psychotherapies to an online intervention format with a positive clinical response [27–30]. It must be taken into account that the use of social networks in young people is constant, considering the current existence of a change of relationship model in this population group [31, 32].

The objective of this article is to perform a systematic review of existing technology for suicide prevention. The methodology used in this revision of the state of the art consists of reading articles related to the subject and the selection after analyzing the most relevant ones. Subsequently, the results obtained are shown. It will conclude with a discussion of the results and the conclusion to the research carried out.

Methodology

The procedure for the selection of papers consisted in reading the title and abstract of the articles, and only those that had a direct relation with the prevention of suicidal behavior through the use of technologies were selected. To carry out the review of the state of the art we have searched the following scientific databases: PubMed, ScienceDirect, PsycINFO, The Cochrane Library and Google Scholar. The terms used in the general search are: “prevention” AND “suicide” AND “technology”. More specific searches have been made using the following combinations of specific technologies: “prevention” AND “suicide” AND (“Web” OR “social network” OR “Facebook” OR “Twitter” OR “mobile” OR “machine learning” OR “Augmented reality”). The search was also carried out with the same terms in Spanish, but finally only the English language articles and the last 10 years were selected.

In this systematic review we have applied the PRISMA standards as shown in the flow diagram of Fig. 1. For the selection of documents whose theme best suited our research, we focused on the search for papers whose title or summary or keywords included words of the topic to be investigated. Searches were made during September 2017.

Results and findings

A total of 90 articles were found in the databases cited in the methodology (see Fig. 1). Of these, 60 have been discarded because they were not related to technology for suicide prevention (either when reading the abstract or reading the entire article), and the other 30 are those selected in this paper. The main reason for our work was to focus on how new technologies are applied to prevention along with traditional methods, which have been widely studied. 13 papers come from journals or congresses in the field of medical informatics and health services, and the rest of medical journals. The objective or contribution of the selected articles is then presented in chronological order. In Table 1 shows the found works indicating the authors, title, main contribution and year of publication.

In Table 1 are many studies based on web and mobile applications. We are surprised that there are no more studies on the advantages and dangers of social networks. No serious studies were found about machine learning and augmented reality.

There are also Web platforms such as Suicide Watch, which brings together people with suicidal impulses in order to be able to identify and speak openly.

The term suicide watch is an intensive monitoring process when an individual exhibit warning signs indicating that they may be at risk of committing bodily harm or fatal self injury. In Reddit, an American social news aggregation, Web content rating and discussion website, we can find information related to this topic such as news, comment information and favor the exchange of opinions that help other users [30].

Other mobile apps are the Prevensuic app (Spanish only), endorsed by the Spanish Society of Suicidology, aimed at health professionals, patients and their families [31].

As a summary, Fig. 2 shows the number of articles using Web, mobile, social networking, machine learning and other technologies for the support and prevention of suicidal behavior.

Figure 3 shows the works by publication date. It is during 2016 when more articles on suicide prevention technologies were published. We understand that the tendency is that the research teams are more involved in the development of technological applications that help in the prevention control and complement the traditional methods.

Discussion and conclusion

What incremental gain is there in publishing this review? How is this effort different? How does it fill a knowledge gap?

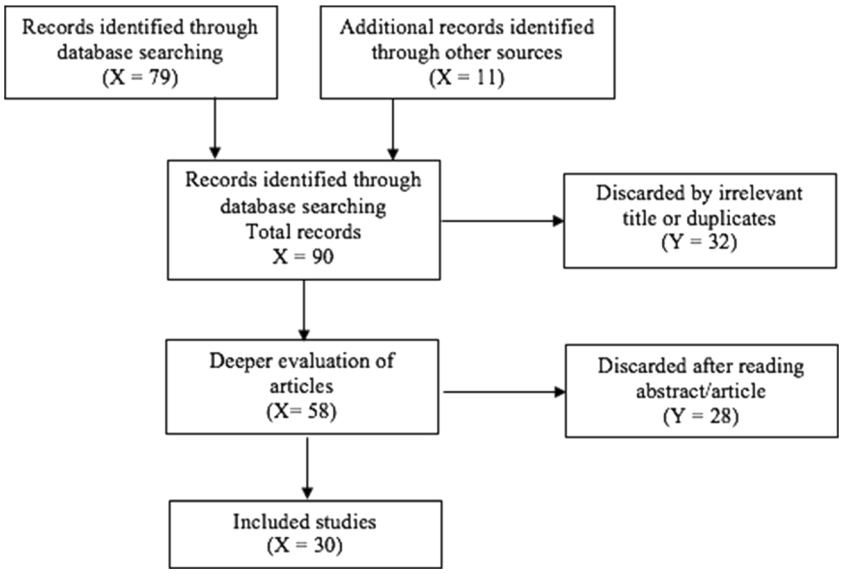

Fig. 1 Diagram followed in the selection of articles in the literature

Although there are reviews on technologies for the prevention of suicide, which we have referenced in our article, our study is based on a broader analysis. Initially, 90 sources were evaluated, including articles related to web and mobile technologies. But the information is also expanded including studies on the influence analysis of social networks. This work has allowed us to detect the lack of studies in this field in social networks and virtual and augmented reality.

Following the review of the literature on suicide prevention technologies, research of worldwide interest has been found, highlighting the need to consider the use of new technologies in suicide prevention programs. In addition, it is a fact that technologies have a greater penetration and impact among the younger population. As a consequence, one of the riskiest groups for the prevention of suicidal behavior, such as adolescents and young people, should be considered the use of technologies, mainly via web and apps.

A total of 30 articles have been analyzed in this work. Many of the research work is focused on adolescents, which is logical because of its importance, since suicide is the second cause of juvenile death [16], as well as the greater acceptance of technologies by this population group. It can be seen in Fig. 1 that most of the work is about Web technologies (51.61%), followed by mobility solutions (22.58%), social networks (12.90%), machine learning (3, 23%) and others (9.68%). There is a clear upward trend (especially since 2012) in the use of technology for the prevention of suicidal behavior. This trend is expected to continue in the future, making it increasingly necessary to include such studies in the intervention of suicidal behavior. It also reveals the existence of numerous experiences and tools that could already be used in clinical practice. These tools are mostly in English. It would be useful for these technologies to adapt to other languages to achieve greater coverage.

In general, the utility of technology in the prevention of suicide is mainly for the training of both the health professionals involved (psychiatrists, therapists, nurses) and patients and their families in the management of these technologies. Especially, in the latter it is useful to be able to teach them strategies to be able to face the risks of suicide of the familiar.

Many of the articles found are reviews on implanted technologies, for example e-learning systems for training caregivers and therapists [22, 38]. However, more clinical studies, and more specifically clinical trials that prove the real effectiveness of this type of technology, are necessary.

Regarding mobile apps, there are not many at the literature level compared to other pathologies such as cardiology [32]. This type of tool serves as a support for the traditional ways in which people with suicidal behavior are treated [24]. These methods evolve over the years driven by technology. As in [42] propose to incorporate a hotline for prevention to the suicide in the mobile apps to help to stop smoking, this type of interventions could be incorporated in other type of mobile applications like those that are destined to follow a certain diet or to lower of weight. In many cases, people with eating disorders may at some point have suicidal thoughts and this type of lines and information can help them.

In some of the studies such as [10, 16] the potential of social networks was analyzed to carry out suicide prevention activities, specifically through the social network Facebook. Concerns were also raised about the potential risks of social networks, however, in the papers analyzed, the potential benefits were greater than the associated risks. In this area, more research is needed to establish the efficacy and safety of possible interventions based on social networks, and ethical norms to ensure that such interventions are managed safely.

One of the latest technological innovations applied in the field of mental health, for example to combat depression (one

Table 1 Research works about technologies for suicide prevention

Citation (Authors; Year; Reference)	Main findings	Type of study and sample size	Type of intervention
Krysinska & De Leo, 2007 [8]	- Research regarding effectiveness of telecommunication-based suicide prevention in various demographic and clinical populations.	Case study developed in diverse demographic and clinical populations	Web
Luxton et al., 2011 [9]	- Reports on current and emerging technologies for suicide prevention.	Observation study	Web, social networks, mobile phones & others
Ruder et al., 2011 [10]	- To discuss potential effects of suicide notes on Facebook on suicide prevention and copycat suicides.	Case report	Social network
Manning and VanDeusen, 2011 [11]	- This article discusses the development, maintenance, use, and impact of the technological aspects of Western Michigan University's Suicide Prevention Program.	Case report	Web site and use of social networking
Marasinghe et al., 2012 [12]	- To test whether a Brief Mobile Treatment (BMT) intervention improve outcomes relative to usual care among suicide attempters.	A randomized controlled trial (a total of 68 participants was recruited)	Mobile phones.
Shand et al., 2013 [33]	- To evaluate the effectiveness of a self-help app for suicidal thoughts amongst young Indigenous people. - Several limitations and strengths of the design are discussed.	A randomized controlled trial was conducted within indigenous communities. 150 participants will be randomly allocated to the intervention-condition (N = 75) or to the wait-list control condition ($N = 75$)	Others: self-help app for suicidal
Aguirre et al., 2013 [34]	- This report analyses existing mobile applications available for suicide prevention and to generate beginning guidelines for the development, implementation, and evaluation of new suicide prevention apps for underserved populations.	Observation study. Twenty-seven apps were analysed and recommendations	Mobile phones
Daine et al., 2013 [35]	- Research to better understand how internet media may exert negative influences and how the internet might be utilised to intervene with vulnerable young people	REVIEW	Web
Lai et al., 2014 [36]	- This document suggests the benefit of using web-based strategies for the prevention of suicide.	REVIEW	Web
Whiteside et al., 2014 [37]	- To get user input and feedback on acceptability of messaging content intended to engage suicidal individuals. - This paper provides one model for including target users in the development of uptake strategies for online mental health interventions.	A randomized controlled trial. 34 individuals provided data on past demographic information	Others: messaging
Ghoncheh et al., 2014 [38]	- To study the effectiveness of online modules and to understand which characteristics are essential to create effective e-learning modules to educate gatekeepers in suicide prevention.	REVIEW	Web
Triñanes et al., 2014 [39]	- To assess the satisfaction of persons with suicidal behavior and their relatives using patient information material included in the Clinical Practice Guidelines on Prevention and Treatment of Suicidal Behaviour.	A randomized controlled trial was made up of 57 patients with suicidal ideation or behaviour, and 52 relatives	Web
Christensen et al., 2014 [40]	- Study about the use of online screening for suicide and the effectiveness of e-health interventions aimed to manage suicidal thoughts.	Randomized controlled-trial	Web
Lancaster et al., 2014 [41]	- Two studies were conducted to assess the feasibility and effectiveness of a web-based version of the Question, Persuade, and Refer (QPR) gatekeeper training program. - The present findings suggest the need to understand how to maintain gatekeepers' knowledge, confidence, motivation, and skills after training.	Case report. Metaanalysis	Web
Christofferson et al., 2015 [42]	- Smoking is an independent risk factor for suicide, so the Department of Veterans Affairs incorporated information about the Veterans Crisis Line into its SmokefreeVET smoking cessation text messaging program.	Observation study	Others: text messaging program
Sueki and Ito, 2015 [14]	- To examine the feasibility and effects of online gatekeeping to prevent suicide by placing advertisements on web search pages.	A randomized controlled trial was made up of 139 consultation service users were analysed. The mean age was 23.8 years. Female users accounted for 80% of the sample	Web
Shtivelband et al., 2015	- The purpose of this study was to identify strategies for strengthening the long-term effects of suicide prevention gatekeeper training.	A randomized controlled trial was made up of 44. In-depth interviews and focus groups were conducted and data were analysed using a qualitative research approach	Web

Table 1 (continued)

Citation (Authors; Year; Reference)	Main findings	Type of study and sample size	Type of intervention
[15]	- Post training interventions that incorporate the themes from this study offer a promising direction in which to sustain the effects of gatekeeper suicide prevention training.		
Robinson et al., 2015 [16]	- Explore the ways in which stakeholders use social media for suicide prevention and assess their views about the potential utility of social media as a suicide prevention tool. - Social media was seen as a useful means of delivering a range of suicide prevention activities.	A randomized controlled trial was made by 10 individuals who conduct research about suicide and social media, 13 organizations that use social media for suicide prevention purposes, and 64 users of social media	Social networks
Larsen et al., 2015 [17]	- The current field of mhealth apps for suicide prevention is assessed. - An innovative application for an indigenous population is presented.	Case report: mhealth apps for suicide prevention is assessed	Mobile phones
Kennard et al., 2015 [29]	- In this paper, participants indicated that transition of care, specific treatment targets, and safety planning were important parts of treatment. - All participants endorsed the use of a smartphone application for these purposes.	A randomized controlled trial. Clinicians, parents, and adolescents participated in qualitative interviews	Mobile phones
Berrouiguet et al., 2016 [19]	- Mobile application for suicide prevention.	Technological application for the prevention of suicide	Web
Larsen et al., 2016 [20]	- There is a clear need to develop useful, pragmatic, and multifaceted mobile resources for this population. - Clinicians should be wary in recommending apps.	REVIEW	Web
Ghoncheh et al., 2016 [22]	- This study investigated the efficacy of a Web-based adolescent suicide prevention program entitled Mental Health Online, which aimed to improve the knowledge and self-confidence of gatekeepers working with adolescents.	A randomized controlled trial was made by 190 gatekeepers (ages 21 to 62 years)	Web
Thiha et al., 2016 [23]	-Text messaging is a well-established medium for promoting behavior change and is the dominant communication medium for youth. - To determine the efficacy of StoryPRIME, a Web-based interface for remotely eliciting high school peer leaders, and helping them produce high-quality, personal testimonials for use in a text messaging extension of an evidence-based, peer-led suicide prevention program.	Technological application for the prevention of suicide	Web
O'Brien et al., 2016 [24]	- A smartphone application intervention developed specifically for suicidal adolescents and their parents to use during this period of increased risk.	Technological application for the prevention of suicide. Tested with 20 adolescent-parent dyads	Web
Vahabzadeh et al., 2016 [25]	- The authors discuss future opportunities for digital suicide prevention, and propose a novel Sensor-driven Mental State Assessment System.	Technological application for the prevention: a novel Sensor-driven Mental State Assessment System	Machine learning
Kreuze et al., 2016 [26]	- Large-scale research and evaluation initiatives are needed to evaluate the costs and long-term population-level impact of technology-enhanced interventions.	REVIEW	Web
Perry et al., 2016 [27]	- More high quality empirical evidence is required to determine the effectiveness of online and mobile interventions for suicide prevention in youth.	REVIEW	Web sites and mobile phones
Siegel, 2016 [28]	-The author considers life-alert systems through very useful smartphones to reduce suicides.	Proposal of a "life-alert" systems into discharge planning for patients deemed at risk	Mobile phones
Tighe et al., 2017 [29]	- To evaluate the effectiveness of a self-help mobile app (ibobbly) targeting suicidal ideation, depression, psychological distress and impulsivity among Indigenous youth in remote Australia.	Technological application for the prevention of suicide. 61 indigenous Australians aged 18–35 years	Mobile phones

of the causes of suicidal behavior), is the augmented reality. In this review we have not found articles in the literature on this subject for the help and prevention of suicide. As for machine learning, only one paper has been found [25]. Researchers at the University of Massachusetts and affiliates are studying to try to detect suicidal behavior through their responses to interactive videos. There is much to be done in this field and could be very useful for detecting certain suicidal behaviors automatically. It is significant that articles that use accessible technologies have been used mainly, which is quite logical since

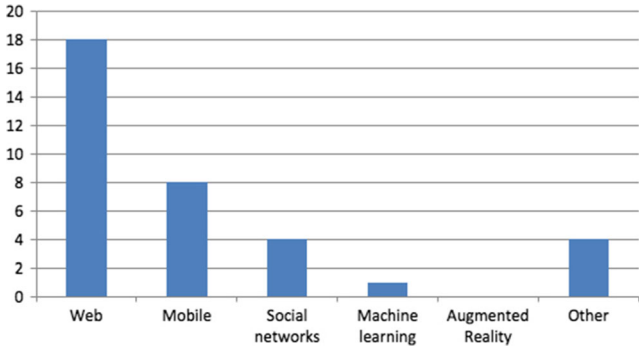

Fig. 2 Works of the scientific literature on different technologies to help and prevent suicidal behaviour

the goal that technology should have in prevention is that it is very accessible.

Further large-scale research and evaluation initiatives are needed to analyze cost-effectiveness and effectiveness in reducing suicidal behavior with the use of different technologies. In turn, a more in-depth investigation could be proposed as future work to confirm the effectiveness and risks versus benefits of all technologies regarding suicidal behavior. Likewise, it is necessary to carry out clinical trials that can analyze both the efficacy and the cost-effectiveness of these tools, so that they can be more widely implemented in clinical practice.

The lack of studies related to social networks leads us to think that there is much to be done in this area. Through these platforms, strategies should be developed to detect and guide people at risk. It is necessary to develop tools, within the best-known social networks, that facilitate access to support groups and specialists who manage the problem in an efficient and anonymous way. Therefore, the work team is investigating this line of research while continuing to review related works.

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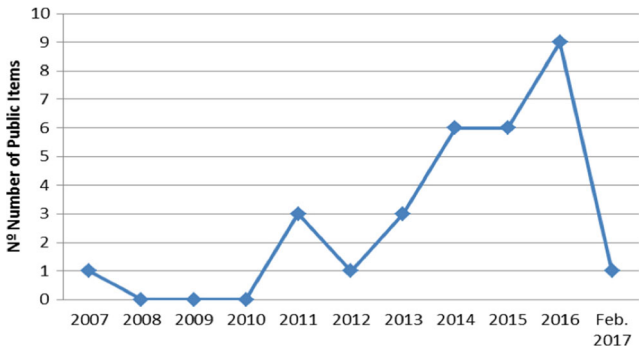

Fig. 3 Articles published in the last 10 years about technology to prevent suicide

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

References

1. WHO | Suicide data. WHO, 2017. http://www.who.int/en/. Accessed 10 January 2018
2. Mathias, C. W., Furr, R. M., Sheftall, A. H., Hill-Kapturczak, N., Crum, P., and Dougherty, D. M., What's the Harm in Asking About Suicidal Ideation? *Suicide Life-Threat. Behav.* 42(3):341–351, 2012. https://doi.org/10.1111/j.1943-278X.2012.0095.x.
3. Giner, L., and Guija, J. A., The necessity of Improvement in Statistical Management and Communication of identified suicides. *Revista de Psiquiatría y Salud Mental (English Edition)* 8:250–251, 2015.
4. Westerlund, M., Hadlaczky, G., and Wasserman, D., The representation of suicide on the Internet: implications for clinicians. *J. Med. Internet Res.* 14(5):e122, 2012.
5. Joiner, T., Why people die by suicide. Harvard University Press, 2007.
6. De Beurs, D. P., de Vries, A. L., de Groot, M. H., de Keijser, J., and Kerkhof, A. J., Applying computer adaptive testing to optimize online assessment of suicidal behavior: a simulation study. *J. Med. Internet Res.* 16(9):e207, 2014.
7. Mishara BL, Côté L-P (2013) Suicide prevention and new technologies: towards evidence based practice. In: Mishara BL et al (eds) Suicide prevention and new technologies. Palgrave Macmillan UK, pp 1–23. doi:https://doi.org/10.1057/9781137351692_1
8. Krysinska, K. E., and De Leo, D., Telecommunication and suicide prevention: hopes and challenges for the new century. *OMEGA – J. Death Dying* 55:237–253, 2007.
9. Luxton, D. D., June, J. D., and Kinn, J. T., Technology-based suicide prevention: current applications and future directions. *Telemed. e-Health* 17(1):50–54, 2011. https://doi.org/10.1089/tmj.2010.0091.
10. Ruder, T. D., Hatch, G. M., Ampanozi, G., Thali, M. J., and Fischer, N., Suicide announcement on Facebook. Crisis 32(5):280–282, 2011. https://doi.org/10.1027/0227-5910/a000086.
11. Manning, J., and VanDeusen, K., Suicide prevention in the dot com era: technological aspects of a university suicide prevention program. *J. Am. Coll. Health* 59(5):431–433, 2011. https://doi.org/10.1080/07448480903540507.
12. Marasinghe, R. B., Edirippulige, S., Kavanagh, D., Smith, A., and Jiffry, M. T. M., Effect of mobile phone-based psychotherapy in suicide prevention: a randomized controlled trial in Sri Lanka. *J. Telemed. Telecare* 18(3):151–155, 2012. https://doi.org/10.1258/jtt.2012.SFT107.
13. Martínez-Miranda, J., Embodied conversational agents for the detection and prevention of suicidal behaviour: current applications and open challenges. *J. Med. Syst.* 41(9):e135, 2017. https://doi.org/10.1007/s10916-017-0784-6.
14. Sueki, H., and Ito, J., Suicide prevention through online gatekeeping using search advertising techniques. *Crisis* 36(4):267–273, 2015. https://doi.org/10.1027/0227-5910/a000322.
15. Shtivelband, A., Aloise-Young, P. A., and Chen, P. Y., Sustaining the effects of gatekeeper suicide prevention training. *Crisis* 36(2):102–109, 2015. https://doi.org/10.1027/0227-5910/a000304.

16. Robinson, J., Rodrigues, M., Fisher, S., Bailey, E., and Herrman, H., Social media and suicide prevention: findings from a stakeholder survey. *Shanghai Arch. Psychiatr.* 27:27–35, 2015. https://doi.org/10.11919/j.issn.1002-0829.214133.
17. Larsen, M. E., et al., The use of technology in Suicide Prevention. In: 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp 7316-7319, 2015. doi:https://doi.org/10.1109/EMBC.2015.7320081.
18. Kennard, B. D. et al., Developing a brief suicide prevention intervention and mobile phone application: a qualitative report. *J. Technol. Human Serv.* 33(4):345–357, 2015. https://doi.org/10.1080/15228835.2015.1106384.
19. Berrouiguet, S. et al., Toward E-Health Applications for Suicide Prevention. In: 2016 I.E. First International Conference on Connected Health: Applications, Systems and Engineering Technologies (CHASE), pp 346–347, 2016. doi:https://doi.org/10.1109/CHASE.2016.37.
20. Larsen, M. E., Nicholas, J., and Christensen, H., A Systematic Assessment of Smartphone Tools for Suicide Prevention. *PLoS ONE* 11(4):e0152285, 2016. https://doi.org/10.1371/journal.pone.0152285.
21. Chen, P., Chai, J., Zhang, L., and Wang, D., Development and application of a Chinese Webpage Suicide Information Mining System (Sims). *J. Med. Syst.* 38(11):e88, 2014. https://doi.org/10.1007/s10916-014-0088-z.
22. Ghoncheh, R., Gould, M. S., Twisk, J. W., Kerkhof, A. J., and Koot, H. M., Efficacy of adolescent suicide prevention e-learning modules for gatekeepers: a randomized controlled trial. *JMIR Mental Health* 3(1):e8, 2016. https://doi.org/10.2196/mental.4614.
23. Thiha, P. et al., Efficacy of web-based collection of strength-based testimonials for text message extension of youth suicide prevention program: randomized controlled experiment. *JMIR Publ. Health Surveill.* 2(2):e164, 2016. https://doi.org/10.2196/publichealth.6207.
24. McManama O'Brien, K. H., LeCloux, M., Ross, A., Gironda, C., and Wharff, E. A., A pilot study of the acceptability and usability of a smartphone application intervention for suicidal adolescents and their parents. *Arch. Suicide Res.* 21(2):254–264, 2016. https://doi.org/10.1080/13811118.2016.1182094.
25. Vahabzadeh, A., Sahin, N., and Kalali, A., Digital suicide prevention: can technology become a game-changer? *Innov. Clin. Neurosci.* 13(5–6):16–20, 2016.
26. Kreuze, E. et al., Technology-enhanced suicide prevention interventions: A systematic review. *J. Telemed. Telecare* 23(6):605–617, 2017. https://doi.org/10.1177/1357633X16657928.
27. Perry, Y., Werner-Seidler, A., Calear, A. L., and Christensen, H., Web-based and mobile suicide prevention interventions for young people: a systematic review. *J. Can. Acad. Child Adolesc. Psychiatry* 25(2):73–79, 2016.
28. Siegel, A. J., Suicide prevention by smartphone. *Am. J. Med.* 129(8):e145, 2016. https://doi.org/10.1016/j.amjmed.2016.01.034.
29. Tighe, J. et al., Ibobbly mobile health intervention for suicide prevention in Australian Indigenous youth: a pilot randomised controlled trial. *BMJ Open* 7(1):e013518, 2017 http://bmjopen.bmj.com/content/7/1/e013518.
30. Suicide Watch. Available at: https://www.reddit.com/r/SuicideWatch/. Accessed 10 January 2018.
31. PrevenSuic. Prevención del Suicidio - Página web de prevensuic. Available at: https://www.prevensuic.org/. Accessed 10 January 2018.
32. Martínez-Pérez, B., de la Torre-Díez, I., López-Coronado, M., and Herreros-González, J., Mobile apps in cardiology: review. *JMIR Mhealth Uhealth* 1(2):e15, 2013. https://doi.org/10.2196/mhealth.2737.
33. Shand, F. L., Ridani, R., Tighe, J., and Christensen, H., The effectiveness of a suicide prevention app for indigenous Australian youths: study protocol for a randomized controlled trial. *Trials* 14:396, 2013. https://doi.org/10.1186/1745-6215-14-396.
34. Aguirre, R. T. P., McCoy, M. K., and Roan, M., Development guidelines from a study of suicide prevention mobile applications (Apps). *J. Technol. Human Serv.* 31(3):269–293, 2013. https://doi.org/10.1080/15228835.2013.814750.
35. Daine, K. et al., The power of the web: a systematic review of studies of the influence of the internet on self-harm and suicide in young people. *PLoS ONE* 8(10):e77555, 2013. https://doi.org/10.1371/journal.pone.0077555.
36. Lai, M. H., Maniam, T., Chan, L. F., and Ravindran, A. V., Caught in the web: a review of web-based suicide prevention. *J. Med. Internet Res.* 16(1):e30, 2014. https://doi.org/10.2196/jmir.2973.
37. Whiteside, U. et al., Designing messaging to engage patients in an online suicide prevention intervention: survey results from patients with current suicidal ideation. *J. Med. Internet Res.* 16(2):e42, 2014. https://doi.org/10.2196/jmir.3173.
38. Ghoncheh, R., Koot, H. M., and Kerkhof, A. J. F. M., Suicide prevention e-learning modules designed for gatekeepers. *Crisis* 35(3):176–185, 2014. https://doi.org/10.1027/0227-5910/a000249.
39. Triñanes, Y. et al., Perceived satisfaction and usefulness of suicide prevention information for patients and relatives. *Revista de Calidad Asistencial* 29(1):36–42, 2014. https://doi.org/10.1016/j.cali.2013.09.004.
40. Christensen, H., Batterham, P. J., and O'Dea, B., E-health interventions for suicide prevention. *Int. J. Environ. Res. Publ. Health* 11(8):8193–8212, 2014. https://doi.org/10.3390/ijerph110808193.
41. Lancaster, P. G. et al., Feasibility of a web-based gatekeeper training: implications for suicide prevention. *Suicide Life-Threat. Behav.* 44(5):510–523, 2014. https://doi.org/10.1111/sltb.12086.
42. Christofferson, D. E., Hamlett-Berry, K., and Augustson, E., Suicide prevention referrals in a mobile health smoking cessation intervention. *Am. J. Publ. Health* 105(8):e7–e9, 2015.