Remote interventions for informal caregivers of patients with stroke: a systematic review and meta-analysis

Ting Yu,1 Jing-wen Ren,2 Cong Wang,1 Shan-shan Liu,1 Wei Cun,1 Yan Jiang3

ABSTRACT

Objectives It is unclear whether remote interventions are effective in improving outcomes of informal caregivers of patients who had a stroke. We synthesised evidence for the impact of remote interventions on informal caregivers of patients who had a stroke. Moreover, we also analysed its potential effects on patients who had a stroke.

Design Systematic review and meta-analysis.

Data sources PubMed, Excerpta Medica Database, Web of Science, the Cochrane Library, China National Knowledge Infrastructure, Wanfang Database and China Science and Technology Journal Database were searched from inception up to 1 February 2022.

Eligibility criteria We included randomised controlled trials (RCTs) that assessed the effect of remote interventions on informal caregivers who provide unpaid care for patients who had a stroke at home compared with traditional interventions, including with respect to caregivers’ mood, care burden, life satisfaction and perceived competence. Moreover, we considered the potential impact of remote interventions on the depressive and anxiety symptoms, functional rehabilitation and re-admission of patients who had a stroke. Only studies published in Chinese or English were included. We excluded studies of interventions aimed at healthcare professionals or patients who had a stroke and those that could not provide complete data.

Data extraction and synthesis Data analyses were performed using RevMan V5.3. The Cochrane Collaboration risk of bias tool for RCTs was used to evaluate the quality of the included studies, and the review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. For continuous outcomes, we calculated the mean difference or standardised mean difference (SMD) and 95% CIs. The Grading of Recommendations, Assessment, Development, and Evaluation method was used to assess the certainty of the evidence.

Results Eight RCTs with a total of 733 participants were included. Compared with traditional interventions, for informal caregivers, we found that remote interventions did not produce significant effects on depressive symptoms (SMD –0.04, 95% CI –0.24 to 0.15), anxiety symptoms (SMD –0.26, 95% CI –0.94 to 0.43), care burden (SMD –0.06, 95% CI –0.56 to 0.45), life satisfaction (SMD –0.16, 95% CI –0.43 to 0.11), or perceived competence (SMD 0.37, 95% CI –0.23 to 0.96). Similarly, for patients who had a stroke, remote interventions had no significant effect on depression (SMD 0.16, 95% CI –0.61 to 0.93) or anxiety symptoms (SMD –0.34, 95% CI –0.72 to 0.04). The effects of remote interventions on functional rehabilitation and re-admission in patients who had a stroke were evaluated by three studies and two studies, respectively, but the studies were too varied to combine their data in meta-analysis.

INTRODUCTION

Stroke is a major public health problem. Stroke remains the second leading cause of death worldwide, accounting for 11.6% of all deaths, and the third leading cause of disability. By 2050, it is predicted that there will be more than 200 million stroke survivors worldwide each year,1 of which 80% will live with long-term dysfunction. A study showed that activities of daily living dependence rates at 3 months and 12 months after stroke were 16.2% and 28.3%, respectively.2 The incidence of care dependence in elderly patients who had a stroke ranged from

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This systematic review and meta-analysis included only relevant randomised controlled trials.
⇒ The Grading of Recommendations, Assessment, Development, and Evaluation approach was used to evaluate the strength and quality of evidence.
⇒ Only studies published in both Chinese and English were included in this review.
⇒ Combining results was complex due to substantial heterogeneity between research methods and outcome measures.
⇒ Because of the low number of included studies, the limited study quality and the fact that some results could not be quantitatively synthesised, the final results should be treated with caution.

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64.71% to 80.5%. Therefore, the caregiving burden of stroke caregivers is an urgent public health concern.

Due to the increase in the number of stroke survivors, imbalance between supply and demand of medical resources, imperfect long-term care system, high turnover rate of beds, and high cost of hospitalisation, stroke survivors often received informal care from an unpaid informal caregiver (a family member or relative) who is unprepared to manage the needs of the survivor. Informal care is projected to become the largest source of long-term care services in the USA, growing by 85% from 2000 to 2050. However, informal caregivers suffer serious physical, emotional, financial and social harm because of their role as caregivers for people with progressive and irreversible diseases. Oliva et al found that the average daily time needed for informal care was 8.7 hours and 7.2 hours, 3 months and 12 months after stroke, respectively, creating a significant physical burden. Moreover, studies showed that 43.9%, 26.5% and 27.4% of caregivers of patients who had a stroke had anxiety symptoms, mild-to-moderate depressive symptoms and severe depressive symptoms, respectively, and 68.4% of the caregivers had a moderate or higher care burden.

Given their specific impact on informal caregivers’ physical and mental health, it is critical to provide them with effective and practical support. Traditional interventions (face-to-face) for informal caregivers have been extensively explored in the past. However, these programmes were underused by caregivers, with time constraints, lack of transportation and respite services cited as reasons. Therefore, the WHO and American Heart Association have emphasised the importance of focusing on informal caregivers for stroke and recommend more research into remote interventions to better meet the rapidly changing needs of caregivers. Remote intervention is defined as the long-distance delivery of health services through information and communications technology, such as telephone, online video and internet. Compared with traditional interventions, remote interventions have many advantages, including ease of implementation, asynchronous communication, use of multimedia platforms and convenience, which can narrow the resource access gap between remote rural and urban areas.

Against the background of the COVID-19 pandemic, the development of remote interventions has become even more urgent. Some systematic reviews have discussed the effects of remote interventions on health outcomes for informal caregivers of patients with dementia. However, because the dysfunction and dependence of patients with different diseases vary greatly, the impact on informal caregivers may also differ. Therefore, there were differences in the effectiveness of remote interventions for caregivers of different patients. Currently, remote interventions have been used for informal caregivers of patients who had a stroke, but the conclusions about their effects have been inconsistent. For example, in an earlier study, Grant et al noted that phone-based interventions significantly improved problem-solving skills, mental health and social functioning among informal caregivers of patients who had a stroke, but did not differ significantly from controls in terms of caregiver burden. However, van den Berg et al identified statistical differences in the interventions’ ability to reduce caregiving burden. Furthermore, to the best of our knowledge, no systematic review has evaluated the impact of remote interventions on both caregivers and patients who had a stroke.

Therefore, this systematic review aimed to clarify the efficacy of remote interventions on informal caregivers of patients who had a stroke, including with respect to caregiver mood, care burden, life satisfaction and perceived competence. Additionally, potential effects in patients were explored, such as depressive and anxiety symptoms, functional rehabilitation and re-admission.

METHODS
Study design
In our systematic review and meta-analysis, reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (appendix S1). We performed a literature search to identify studies on the impact of remote interventions on informal caregivers of patients who had a stroke. Our review was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42022313544) and did not involve ethics-related issues.

Search strategy and selection criteria
We consulted relevant evidence-based experts and library search experts as part of the search strategy. Electronic literature searches of PubMed, Excerpta Medica Database, Web of Science, the Cochrane Library, China National Knowledge Infrastructure, Wanfang Database and China Science and Technology Journal Database were conducted from databases inception to 1 February 2022 (full search terms in appendix S2). Additional relevant studies were identified through manual searches of the reference lists of the included studies and previous related systematic reviews. Clinical trial registries were also searched using the same strategy to identify ongoing studies, including the Chinese Clinical Trial Registry and ClinicalTrials.gov. Each database had its own customised search strategy, and therefore we consulted with medical librarians and system search experts to complete this part. The key search terms were a combination of Medical Subject Heading and entry terms.

Studies were included in our review based on the following criteria: (1) Participants were informal caregivers of people with stroke receiving care at home, who were defined as a family member such as their spouse or adult children providing unpaid care, were of either sex, and of any ethnic or geographical origin; (2) Interventions were digitally delivered via any remote modality, such as telephone, internet or a mixture of these, which
could include either single-component or multi-component interventions; (3) Control conditions were provision of information alone or a waiting list, usual care or any non-specific intervention serving as an attention control; (4) Outcomes of interest were identified as relevant to evaluate the effectiveness of remote interventions in stroke care. The primary outcomes were caregiver-related outcomes, such as caregiver mood and caregiver burden, and the secondary outcomes were related mood and functional rehabilitation of patients who had a stroke; (5) To achieve high levels of evidence, we included only randomised controlled trials (RCTs); (6) Limited to Chinese and English literature.

Studies were excluded from our review based on the following: (1) Interventions which aimed at other groups, such as healthcare professionals and patients who had a stroke; (2) The outcome measures we focused on were not fully reported, and were not available even after contacting the original author.

**Literature screen**

All searched records were imported into EndNote V.X8 to eliminate duplicate studies. The titles and abstracts were then screened, and studies not meeting the inclusion criteria were ruled out. When it was uncertain if studies met the inclusion criteria, they were kept for the next stage of screening. Finally, full-text articles were screened based on the inclusion/exclusion criteria. All stages of screening were completed in parallel by two independent reviewers, and disagreements were resolved by a third reviewer.

**Data extraction**

Data were extracted from the included studies by two independent reviewers (TY and Ji-wR) using the standardised data extraction tool: that is, different reviewers used Excel containing the same content to extract data, and the extracted contents were formulated according to the purpose of this study and reference to other high-quality literature. From each included study, we extracted data including the author, publication year, country, sample size, participant characteristics, remote intervention details (methods, content and duration), data collection time points, outcome and measurement tool. To get a comprehensive analysis, when a study reported outcomes at multiple follow-up times, the results with the longest follow-up time24 or a common follow-up time of different studies were selected for data combination. In case of disagreement, a third-party review author (WC) was consulted, and consensus was sought. For incomplete data, we tried to contact the authors to obtain the required information.

**Quality evaluation**

We assessed the quality of each included study using the Cochrane Collaboration Risk of Bias tool for RCTs.25 This tool assessed bias in seven domains, including random sequence generation, allocation concealment, blinding of participants, personnel, outcome assessment, incomplete outcome data, selective reporting and other sources bias. The risk of bias for each domain was categorised as ‘low risk’, ‘unclear’, and ‘high risk’. The risk of bias assessment was performed by two independent reviewers by extracting the appropriate information and independently rating the risk of bias for each study and outcome. Discrepancies were resolved through discussions.

**Data synthesis**

RevMan V.5.3, provided by the Cochrane Collaboration, was used for statistical analysis. If studies used different outcome scales, standardised mean difference (SMD) with 95% CIs was used, and mean difference with 95% CIs was applied when studies used the same outcome scales. Heterogeneity was evaluated using the I² statistic.26 An I² >50% was considered as significant heterogeneity, and the source of heterogeneity was further analysed. The fixed-effects model was used to calculate the pooled effect size if the data were homogeneous. When I² was >50%, indicating significant heterogeneity, the random-effects model was used. Publication bias was evaluated using funnel plots where there were 10 or more studies in a comparison. A sensitivity analysis was performed by excluding studies with large sample sizes or a high risk of bias, one by one, to confirm the consistency of the findings. A value of p<0.05 was considered to be statistically significant.

For each effect estimate, we used the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach27 to assess our confidence in the correctness of the estimate (high, moderate, low or very low certainty). The GRADE ratings consider study limitations, imprecision of effect estimates, inconsistencies among studies, indirectness of evidence and publication bias. In assessing imprecision, the absolute value of SMD of 0.50 probably represented an important difference between the groups.28 If I² was >60%, we considered inconsistency to be large enough to reduce our confidence in the effect estimate.

**Patient and public involvement**

None.

**RESULTS**

**Study selection**

A total of 6008 studies were identified by searching electronic databases. After a more detailed screening of titles and abstracts, we retrieved 51 full-text studies for assessment. We then excluded 43 studies, recording the reasons for exclusion. Ultimately, 8 studies with 733 participants were included. Figure 1 summarises the PRISMA flow of studies.

**Study characteristics**

**Setting and participants**

The characteristics of the included studies are presented in appendix S3. The included studies were conducted or
published over 10 years (from 2009 to 2020). Most studies were from America (three studies);28–31 China contributed two studies;32 33 the Netherlands,34 Germany35 and Korea36 contributed one study each. In the included studies, the smallest number of participants was only 36,36 and the largest number was 215.32 In addition, some studies had placed stricter limits on informal caregivers, such as providing care for stroke survivors for an average of at least 6 hours per day after discharge.35 In most studies, informal caregivers were middle-aged or elderly (appendix S3).

Interventions
Among the eight included studies, the delivery mode of remote interventions was mainly applications (three studies)32–34 such as WeChat. Two studies used telephone,29 35 two studies used web-based interventions,31 36 and one study combined telephone and web-based interventions.30 The intervention framework included in the study focused on problem solving, and there were significant differences in intervention frequency and intervention length. Detailed information is shown in appendix S3. The purpose of the interventions was to enhance caregivers’ care-taking skills, improve mood and reduce care burden. Intervention durations ranged from 2 months to 12 months. The intervention duration was 2 months in three studies,30 33 34 6 months in two studies29 32 and 12 months in two studies.31 35 The study by Kim et al36 had an intervention duration of 9 weeks. Eight studies adopted usual care or usual treatment as the control condition, without any remote intervention, and
control conditions varied across studies to include non-remote interventions, such as standard medical follow-up or routine discharge education.

Outcomes
Primary outcomes
Caregiver depression and anxiety symptoms, caregiver burden, life satisfaction and perceived competence were the primary outcomes of this study. Among them, caregiver mood, including depression and anxiety symptoms, were the most frequently reported outcomes across studies. Of the studies, 62.5% (5/8) reported caregiver depressive symptoms using three different scales. Caregiver anxiety symptoms were reported in two studies (2/8, 25.0%) with two different scales. Three studies (3/8, 37.5%) used two different scales to assess caregiver burden. At the same time, three studies (3/8, 37.5%) reported caregiver life satisfaction using three different scales. For the sake of accuracy, we simply describe the results as caregiver life satisfaction. In addition, three studies (3/8, 37.5%) reported perceived competence of the caregiver with three different scales. Detailed information is shown in appendix S3.

Secondary outcomes
Secondary outcomes of this study included the depressive and anxiety symptoms, functional rehabilitation, and readmission of patients who had a stroke. The depressive and anxiety symptoms of patients were reported in two studies (2/8, 25.0%) using different scales and functional rehabilitation was reported in three studies (3/8, 37.5%) using two different scales. Two studies (2/8, 25.0%) examined re-admission through participants’ reports. The specific measurements used for each study result are shown in appendix S3.

Risk of bias of the included studies
The risk of bias summary is displayed in figures 2 and 3. Overall, all the included studies showed a risk of bias in the acceptance range. Most of the studies (7/8, 87.5%) reported in detail how groups were randomised; however, one study (1/8, 12.5%) only mentioned randomisation without detailing specific methods, and we considered the risk to be unclear. Allocation concealment was described in detail in three studies (3/8, 37.5%), while the rest (5/8, 62.5%) considered the bias risk to be unclear. Due to the nature of the intervention characteristics for studies included in this review, it was difficult to blind participants and personnel. Four studies (4/8, 50.0%) were blind to outcome assessment, two studies (2/8, 25.0%) had results measured directly by the intervenor and were therefore judged to be high risk, and two of the studies (2/8, 25.0%) did not mention blinding and were judged to have an unclear risk of bias. There was no evidence of risk for incomplete outcome data in all the included studies, and the incomplete outcome data were analysed using appropriate statistical methods (intention-to-treat). None of the studies had evidence of selective reporting and other biases; therefore, the risk of bias for these studies was categorised as low.

Meta-analysis results
Primary outcomes
Caregiver depressive symptoms
Based on evidence from five randomised studies including 399 participants, we found that there was no evidence that remote interventions affected the depressive symptoms of the caregiver (SMD=−0.04, 95% CI −0.24 to 0.15, I²=49%, p=0.66). The range of SMD values included no effect and moderate effects in favour of either the experimental or control group (figure 4A).

Caregiver anxiety symptoms
Two studies with 101 participants reported outcomes regarding anxiety symptoms. However, there was no evidence of a significant difference between the remote intervention and control group (SMD=−0.26, 95% CI −0.94 to 0.43, I²=66%, p=0.46) (figure 4B).
Caregiver burden
A total of three studies with 290 participants assessed the effects of remote interventions on caregiver burden. The results showed that there was no evidence of the effect of remote interventions on caregiver burden (SMD=−0.06, 95% CI −0.56 to 0.45, I²=64%, p=0.83). The range of SMD values included no effect, a moderate effect in favour of the experimental intervention and a small effect in favour of the control intervention (figure 4C).

Caregiver life satisfaction
Three studies with 216 participants reported outcomes concerning caregiver life satisfaction. We found that the results did not support that remote interventions impact caregiver life satisfaction (SMD=−0.16, 95% CI −0.43 to 0.11, I²=36%, p=0.25) (figure 4D).

Caregiver perceived competence
Based on evidence from three studies including 189 participants, we found that evidence did not support that remote interventions affect the caregiver perceived competence (SMD=0.37, 95% CI −0.23 to 0.96, I²=72%, p=0.22). The range of SMD values included no effect, a moderate effect in favour of the control intervention and a small effect in favour of the experimental intervention (figure 4E).

Secondary outcomes
Mood of patients who had a stroke
Two studies with 108 participants reported outcomes regarding depressive symptoms of patients who had a stroke. The results showed that there was no evidence of an effect of remote interventions on the depressive symptoms (with high heterogeneity) (SMD=0.16, 95% CI −0.61 to 0.93, I²=75%, p=0.68). The range of SMD values included no effect and small effects in favour of either experimental or control interventions. These studies also assessed the effects of remote interventions on the anxiety symptoms of patients who had a stroke. We found that the remote interventions may have no effect on patients’ anxiety symptoms (SMD=−0.34, 95% CI −0.72 to 0.04, I²=0%, p=0.08) The range of SMD values included no effect, a moderate effect in favour of the experimental intervention and a small effect in favour of the control intervention.

Description of studies not suitable for meta-analysis
A study by Xiaoli et al evaluated caregivers’ stroke knowledge and skills using a self-developed scale. The results showed that the score of the intervention group was significantly higher than that of the control group, and the difference was statistically significant (p<0.01).

Three studies which had reported functional rehabilitation of the patients were not included in the meta-analysis due to the limitation of high inconsistency. Instead, the results of these studies are described and summarised in the following narrative review. Bishop et al and Vloothuis et al found no evidence of an effect of remote interventions on functional rehabilitation. However, Hongli et al found that remote intervention significantly improved the activities of daily living of patients who had a stroke after 6 months (p<0.000).

Two studies investigated patients’ re-admission, but the two results could not be combined due to different data types. Bishop et al reported that the patients were rehospitalised at 3 months and 6 months, which showed that there was no evidence of an effect of remote interventions on patients’ re-admission (p=0.45, p=0.58). Pierce et al found that there was a significant effect on the number of hospital re-admissions for the patients who had a stroke.

LeLaurin et al conducted qualitative research on the feasibility and acceptability of the remote interventions, and found that the use of technology is less among elderly caregivers, and increasing the flexibility of the schedule can make the intervention more convenient.

Publication bias and sensitivity analyses
Because only eight studies were included, it was not possible to test for publication bias using a funnel plot. Meanwhile, we conducted a sensitivity analysis by...
removing all the studies included in this meta-analysis one by one and confirmed that the findings were not significantly influenced by any single study.

**GRADE assessment of intervention effects**
The GRADE approach was used to evaluate each effect estimate, and the detailed results are shown in table 1.

**DISCUSSIONS**
To our knowledge, this is the first systematic review and meta-analysis to investigate the effect of remote interventions on informal caregivers of patients who had a stroke. Our review not only explored the effects of remote interventions on informal caregivers but also focused on the effects on stroke survivors. A total of eight studies on remote interventions in informal caregivers of people with stroke were included in this review. Based on the seven included RCTs, the meta-analysis showed that remote interventions make little or no difference to caregiver depressive and anxiety symptoms, caregiver burden, caregiver life satisfaction or caregiver perceived competence compared with the non-remote interventions. Further, the results based on two included studies showed that remote interventions had no potential benefits on depressive and anxiety symptoms in care recipients. The conclusion of this review is consistent with that of previous studies on the impact of remote interventions on other diseases.37 38

**Figure 4** Forest plot of comparison: remote interventions versus control.
Table 1  Quality of evidence graded by the GRADE approach

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Anticipated absolute effects* (95% CI)</th>
<th>Risk with usual treatment, waiting list or attention</th>
<th>Risk with internet-based intervention</th>
<th>Relative effect (95% CI)</th>
<th>No of participants (studies)</th>
<th>Certainty of the evidence (GRADE)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregiver depressive symptoms Follow-up: median 25 weeks</td>
<td>–</td>
<td>SMD −0.04 (−0.19, 0.27)</td>
<td>–</td>
<td>298 (5 RCTs)</td>
<td>⏩➫➫➫</td>
<td>Low†‡</td>
<td>–</td>
</tr>
<tr>
<td>Caregiver anxiety symptoms Follow-up: median 18 weeks</td>
<td>–</td>
<td>SMD −0.26 (−0.94, 0.43)</td>
<td>–</td>
<td>101 (2 RCTs)</td>
<td>⏩➫➫➫</td>
<td>Very low††§</td>
<td>–</td>
</tr>
<tr>
<td>Caregiver burden Follow-up: median 24 weeks</td>
<td>–</td>
<td>SMD −0.06 (−0.56, 0.45)</td>
<td>–</td>
<td>290 (3 RCTs)</td>
<td>⏩➫➫➫</td>
<td>Very low††§</td>
<td>–</td>
</tr>
<tr>
<td>Caregiver life satisfaction Follow-up: median 12 months</td>
<td>–</td>
<td>SMD −0.17 (−0.52, 0.17)</td>
<td>–</td>
<td>216 (3 RCTs)</td>
<td>⏩➫➫➫</td>
<td>Low†‡</td>
<td>–</td>
</tr>
<tr>
<td>Caregiver perceived competence Follow-up: median 12 months</td>
<td>–</td>
<td>SMD 0.37 (−0.23, 0.96)</td>
<td>–</td>
<td>189 (2 RCTs)</td>
<td>⏩➫➫➫</td>
<td>Very low††§</td>
<td>–</td>
</tr>
<tr>
<td>Depressive symptoms of patients who had a stroke Follow-up: median 18 weeks</td>
<td>–</td>
<td>SMD 0.16 (−0.61, 0.93)</td>
<td>–</td>
<td>108 (2 RCTs)</td>
<td>⏩➫➫➫</td>
<td>Very low††§</td>
<td>–</td>
</tr>
<tr>
<td>Anxiety symptoms of patients who had a stroke Follow-up: median 18 weeks</td>
<td>–</td>
<td>SMD −0.34 (−0.72, 0.04)</td>
<td>–</td>
<td>108 (2 RCTs)</td>
<td>⏩➫➫➫</td>
<td>Low†‡</td>
<td>–</td>
</tr>
</tbody>
</table>

GRADE Working Group grades of evidence.

**High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

**Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.

**Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of the effect.

*The risk in the intervention group (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
†Downgraded for study limitations: Presence of high risk for performance and detection bias due to the lack of blinding for participants, personnel and the use of self-reported outcome scales by unblinded participants. Also, presence of attrition bias.
‡Downgraded for imprecision: Few participants to get precise estimates (<300 overall).
§Downgraded for inconsistency: Unexplained important heterogeneity (I²>60% or not overlapping 95% CIs).

For primary outcomes, caregiver mood was the most frequently assessed, but the assessment of mood in most studies relied on scales of depressive symptoms. Notably few studies used validated measures of caregiver anxiety. Three studies assessed caregiver burden, life satisfaction and perceived competence. Current evidence failed to support the efficacy of remote interventions on caregiver-related outcomes, with increase over time, which may have caused effects that were not significant.39 40 Meanwhile, the average age of caregivers in our review was over 60 years. Remote interventions presented additional barriers for elderly caregivers; for example, they did not want to learn how to use new technology, including computers, tablets, video-calling apps or the internet, or were bored with them.41 42 Simple interventions, such as telephone calls, were acceptable to most caregivers, but it was difficult to use interventions that required certain skills.13 This is consistent with the conclusions of a rapid review that pointed to the need to include the user throughout the design process, and the use of user-centred design techniques that may generate acceptance, satisfaction and effectiveness throughout the disease trajectory.44 Technological illiteracy is one of the most common barriers to using remote interventions.46 In addition, studies found that people were sensitive to data sharing, resulting in lower engagement, and privacy...
and security were seen as important factors in remote interventions. At the same time, scholars have consistently emphasised that building trust face to face is a key factor in the success of therapy, which was missing from remote interventions.

Remote intervention is an emerging field, and current research in this field lacks consistency, such as inconsistent theoretical model selection, intervention curriculum content, intervention dose, control group conditions and measurement tools. Similar to the studies included in our review, some of the interventions were based on theoretical models, but a few studies did not have a theoretical framework and were less scientific. At the same time, the optimal intervention type and dose could not be determined in this study. These inconsistencies need to be taken seriously, and further exploration of the effects of these interventions is warranted to identify the best form and frequency of remote intervention to achieve the goal of maximising relevant outcomes for informal caregivers of patients who had a stroke.

Furthermore, in our included studies, the severity of patients who had a stroke was inconsistent, and if the degree of illness of patients was different, the burden of caregivers may also be different. The study by Rodriguez et al indicated that the effect of remote interventions on caregivers of patients with different disease severity levels should be evaluated because it may be tied to different levels of caregiver burden. Meanwhile, in the eight included studies in our review, the specific content of remote interventions was mainly based on the experience of different intervention makers and previous literature, ignoring the preferences and needs of patients who had a stroke and their informal caregivers. As a result, the remote interventions implemented were extensive, lacked specificity and personalisation, but research emphasised that targeted interventions were important. Zhan Jie et al conducted a follow-up intervention for patients undergoing remote ischaemia adaptation. The formulation of intervention measures considered patient needs to a large extent, including stakeholder interviews, and continued to solve the problems encountered by patients in the follow-up intervention process to meet their needs to the greatest extent. The results showed that individualised need-based interventions could significantly improve patients’ treatment compliance and effectiveness. Therefore, the support provided should be personalised to achieve the best results. Additionally, it was recommended that tens of thousands of participants be used to demonstrate that a general intervention programme could have a significant effect over the long term. However, the sample size of the included studies was small, which might have results in the weak reliability of the conclusions. For patients who had a stroke, the evidence for potential effects was limited, as only four studies provided effect data about them and only two studies were suitable for meta-analysis. Therefore, further research is needed to explore the effects of access to remote interventions of caregivers on their care recipients.

Moreover, we found no explicit reports of the adverse effects of remote interventions and the additional burden they may place on informal caregivers. There was no statistical difference between the results of remote intervention and traditional intervention, but the former had no adverse effects and was more convenient and faster, compensating for the deficiency of traditional intervention. Therefore, there is still a potential benefit of remote intervention, and its associated cost-effectiveness should be evaluated in the future.

We also used the GRADE method to score the overall certainty of evidence for each outcome. All results were downgraded owing to study limitations. The most prevalent risk of bias was that of performance bias due to the self-assessment of subjective outcomes by participants who were not blinded to the intervention. Reports of randomisation methods were not always detailed enough to assess the risk of bias. We also downgraded some results because of inconsistencies between the studies. For the comparison of any intervention versus usual treatment, we considered the certainty of evidence to be very low to low. Evidence certainty is low for caregiver depressive symptoms, caregiver life satisfaction and the anxiety symptoms of patients who had a stroke, and very low for caregiver anxiety symptoms, caregiver burden and caregiver perceived competence, and for the depressive symptoms of patients who had a stroke. As the quality of our evidence was generally poor, the results should be interpreted with caution.

Our study has some limitations. First, the included studies lacked consistency, the content and duration of interventions varied widely, and the instruments used to measure the outcome variables varied. Therefore, the optimal intervention design for informal caregivers of patients who had a stroke remains unclear. Second, there was a degree of heterogeneity in the data analysis, and despite attempts to account for heterogeneity through subgroup analysis, postanalytical heterogeneity persisted. Therefore, this study used a random-effects model for data analysis, and the conclusions still need to be treated with caution. Third, due to the limited number of partial studies and data types, some results (3/10, 30.0%) failed to meet the criteria to be included in the meta-analysis, but were described and summarised in the narrative review. Therefore, further studies are needed to provide sufficient evidence for practice.

Conclusion

Overall, our results suggest that current evidence for the use of remote interventions for informal caregivers of people with stroke is of low quality and insufficient to make a recommendation regarding their use to improve relevant outcomes. Meanwhile, only one study measured caregiver knowledge and skills, which severely limits our assessment of these results in this study. These results should be included in future research without disregarding core outcomes, such as caregiver burden and mood, including depression and anxiety. Additionally,
to increase caregiver usage and reduce dropouts, it is important to allow for simple adjustments to meet the needs of older adults, such as a larger font size and simpler operating pages, and an appropriate remote intervention should be selected according to the caregiver’s use preferences. Moreover, our review highlights the need for more robust, high-quality studies to allow for meaningful assessment of the literature.

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