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Research report

Training mental health professionals in suicide practice guideline adherence: Cost-effectiveness analysis alongside a randomized controlled trial

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ABSTRACT

Background: There is a lack of information on the cost-effectiveness of suicide prevention interventions. The current study examines the cost-effectiveness of a multifaceted structured intervention aiming to improve adherence to the national suicide practice guideline in comparison with usual implementation.
Methods: In the intervention condition, professionals of psychiatric departments were trained using an e-learning supported Train-the-Trainer program. Newly admitted suicidal patients were assessed as soon as their department was trained and at 3 months follow-up. The primary outcome was improvement in suicide ideation. Missing cost and effect data were imputed using multiple imputation. Cost-effectiveness planes were plotted, and cost-effectiveness acceptability curves were estimated.
Results: For the total group of suicidal patients ($n=566$), no effect of the intervention on suicide ideation or costs was found. For a subgroup of depressed suicidal patients ($n=154$, intervention=75, control=79), mean level of suicide ideation decreased with 2.7 extra points in the intervention condition, but this was not statistically significant. For this subgroup, the intervention may be considered cost-effective in comparison with usual implementation if society is willing to pay ≥ € 6100 per unit of effect on the suicide ideation scale extra.
Limitations: Considering the cost outcomes, we had almost no cases that were complete, and heavily relied on statistical techniques to impute the missing data. Also, diagnoses were not derived from structured clinical interviews.
Conclusions: We presented the first randomized trial (trial registration: The Netherlands Trial Register (NTR3092 www.trialregister.nl)) on cost-effectiveness of a suicide practice guideline implementation in mental health care. The intervention might be considered cost-effective for depressed suicidal patients if society is willing to make substantial investments.

1. Introduction

In The Netherlands, about 1700 persons a year die by suicide, and it is estimated that 99,600 suicide attempts take place annually (Hoeymans et al., 2010). Each year, 15,000 patients with non-fatal suicidal behavior are treated at hospital emergency departments, of whom 9000 are hospitalized (Kerkhof et al., 2007). About 40% of all suicides are done by patients who are treated in mental health care (Huisman et al., 2009). The disability burden caused by suicide and suicide attempts is 11th on the list of most

Abbreviations: IAU, Implementation as usual; MHI, Mental Health Institution; PGSB, Multidisciplinary practice guideline for the assessment and treatment of suicidal behavior; PITSTOP, Professionals In Training to STOP suicide; TtT-e, E-learning supported Train-the-Trainer program; CEA, cost effectiveness analysis; EMGO, Dutch Institute for Health and Care institute; ROM, Routine Outcome Monitoring; TiC-P, Trimbos questionnaire for costs associated with psychiatric illness; ICER, Incremental Cost Effectiveness Ratio; QALY, Quality-adjusted life years; BSS, Beck Scale for Suicide Ideation

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burdensome diseases in The Netherlands (van Spijker et al., 2011). The economic impact of both completed and attempted suicides is substantial (McDaid and Kennelly, 2009). To calculate the total costs associated with suicide, three types of costs should be taken into account; direct costs (e.g. demand on emergency services, funerals), indirect costs (loss of contribution to economy via paid work, family responsibilities) and intangible costs (pain and grief of family, loss of chance to experience all that life holds). In Scotland, total costs per completed suicide were estimated to be around 1.6 million euro (Platt et al., 2006). No comparable economic studies have been done to estimate the costs of suicide ideation, but given the estimated costs of depression (e.g. (Kleine-Budde et al., 2013)), which is prevalent in 90% of people with suicide ideation (O'Connor et al., 2011), the costs are likely to be large. A recent cost-effectiveness analysis of a web-based self-help program to reduce suicide ideation (van Spijker et al., 2012) reported that for each significantly improved individual, €34,727 of societal costs were saved.

In May 2012, the evidence-based multidisciplinary practice guideline for assessment and treatment of suicidal behavior (PGSB) (van Hemert et al., 2012) was issued. It was argued that introduction of a national evidence-based guideline may result in better and therefore more cost-effective treatment of suicidal behavior (Bool and Doeven, 2007). Suicide prevention training has been shown to improve knowledge, skills, and attitudes towards suicidal behavior of both gatekeepers (Capp et al., 2001; Chagnon et al., 2007; Gullestrup et al., 2011; Isaac et al., 2009; Joffe, 2008; King and Smith, 2000; Matthieu et al., 2008; Stuart et al., 2003; Wyman et al., 2008) and mental health professionals (Appleby et al., 2000; Oordt et al., 2009). Additionally, professional and gatekeeper training in diagnosis and treatment of depressive disorders, which are associated with suicidal behavior (Hawton and van Heeringen, 2009) has been shown to result in a reduction of suicides (Hegerl et al., 2010; Knox et al., 2003; Matthieu et al., 2008; Rutz et al., 1989; Szanto et al., 2007). However, adherence to evidence based guidelines has been shown to be unsatisfactory (Grol and Grimshaw, 2003; Shafran et al., 2009; Weinmann et al., 2007; Wobrock et al., 2009), resulting in less effective patient care, and thus extra costs for society. A structured implementation program may improve adherence to the guideline, which may result in better assessment and treatment of suicidal behavior, which might lead to less suicide attempts and suicide ideation.

To implement the PGSB in Dutch mental health care, we developed an e-learning supported Train-the-Trainer program (TtT-e) to be delivered to the full staff of psychiatric departments (de Beurs et al., 2013b; de Groot et al., 2015). The Train-the-Trainer model is based on the Adult Learning Theory (Knowles, 1970) stating that the best resource for learning comes from peers, and on the Diffusion of Innovation Theory (Rogers, 2010) stating that people adopt new information better through their trusted social networks. TtT-e combines a one day face-to-face training with an additional e-learning module. This form of blended learning is used extensively in medical education and has been found to be more effective when compared with traditional instructor-based trainings (Means et al., 2013; Pearce et al., 2012).

Little is known about the cost-effectiveness of suicide prevention programs consisting of training professionals in comparison with usual practice. By retrospectively considering the costs due to a reduction in suicides, an educational program for Swedish general practitioners in the Island of Gotland was argued to be cost-effective (McDaid and Kennelly, 2009) when compared to not training professionals. It was estimated that the costs per life year gained of a training intervention in England (Appleby et al., 2000) were €4049 in comparison with no additional training, which is considered to be highly cost effective.

Evidence on clinical effectiveness is not sufficient for policy making. Before policy makers and managers can decide to disseminate our intervention, information on the cost-effectiveness of the guideline implementation strategy evaluated in this study in comparison with implementation as usual (IAU) is needed.

This paper presents a cost-effectiveness analysis alongside a cluster randomized trial in which an e-learning supported Train-the-Trainer program (TtT-e) is compared with IAU with regard to change in suicide ideation and change in quality of life. We hypothesized that patients in the intervention condition will feel better treated by their professionals, resulting in less direct and indirect health costs, making the intervention cost-effective when compared to the control condition.

2. Methods

2.1. Study design, setting and participants

Our economic evaluation was performed alongside the PITSTOP suicide trial (de Beurs et al., 2013a). As soon as the professional staff in the intervention departments was trained in suicide guideline adherence, all newly admitted patients were assessed at admission (T0) and at three months after admission (T1). If a patient was discharged within three months, T1 was arranged just before discharge. In the control departments, T0 measurements started when the department was informed of the allocation outcome. Data was collected via Routine Outcome Monitoring (ROM), an online assessment method by which data on the effectiveness of treatment in everyday clinical practice are systematically collected (De Beurs et al., 2011). In MHIs not using ROM, graduate students and/or research assistants used paper and pencil questionnaires to collect similar data.

All eligible patients were informed about the study and participants provided written informed consent. For each included patient, the main DSM-IV diagnosis as entered in their Electronic Health Record during enrollment was collected. We used the DSM-IV diagnosis for subgroup analysis for separate disorders.

2.2. Inclusion and exclusion criteria

Within the PITSTOP suicide trial, departments were considered eligible for participation if they treated patients ≥ 18 years of age, professionals felt a need for training in suicide prevention skills, and their management was willing to provide support, including financial support for covering loss of production while attending the training. For our economic evaluation, patients were eligible if they had suicide ideation at baseline (i.e. if they scored > 0 on the Beck Scale of Suicide Ideation (Beck et al., 1997)). As admitted patients were often affected by emotional and/or cognitive problems, patients who were emotionally and/or cognitively unable to complete questionnaires were excluded. Whether a patient was able to enter the study was left to the discretion of the staff.

2.3. Matching and randomization

Eligible departments were matched in pairs on basis of the main diagnostic DSM-IV category of patients treated in the department, and on comparable average length of treatment. Members of matched pairs were randomly allocated to either implementation as usual (IAU) with TtT-e (intervention), or IAU (control condition). Binary randomization was performed by an independent researcher of the Dutch Institute for Health and Care institute (EMGO) research institute who was not involved in the study. Patients were blind to the allocation, but due to the nature of the intervention professionals were not.

2.4. Intervention

In the intervention condition, complete multidisciplinary teams (all registered nurses, psychologists, and psychiatrists) were trained by peers via TtT-e in the application of the PGSB. In TtT-e, three types of professionals were involved: masters, trainers and trainees. Training was applied on two levels: first, trainers were trained by masters. Subsequently, trainees were trained by trainers. The training consisted of a one day small group training and was supported by an e-learning module that lasted an hour. The TtT-e program as applied by masters was similar to the program applied by the trainers.

Masters were experts in the field of suicide prevention due to extensive scientific and clinical experience with suicidal behavior. Trainers were mental health professionals of various disciplines (psychiatrists, psychologists or mental health nurses) selected by their management because of their role model in a team, and their excellent training skills. Trainees were health professionals within the team of the trainer.

The PGSB recommendations served as the starting point to develop the content of the TtT-e program. The PGSB recommends systematic investigation of the suicidal condition of patients by using the Chronological Assessment of Suicidal Events (CASE) interview (Shea, 1998). Based on its outcome, risk and protection factors for suicide of individual patients are weighted. Subsequently, structured diagnosis, treatment strategy, and a safety protocol are developed. In the TtT-e program, the CASE interview was the overall framework for each of four role plays in which one trainee acts as a suicidal patient and the other trainee interviews the 'patient' via the CASE interview. The intervention is described elsewhere in more detail (de Beurs et al., 2013b).

To survey adherence to the training program by trainers, graduate students randomly visited training sessions, and rated adherence on a four-point Likert scale: 1, very strong adherence, to 4, very low adherence.

In the control condition, no additional actions next to IAU were undertaken. Care was not restricted in any way in this condition.

2.5. Effect outcomes

Primary outcome of the study was change in suicide ideation. At both T0 and T1, level of suicide ideation was measured with the first 19 items of the Beck Scale for Suicidal Ideation (BSS) (Beck et al., 1979; de Beurs et al., 2015a). Total score ranged from 0 to 38, a higher score reflecting a higher level of suicide ideation. Patients that scored >0 on the BSS have suicide ideation (Beck et al., 1997).

Quality of life was measured with the EQ-5D (EuroQol, Rotterdam, The Netherlands) (Brooks, 1996) a five-item questionnaire developed to assess health-related quality of life. The five items represent the dimensions of mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Items are scored on a three-point Likert scale: 1, no problem; 2, some problems; and 3, extreme problems. The health states obtained from EQ-5D were converted to utility scores using the Dutch EQ-5D tariff. Quality-adjusted life years (QALYs) were calculated using the area-under-the-curve method with linear interpolation between time points.

2.6. Cost outcomes

Costs incurred by patients during the course of the study were measured from a societal perspective with an adapted version of the Trimbos questionnaire for costs associated with psychiatric illness (TiC-P) (Hakkaart-van Roijen et al., 2002). The TiC-P consists of two parts: part one measures direct medical costs (for example visits to a psychiatrist or a psychologist) and part two measures indirect costs (for example costs due to sick leave and productivity losses while being at work but not functioning optimally). Dutch standard costs were used to value resource use (Tan et al., 2012). Lost productivity costs were calculated according to the friction cost approach (friction period 154 days) using the mean age- and sex-specific income of the Dutch population (Tan et al., 2012).

2.7. Per-patient intervention costs

To estimate the per-patient intervention costs, we first estimated the average cost to train one trainee/professional. After adding the salary costs of the trainees (on average 350 euro) and the costs due to production losses of trainees (on average €640), the estimated cost to train one professional was set at €1000. For the intervention to be effective, professionals have to be trained once a year. So, per department, we multiplied the number of professionals with €1000 and divided this total cost estimate by the estimated number of patients treated each year within that department.

2.8. Sample size

For the primary outcome (suicide ideation) we calculated the effect size according to recommendations of Twisk (2006). The number of patients that needs to be included was set to 423. This number is sufficient to find a small effect size (Cohen's d) of 0.3, assuming an alpha of 0.05 and the statistical power of 1-Beta=0.80. A correction of 20% for clustering of effects within departments was applied.

2.8.1. Statistical analysis

All analyses were performed on patients who scored BSS >0 at baseline. A subgroup analysis was done for patients diagnosed with a depressive disorder and with BSS >0 at baseline. The statistical analyses were performed according to the intention-to-treat principle (ITT). Multiple imputation was used to impute missing cost and effect data. Variables found to be related to cost and effect outcomes and missing follow-up data, were included in the multiple imputation model. Fifteen imputations were needed to reduce the fraction of missing information to less than 5% (White et al., 2011). Each of the 15 imputed data sets was separately analyzed and the results of the 15 analyses were pooled using Rubin's rules (Rubin, 2009). For effects and costs, linear multilevel regression models were estimated. Clustering at the level of psychiatric department was included in these multilevel models. The models for BSS were adjusted for baseline BSS value. Costs generally have a highly skewed distribution; therefore, bootstrapping with 5000 replications was used to estimate bias-corrected and accelerated confidence intervals around cost differences (Chaudhary and Stearns, 1996). To account for the clustering of data, bootstrap replications were stratified for department (Van der Leeden et al., 2008). ICERs were calculated by dividing the difference in total costs between the intervention and usual care group by the difference in clinical effects. This ICER indicates the additional cost per unit of health gain. The bootstrapped cost-effect pairs were plotted on a cost-effectiveness plane and used to estimate cost-effectiveness acceptability (CEA) curves. In a cost-effectiveness plane, incremental costs between the intervention and usual care are plotted on the *y*-axis and incremental effects on the *x*-axis resulting in four quadrants. The northeast quadrant indicates that the intervention is more expensive and more effective than usual care. In the southeast quadrant the intervention dominates usual care, i.e. is less expensive and more effective than usual care. In the southwest quadrant the intervention is less expensive and less effective than usual care. Finally, in the northwest quadrant the intervention is

dominated by usual care (more expensive and less effective). Most newly developed interventions are more expensive and more effective than usual care, which implies that a trade-off needs to be made about whether the additional benefits justify the additional costs. This decision depends on the societal willingness to pay for an additional unit of effect. However, this willingness to pay is generally not known. CEA curves show the probability that the intervention is cost-effective in comparison with the control treatment for a range of willingness to pay values (Drummond et al., 2005).

2.8.2. Ethics statement

Written informed consent was obtained for all individual participants after the procedures had been fully explained. The study was approved by the Medical ethical commission of the VU Medical Centre (2011/151) on 17th May 2011. It was registered in The Netherlands Trial Register (NTR3092 www.trialregister.nl) on 4th October 2011. The authors confirm that all ongoing and related trials for this intervention have been registered.

3. Results

Fig. 1 shows the flow of departments through the trial, showing that 566 patients with baseline suicide ideation from 33 departments started the study.

More females were included in the intervention condition when compared to the control condition (Table 1). Also, the intervention condition contained more patients with a diagnosis of a personality disorder or an eating disorder, whereas the control condition comprised more patients with a depression or a substance dependence disorder. Distribution of suicidal ideation and percentage of previous attempters within the suicidal sample were comparable between both conditions. DSM-IV diagnoses were missing in 36% (208) of the suicidal patients.

3.1. Results clinical outcome

For the total group of suicidal patients ($n=566$), multilevel analysis showed no effect of the intervention on change in suicide ideation ($b=0.93$, 95% CI −0.59;2.5) and QALYs ($b=0.01$ CI 95% −0.003;0.03) (see also Table 3). For the depressed suicidal patients ($n=154$, intervention=75, control=79), mean level of suicide ideation decreased with 2.7 extra points in the intervention condition, but this was not statistical significant ($b=-2.7$ CI 95% −5.6;0.19). No statistical significant effect between conditions was found in QALYs ($b=0.01$ CI 95% −0.01;0.04) (see also Table 4).

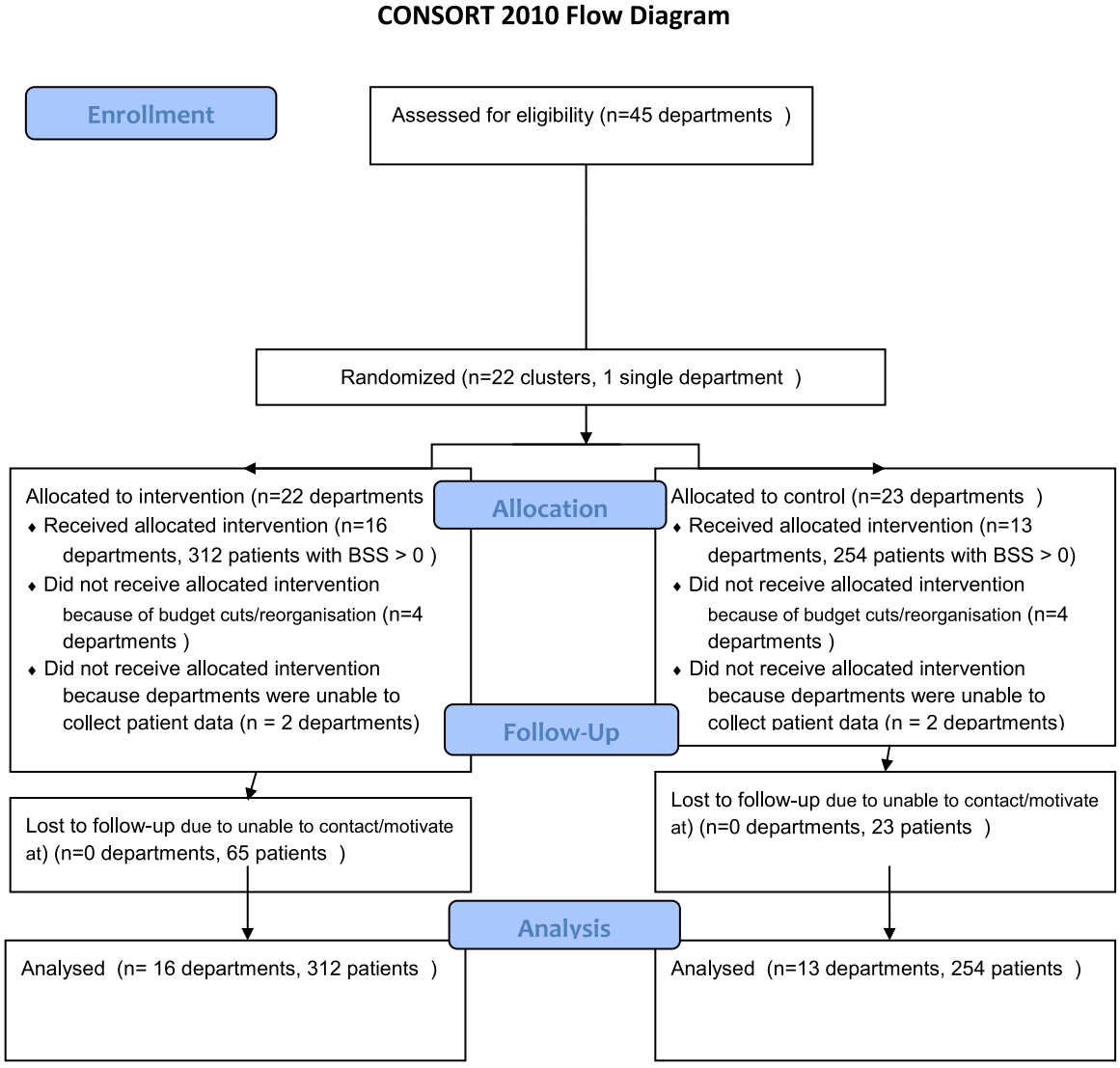

Fig. 1. flow of the trial IAU=implementation as usual TtT-e=e-learning supported Train-the-Trainer program.

3.2. Costs per patient

Average intervention costs per patient were € 68 with a range from €6.80 per patient to €312.50 per patient.

Table 2 shows the mean (SE) of the costs for the separate and total cost categories after multiple imputation during 3 months follow up. There was no statistical significant difference in total costs between the intervention and the control group (mean difference € 1572; CI 95% −732;4567). Secondary care costs were the largest contributor to the total costs in both groups. Secondary care costs were statistically significantly higher in the intervention group, and primary care and lost productivity costs were statistically significantly higher in the control group.

Table 1
Baseline characteristics of suicidal sample, split per condition. In *N*% unless otherwise specified.

N (%)	Total (*n* =566)	Intervention group 312	Control group 254
Demographic characteristics			
Female gender	295(55)	160(54)	134(46)
Age (M,SD)	42(15)	42(15)	41(14)
Education			
Lower	37(11)	21(57)	16(43)
Intermediate	233(69)	145(62)	88(38)
Higher	69(20)	37(54)	32(46)
Living with partner	133(38)	84(63)	49(37)
Born in the NL	253(94)	162(64)	91(36)
Paid employment	34(16)	13(38)	21(62)
Data collected with ROM	192(34)	98(51)	94(49)
Clinical characteristics			
Suicidal thoughts(M,SD)	12(9)	13(9)	11(8)
Attempted suicide *N*=538			
Never	303(57)	166(55)	137(45)
once	120(22)	66(64)	54(46)
More than once	114(21)	72(63)	42(37)
Diagnosis N=358			
Depression	154(41)	75(48)	79(52)
Anxiety	25(7)	12(47)	13(53)
Psychosis	29(8)	17(59)	12(41)
Personality disorder	62(17)	47(76)	15(24)
Substance dependence	39(11)	9(23)	30(77)
PTSS	21(6)	12(57)	9(43)
Eating disorder	27(7)	26(96)	1(4)

Table 2
mean (SE) of the costs(€) for the separate and total cost categories during 3 months follow-up.

Cost category	Intervention	Usual care	Difference (95% CI)*
Primary care	228 (24)	425 (131)	−658 (−1539;−89)
Secondary care	8960 (1115)	5851 (914)	2562 (412;5211)
Home care	38 (20)	30 (10)	8 (−19;41)
Intervention	90 (5)	0 (0)	105 (101;110)
Lost productivity	118 (82)	796 (317)	−791 (−1400;−296)
Total costs	9434 (1100)	7103 (1042)	1572 (−732;4567)

* Multilevel analysis with a level for department.

3.3. Cost-effectiveness and cost-utility for total group of suicidal patients

Table 3 presents the results of the cost-effectiveness and cost-utility analyses for the total group of suicidal patients. No significant differences in effects and costs between the two groups on the BSS at follow-up were found. The difference in QALY between groups was extremely small, resulting in an extremely large and uninterpretable ICER. If society is not willing to pay anything for one point of improvement on the BSS, the CEA curves show that the probability that our intervention would be cost-effective is 0.18. The CEA curve decreased towards 0.10 for infinite values of willingness to pay.

3.4. Cost utility and cost effectiveness for depressed suicidal patients

Table 4 shows the analysis for the subgroup of depressed suicidal patients.

The ICER for reduction of suicide ideation was −€538. This means that €538 needs to be invested per depressed suicidal patient to decrease one extra point on the BSS in the intervention condition. Fig. 2 shows the CE plane for reduction in suicide ideation. Most cost-effect pairs were located in the north east (62%) and south east (36%) quadrants. This means that, although not statistically significant, the intervention was more effective on the reduction of suicide ideation, and associated with higher costs when compared to the control condition. The CEA curve (Fig. 3) graphs the probability that the intervention was cost-effective compared to the control condition for a range of ceiling ratios. The probability that the intervention is cost effective is 28% if society is willing to invest €0 per one point reduction of suicide ideation and increases to 95% if society is willing to invest €6100.

Again, differences in QALYs were very small leading to a very large ICER. The CEAC showed that the probability of the intervention being cost-effective in comparison with control remained more or less stable at 0.28 regardless of the ceiling ratio.

4. Discussion

This study showed that a structured implementation of the Dutch guideline on the assessment and treatment of suicidal behavior did not result in statistically significant differences in costs or effects compared to implementation as usual. In the group of depressed suicidal patients, TtT-e may be considered cost-effective in comparison with usual implementation if society is willing to pay €6100 per unit of effect extra on the BSS. It is difficult to interpret the clinical importance of one point reduction on the BSS. A prospective study showed that, if a patient scores > 2 on the BSS, the risk for future suicidal behavior has been found to increase sevenfold (Brown et al., 2000). Therefore, a reduction of one point on the BSS from 3 to 2 will have a larger effect on patients well-being when compared to a change on the BSS from 35 to 34 (de Beurs et al., 2014). As there are no previous cost-effectiveness studies on the effect of guideline implementation on suicidal ideation, our results cannot be compared directly. Other studies

Table 3
Effects and costs (€) for the total Group with suicidal ideation.

				CEA curve		
Outcome	**Cost (95% CI)**	**Effect (95% CI)**	**ICER**	***p*(CE) at 0**	***p*(CE) at 20,000**	**Ceiling ratio at *p*(CE)=0.95**
BSS	**1572 (−732;4567)**	**0.93 (−0.59;2.5)**	**1683**	**0.18**	**0.10**	**NA**
QALY	**1572 (−732;4567)**	**0.01 (−0.003;0.03)**	**109,492**	**0.18**	**0.23**	**5,000,000**

CE plane=cost-effectiveness plane; CEA curve=cost-effectiveness acceptability curve; BSS=Beck Scale for Suicide Ideation; QALY=quality of life.

Table 4
Effects and costs(€) for Group with suicidal ideation and depressive symptoms.

			CEA curve			
Outcome	**Cost (95% CI)**	**Effect (95% CI)**	**ICER**	***p*(CE) at 0**	***p*(CE) at 20,000**	**Ceiling ratio at *p*(CE)=0.95**
BSS	1453 (−2263;5805)	−2.7 (−5.6;0.19)	−538	0.28	0.96	6100
QALY	1453 (−2263;5805)	0.01 (−0.01;0.04)	116,963	0.28	0.31	NA

CE plane=cost-effectiveness plane; CEA curve=cost-effectiveness acceptability curve; BSS=Beck Scale for Suicide Ideation; QALY=quality of life.

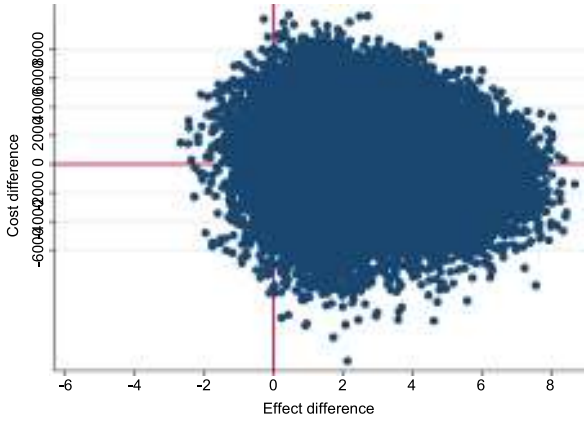

Fig. 2. Cost-effectiveness plane for the reduction in score on suicide ideation during 3 months.

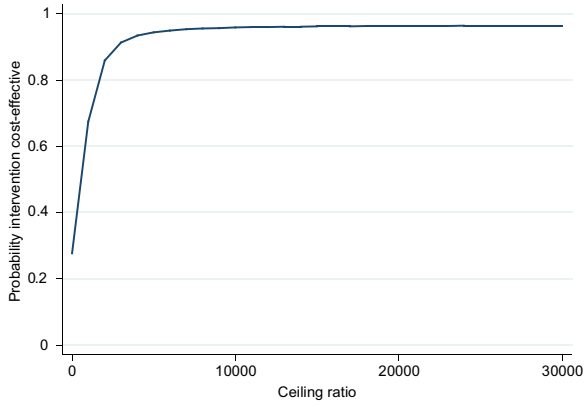

Fig. 3. Cost-effectiveness acceptability curve for the reduction in score on suicide ideation during 3 months.

(Appleby et al., 2000; Rutz et al., 1989) on the training of professionals in suicide prevention skills estimated the saved costs retrospectively on basis of possible reduction of completed suicides but not on change in level of suicide ideation. Future studies on the cost-effectiveness of suicide prevention interventions should be conducted to put our findings in perspective.

As in earlier studies (Van Spijker, 2012; van Spijker et al., 2012), the ICER based on the scores of the EuroQol were very large making interpretation difficult. The EuroQol is widely used, but is known to have limited sensitivity (Van de Willige et al., 2005). Moreover, the EuroQol is developed to measure improvements in various areas of health such as mobility and pain, making it less sensitive to change due to an implementation intervention based on improving suicide prevention skills. Future research should consider using additional instruments to measure quality of life (Günther et al., 2008).

Our results showed that implementing suicide guidelines with an e-learning supported Train-the-Trainer program is not cost-effective for suicidal patients compared to implementation as usual. This may be explained by the fact that, since practice guidelines reflect every day practice, professionals already showed certain levels of guideline adherence without being trained leading to reduced suicide ideation in the usual implementation group (de Beurs et al., 2015b). Therefore, the effectiveness of TtT-e on suicide ideation was presumably smaller than our sample size allowed us to detect. This is a common observation when implementing guidelines in psychiatry (Weinmann et al., 2007). The finding that the intervention may be cost-effective in comparison with control for some ceiling ratios in the subgroup of depressed suicidal patients when compared to the non-findings for the total group might be explained by the current focus on making contact and discussing suicidality of the training program, which might be more appropriate for suicidal patients with a depressive disorder and less for suicidal patients with for example a borderline personality disorder or psychotic disorder.

4.1. Limitations and strengths

Although MHI institutional boards agreed on collecting patient data using ROM, only 34% (192) of the data was collected via ROM. Although ROM collects data systematically and on a large scale compared to assessing each patient with a pencil and paper questionnaire, we had less participants and more missing values than we anticipated for. Considering the cost outcomes, we had almost no cases that were complete, and heavily relied on statistical techniques to impute the missing data. Also, due to the unavailability of the ROM, we were limited to assess patients at two time points (baseline and after three months). A three months period is a very short time span to measure any significant changes in health status or healthcare services uptake, especially for patients admitted to specialized mental health care institutions. Next, it was difficult for our research assistants to get access to the DSM-IV diagnosis of each patient. This resulted in a large amount of missing patient diagnoses (36%). Therefore, we were not able to test the effect of our intervention for other subgroups, except for patients with a diagnosis of depression. Also, the diagnoses were based on the registration in the Electronic Health Records. As this was a clinical diagnosis at intake, it is possible that the initial diagnosis was changed during hospitalization. Finally, diagnoses were not derived from structured clinical interviews like the structured clinical interview for DSM disorders (SCID), making the reported diagnoses less thorough.

An important element of our intervention was making contact with suicidal patients, and having more attention for suicide ideation. As most of the data (66%) was collected via paper and pencil instead of via the ROM, patients in both conditions might have experienced more attention for their suicidal thoughts due to contact with the interviewer, making any effect of our intervention more difficult to detect. Finally, as part of our safety plan, when patients showed heightened suicide ideation at baseline in either the control or the intervention condition, we reported this to their therapist. This increased monitoring and supervision has led to more attention to suicidal patients in both conditions, making it more difficult to detect an effect of our intervention.

Importantly, costs calculated in this study only pertain to the

direct and indirect costs made by the patient. By not taking changes in for example indirect costs made by significant others (ie less productive due to care for the patient) into account, we might underestimate the cost-effectiveness of our intervention (McDaid and Kennelly, 2009).

A strength of this study is its randomized controlled design, which is scarce in this field of research (Weinmann et al., 2007) and provides a high level of evidence. Also, the included departments well represent the psychiatric departments in The Netherlands. Therefore, the external validity of the findings is considerable. Also, by using advanced statistical techniques such as multiple imputation, multilevel modeling and bootstrapping, the results are more reliable.

4.2. Future studies

This is the first randomized trial to investigate the cost-effectiveness of the implementation of suicide prevention guidelines in comparison with usual implementation. As suicide rates are rising, while at the same time there is a need to reduce costs within mental health care, information on the cost-effectiveness of suicide prevention interventions is crucial for policy advisors and managers. Training specialized professionals in evidence based guidelines is both necessary to improve the quality of care and expensive. Due to the high baseline level on outcomes at the professional level, change on professional outcomes due to any training is not likely to be larger than 10% (Grimshaw and Eccles, 2004; Grol and Wensing, 2006). Also, guideline training, whether via e-learning, blended or face-to-face leads to both production loss (no patients are treated) and salary costs. Therefore, the training of highly specialized professionals is not likely to be cost-effective. We argue that training so-called gatekeepers (teachers, general practitioners, police) in suicide prevention might be a more likely to be cost-effective intervention compared to the training of specialized mental health professionals, as they are more likely to show more increase in professional outcome variables. This could then translate to the patient level, which ultimately could lead to less health care services up take from a societal perspective.

In our study we did not assess completed suicide. As total costs for a completed suicide are estimated to be around 1.6 million euro, the prevention of only one suicide due to training of professionals would make this structured approach cost-effective. Future studies should aim to also monitor completed suicides.

Considering the methodological and diagnostic issues discussed earlier, our study needs replication. Ideally, data on suicide ideation should be collected in a more systematic and less obtrusive manner via computerized outcome monitoring. Future studies should also investigate whether a more tailored program, with special attention for the specific patient group of a department, would result in the same effect on for example suicidal patients with a personality disorder, as we found for depressed suicidal patients. By collecting a large amount of data from multiple psychiatric departments among a heterogeneous sample of patients within a randomized design, and by using state of the art cost effectiveness analysis, our study adds information on the cost-effectiveness of a suicide guideline implementation program. In sum, our intervention was not cost-effective for all suicidal patients, but showed promising effects for depressed suicidal patients.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Author's contributions

AK, MdG, and JM obtained funding for this study. DP and MdG drafted the manuscript and carried out the study. JB conducted all analysis. MdG and AK designed the TtT-e protocol; all authors contributed to the execution of the study, and approved the final draft.

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