JNCI Cancer Spectrum (2021) 5(4): pkab057

doi: 10.1093/jncics/pkab057
First published online 4 June 2021
Article

Suicide Risk Screening and Suicide Prevention in Patients With Cancer

Bryan Gascon, HBSc,[1] Yvonne Leung, PhD,[2,3] Osvaldo Espin-Garcia, PhD,[4,5] Gary Rodin, MD,[1,3,6] Dominic Chu, MB, BCh,[6] Madeline Li, MD, PhD[1,3,6,*]

[1]Institute of Medical Science, Temerty Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada, [2]de Souza Institute, University Health Network, Toronto, Ontario, Canada, [3]Department of Psychiatry, Temerty Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada, [4]Department of Biostatistics, Princess Margaret Cancer Centre, University Health Network, Toronto, Ontario, Canada, [5]Division of Biostatistics, Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada and [6]Department of Supportive Care, Princess Margaret Cancer Centre, University Health Network, Toronto, Ontario, Canada

*Correspondence to: Madeline Li, MD, PhD, FRCPC, Department of Supportive Care, Princess Margaret Cancer Center, University Health Network, 16-749 610 University Avenue, Toronto, CA M5G 2M9, USA (e-mail: madeline.li@uhn.ca).

Abstract

Background: Suicide rates are up to 4 times greater in cancer compared with the general population, yet best practices for institutional suicide prevention are unknown. The objective of this study was to examine the association between suicide risk screening (SRS), clinician response, and suicide mortality at a comprehensive cancer treatment center. **Methods:** We conducted a naturalistic, retrospective cohort study of patients attending the Princess Margaret Cancer Centre, where routine screening for suicidal intent within the Distress Assessment and Response Tool (DART-SRS) was implemented in 2010. Inverse probability of treatment weighting was used to evaluate the impact of DART-SRS completion on suicide mortality from 2005 to 2014. Chart audits were conducted for clinician response to suicidality, and crude suicide rates over the study period were analyzed. All statistical tests were 2-sided. **Results:** Among 78 650 cancer patients, 89 (0.1%) died by suicide, of whom only 4 (4.5%) had completed DART-SRS. Among DART-SRS completers (n = 14 517), 69 (0.5%) reported suicidal intent, none of whom died by suicide. DART-SRS completion was associated with increased clinician response to suicidality (17.4% vs 6.7%, $P = .04$), more psychosocial service usage (30.5% vs 18.3%, $P < .001$), and lower suicide mortality (hazard ratio = 0.29, 95% confidence interval = 0.28 to 0.31). Crude suicide rates at the Princess Margaret Cancer Centre were lower in patients whose first contact year was after DART-SRS implementation. **Conclusion:** DART-SRS completion is associated with lower suicide mortality and increased access to psychosocial care, but patients who did not complete DART-SRS were at highest suicide risk. Further research is needed to identify mechanisms to ensure psychosocial and suicidality assessment in cancer patients who do not complete SRS.

Suicide is a leading cause of preventable death worldwide, with more than 800 000 people dying from suicide-related deaths annually (1). The risk of suicide among individuals with cancer may be 4 times greater than that of the general population (2-4). However, there are currently no evidence-based standardized approaches to reduce suicide rates in patients with cancer (5).

National-level strategies to address suicide prevention have recommended suicide risk screening (SRS) in medical populations in some countries (6–8) but not others (9,10). The implementation of SRS remains rare in oncology and is not explicitly included as an accreditation requirement for cancer centers (11,12). This limited uptake of SRS may be related to the lack of consensus on appropriate suicide screening tools (7,13), concerns about medico-legal liabilities, and most importantly, the limited ability of SRS tools to predict suicides (14,15). Meta-analyses have shown that most patients at high risk for suicide will not die by suicide, and approximately half of all suicides will occur among people considered as low risk (16). There have been no studies demonstrating suicide reductions in response to SRS tools in routine care.

Strategies for effective "Zero Suicide" practices in health-care settings have been identified as a research priority by the National Institute of Mental Health in the United States (17). However, there have been no naturalistic, ongoing implementation studies of the impact of suicide prevention practices on long-term patient outcomes in health-care settings (17). A recent study of suicide risk assessment practices in the United Kingdom found that there was more emphasis on using SRS to identify those at risk of suicide than to trigger evidence-based mental health interventions to prevent this outcome (13). SRS,

Received: 11 January 2021; **Revised:** 19 March 2021; **Accepted:** 30 April 2021

without a linked clinical response, does not reduce suicide attempts (18), although psychosocial assessment of patients presenting with self-harm has been associated with reduced risk of repeated self-harm (19).

In 2010, the Princess Margaret Cancer Centre (PM) developed the Distress Assessment and Response Tool (DART) to facilitate routine psychosocial assessment of patients with cancer (20). DART incorporates a SRS (DART-SRS) to alert clinicians about patients with suicidal intention (S-Int) who require urgent clinical intervention (20,21). However, the DART-SRS had not yet been validated for its predictive ability as a suicide risk screen, nor has the effectiveness of the DART-SRS process on suicide prevention been evaluated. The objective of this study was to characterize the association between patient completion of the DART-SRS, suicide mortality, and hospital-wide clinician response at PM.

Methods

Study Design and Setting

This study used a retrospective, observational study design based on naturalistic clinical and sociodemographic administrative data available as of December 31, 2014. Between DART implementation in 2010 and 2014, only 58 patients died by suicide. This sample size was underpowered for analyzing the predictive validity of DART-SRS on suicide mortality. The study therefore adopted a pre-post design to evaluate the impact of DART-SRS completion on suicide mortality in a cohort of patients with a diagnosis of malignant cancer who were first seen at PM in Ontario, Canada, between January 1, 2005, and December 31, 2013 (allowing for at least 1-year follow-up). Patients with in situ tumors or tumors of uncertain behavior were excluded from the analyses.

PM is the largest cancer care and research center in Canada, providing care for more than 17 000 patients annually. PM has a well-developed psychosocial oncology (PSO) program established in 2001, with a multidisciplinary team of social workers, psychiatrists, psychologists, and other health professionals providing treatment for cancer-related emotional distress. This study was approved by the University Health Network research ethics board.

Data Sources

Data linkages were conducted at Cancer Care Ontario, which houses provincial-level administrative health databases, for cause-of-death data available up until December 31, 2014. Available data on sex, age, marital status, postal code, cancer type, cancer stage, number of malignancies, PSO psychiatry and psychology visits, and social work referrals were extracted from PM clinical databases. Patient postal codes were linked to Statistics Canada Postal Code Conversion File version (PCCF+ Version 6B) to obtain median household income as a proxy for socioeconomic status (22).

The Distress Assessment and Response Tool (DART)

The DART program, an electronic symptom screening tool, became a routine standard of care at PM in 2010, with stepwise implementation across all ambulatory clinics. DART implementation gradually reached a target of more than 70% of all cancer patients screened at least once per month by January 2013 (20). DART is comprised of several validated patient-reported outcome measures, including the Edmonton Symptom Assessment System-revised (ESAS-r) for cancer-related symptoms (23) and the Patient Health Questionnaire (PHQ-9) for depression (24). Clinic receptionists direct patients to self-complete DART on iPads in the clinic waiting room before every appointment. A generated DART report (Supplementary Figure 1, available online) is reviewed by the oncology team in clinic. Patients with low to moderate distress are provided with oncology clinic-based support and self-management resources, and patients with high distress are flagged for clinicians to assess the need for a PSO referral (20).

DART Suicide Risk Screening (DART-SRS) Algorithm

The DART-SRS algorithm consists of 3 steps and is facilitated by intelligent software programming (21). The first step involves completing the depression item on ESAS-r, where patients who score 2 or higher are administered the PHQ-9. The second step involves completing the suicidal ideation item of the PHQ-9 ("thoughts that you would be better off dead or hurting yourself in some way") (21), where patients report the frequency of suicidal ideation within the past 2 weeks on a scale of 0 ("Not at all") to 4 ("Nearly every day"). Endorsement of any suicidal ideation triggers the third step inquiry into suicidal intention (S-Int): "Is there a chance you would do something to end your life?" S-Int is reported as a binary "yes" or "no," although declining to answer is permitted after responding to a prompt to skip the question. Only patients who answer "yes" have their DART report flagged for clinicians to "assess for suicidal concerns" (21).

Chart Audits

A chart audit template (Supplementary Figure 2, available online) was developed and conducted on all patients who reported S-Int on DART-SRS, and on patients who died by suicide, for evidence of clinic-based suicide assessment or intervention or to offer a PSO referral. Audits were conducted on the same day that S-Int was endorsed on DART-SRS or at any PM oncology appointment for those who died by suicide but never completed DART-SRS.

Outcome

The primary outcome was time to suicide. Death by suicide was defined by the following *International Statistical Classification of Diseases and Related Health Problems*, 10th edition (ICD-10), codes used in provincial-level mortality reports (25): X60-X84, Y87.0 (intentional self-harm); Y10-Y34, Y87.2, Y89.9 (event of undetermined intent); and X40-X49 (accidental poisoning and exposure to noxious substances). The inclusion of ICD-10 codes for events of undetermined intent and accidental poisonings (AP) in this study's definition of suicide was done to capture all probable cases of suicide, as misclassification and underreporting of suicides is expected to be frequent at a national level (26).

Statistical Analyses

Descriptive statistics were calculated for the entire study cohort, stratified by patients who have completed DART at least once (DART-SRS completers) or not at all (DART-SRS noncompleters) during the study period. Descriptive statistics were

reported separately for all patients who died by suicide and for those who endorsed S-Int on DART-SRS. Differences in baseline characteristics and clinician response among the groups were compared with Wilcoxon or χ^2 tests for continuous and categorical variables, respectively.

A cumulative incidence function was modeled to evaluate univariate associations between DART-SRS completion and suicide death, with the Gray test used to test statistically significant differences in suicide deaths between groups (27). The impact of DART-SRS completion on suicide mortality was evaluated using inverse probability treatment weighting (IPTW), with 95% confidence intervals (CIs) constructed from bootstrap resampling. To compute propensity scores for DART-SRS completion, we used a multivariable logistic regression model that incorporated the following predictors based on previously published suicide risk factors that were available at the PM registry: age, sex, number of malignancies, cancer stage, cancer type, marital status, and household income estimates. First contact year at PM was also incorporated to account for the varying availability of DART at PM over the study period (Supplementary Table 1, available online). Missing categorical data were imputed as an additional variable (ie, "unknown"). Propensity scores were then incorporated into IPTW analyses to estimate the effect of DART-SRS completion on time to suicide, with DART-SRS completion status modeled as a time-varying covariate based on the date of the patient's first DART-SRS survey. The proportional hazards assumption was tested by examination of Schoenfeld residuals. Estimation of treatment effects derived from propensity score models aims to mitigate bias inherent in observational, nonrandomized data (28).

To assess the robustness of our main findings, we conducted multiple sensitivity analyses. To ensure that the effect of DART-SRS completion on suicide mortality was not substantially affected by the inclusion of suicide deaths defined by ICD-10 codes X40-X49 (accidental poisoning and exposure to noxious substances), we repeated our propensity score analyses excluding AP codes in our primary outcome. We also performed alternative statistical approaches accounting for the same covariates, including stratification on propensity scores, multivariable Cox regression (unweighted), and Fine and Gray regression in dealing with competing risks in time-to-event analyses (29). All statistical analyses were 2-sided and conducted using R programming version 3.5.2 (30). A P value of no more than .05 was considered statistically significant.

To assess temporal trends in suicide rates over the study period, we compared crude suicide rates in patients with first contact before (2005-2009) and after (2010-2013) DART implementation and used Joinpoint regression for the PM study cohort and Ontario population (based on publicly available Statistics Canada mortality data) using the Joinpoint Regression Program, Version 4.5.0.1 (National Cancer Institute).

Results

Study Population

Table 1 summarizes the demographic characteristics of our study population. In total, 78 650 adult patients with a confirmed malignant cancer diagnosis were seen at PM from 2005 to 2013. Of these patients, 14 517 (18.5%) completed DART-SRS at least once during the study period, with a majority (52.8%; 7660 of 14 517) completing their first DART-SRS survey within the first year of their initial contact at PM. Almost 61% (39 081 of 64 133) of DART-SRS non-completers had a first contact year prior to DART implementation in 2010, although approximately 10% (4312 of 43 393) of patients with a first contact year before 2010 still completed DART during ongoing care after 2010.

Patients who completed DART-SRS were more likely to be younger and female, have earlier stage disease, and to live in areas associated with higher household income than DART-SRS non-completers. Greater proportions of DART-SRS completers had visits to PSO (30.5% vs 18.3%) compared with non-completers.

Primary Outcome and Chart Audit Outcomes

Table 2 summarizes and compares the characteristics of all patients who died by suicide, patients who died by nonsuicide causes, and those who endorsed S-Int on DART-SRS. There were 89 suicides, which comprised 0.26% of all deaths (n = 34 561) and 0.1% of the entire study cohort (n = 78 650); 4 (4.5%) suicides were in the DART-SRS completer group, and 85 (95.5%) suicides were in the DART-SRS non-completer group. Among the 4 patient suicides who completed DART-SRS, only 1 reported suicidal ideation but denied S-Int. Suicides most often occurred in males (77.5%), in patients with head and neck cancer (27.0%), in patients who were not married (19.0%), in patients who had advanced disease (40.5%), and in patients who were younger compared with other nonsuicide deaths (mean = 60.1 vs 64.9 years; $P < .001$). Approximately half of all suicides occurred within the first year of being treated at PM (49.5%).

Based on patients' first DART-SRS completion, 5003 of 14 517 (34.5%) reported ESAS-r depression 2 or higher, and 613 of 14 517 (4.2%) reported suicidal ideation. Although none of these patients died by suicide, 69 of 613 (11.3%; 0.5% of all DART-SRS completers) reported S-Int, 369 of 613 (60.2%) denied S-Int, and 175 of 613 (28.5%) declined to answer. No differences in sociodemographic and medical characteristics were observed between patients who died by suicide (n = 89) and those who endorsed S-Int on DART (n = 69), with the exception of cancer type ($P = .05$; Table 2). Suicide discussions (17.4% vs 6.7%; $P = .04$) and PSO visits (30.5% vs 18.3%; $P < .001$) occurred more frequently in patients who reported S-Int on DART-SRS compared with patients who died by suicide (Table 3). Overall rates of suicide discussions and supportive care interventions for DART-SRS–reported S-Int were low, at only 17.4% and 13.0%, respectively (Table 3).

Survival Analyses

Figure 1 illustrates the cumulative incidence curve for suicide for DART-SRS completers and non-completers. The median and range of the follow-up times for DART completers and non-completers was 3 (range = 0-10) years and 1.5 (range = 0-10) years, respectively. Cumulative incidence of suicide was statistically significantly lower in DART-SRS completers than in non-completers (Gray test, $P < .001$). DART-SRS completers were at a statistically significant lower risk of suicide compared with non-completers, yielding an IPTW hazard ratio (HR) of 0.29 (95% CI = 0.28 to 0.31) (Table 4).

Sensitivity Analyses

In our sensitivity analyses, exclusion of ICD-10 codes for accidental poisoning and exposure to noxious substance from our definition of suicide did not alter our findings substantially

Table 1. Characteristics of study population

Characteristics	DART-SRS completed (n = 14 517)	No DART-SRS (n = 64 133)	P[a]
Age at first contact, y			< .001
Mean (SD)	56.2 (14.6)	61.7 (14.6)	
Median (min, max)	57.3 (18, 99.9)	63 (18, 103.6)	
Sex, No. (%)			< .001
Female	7725 (53.2)	30 212 (47.1)	
Male	6792 (46.8)	33 921 (52.9)	
Number of malignancies, No. (%)			< .001
Mean (SD)	1.1 (0.3)	1 (0.2)	
Median (min, max)	1 (1, 5)	1 (1, 5)	
Cancer stage, No. (%)			< .001
0	1 (0.0)	12 (0.0)	
1	3577 (24.6)	12 231 (19.1)	
2	2640 (18.2)	11 266 (17.6)	
3	2490 (17.2)	7440 (11.6)	
4	2468 (17.0)	12 272 (19.1)	
Unknown	2832 (19.5)	18 488 (28.8)	
Unstageable	509 (3.5)	2424 (3.8)	
Cancer group, No. (%)			< .001
Breast	1859 (12.8)	8004 (12.5)	
Central nervous system	409 (2.8)	1687 (2.6)	
Colorectal	642 (4.4)	5324 (8.3)	
Esophageal/Liver/Pancreas	420 (2.9)	5049 (7.9)	
Head and neck	1998 (13.8)	3908 (6.1)	
Lung	793 (5.5)	6281 (9.8)	
Lymphatic/Hematologic	1896 (13.1)	7094 (11.1)	
Melanoma/Skin	827 (5.7)	2041 (3.2)	
Prostate	977 (6.7)	8376 (13.1)	
Other	4696 (32.3)	16 369 (25.5)	
Marital status, No. (%)			< .001
Common law	117 (0.8)	364 (0.6)	
Divorced	185 (1.3)	988 (1.5)	
Married	2873 (19.8)	14 255 (22.2)	
Separated	113 (0.8)	534 (0.8)	
Single	1125 (7.7)	3945 (6.2)	
Widowed	134 (0.9)	1302 (2.0)	
Unknown	9970 (68.7)	42 745 (66.7)	
Median household income, No. (%)			< .001
$0-$19999	351 (2.4)	1701 (2.7)	
$20 000-$29 999	375 (2.6)	2163 (3.4)	
$30 000-$39 999	1099 (7.6)	5552 (8.7)	
$40 000-$49 999	1831 (12.6)	9002 (14.0)	
$50 000-$59 999	1995 (13.7)	9100 (14.2)	
$60 000-$69 999	2143 (14.8)	9272 (14.5)	
$70 000-$79 999	1848 (12.7)	7887 (12.3)	
$80 000-$89 999	1538 (10.6)	6368 (9.9)	
$90 000-$99 999	1132 (7.8)	4415 (6.9)	
$100 000-$199 999	1897 (13.1)	7253 (11.3)	
$200 000 and greater	82 (0.6)	348 (0.5)	
No census data	63 (0.4)	334 (0.5)	
Unlinked postal code	163 (1.1)	738 (1.2)	
Year of first contact, No. (%)			< .001
2005	515 (3.5)	7849 (12.2)	
2006	633 (4.4)	7947 (12.4)	
2007	789 (5.4)	8081 (12.6)	
2008	1015 (7.0)	7700 (12.0)	
2009	1360 (9.4)	7504 (11.7)	
2010	2037 (14.0)	6821 (10.6)	
2011	2724 (18.8)	6176 (9.6)	
2012	2910 (20.0)	5945 (9.3)	
2013	2534 (17.5)	6110 (9.5)	

(continued)

Table 1. (continued)

Characteristics	DART-SRS completed (n = 14 517)	No DART-SRS (n = 64 133)	P[a]
PSO service usage during study period			
Any PSO discipline			
Seen at least once, No. (%)	4433 (30.5)	11 739 (18.3)	<.001
Psychiatry			
Seen at least once, No. (%)	1605 (11.1)	2948 (4.6)	<.001
Psychology			
Seen at least once, No. (%)	190 (1.3)	230 (0.4)	<.001
Referral to social work			
Referred at least once, No. (%)	3712 (25.6)	10 566 (16.5)	<.001

[a]P values were calculated using 2-sided Wilcoxon or χ^2 tests for continuous and categorical variables, respectively. DART-SRS = Distress Assessment and Response Tool suicide risk screening; PSO = psychosocial oncology.

Table 2. Characteristics of patients who died by suicide and patients with suicidal intent (S-Int)

Characteristics	Nonsuicide death (n = 34 472)	Suicides (n = 89)	DART-SRS S-Int (n = 69)	P[a] (nonsuicide death vs suicide)	P[a] (suicide vs DART-SRS S-Int)
Sex, No. (%)					
Female	15 421 (44.7)	20 (22.5)	20 (29.0)	<.001	.35
Male	19 051 (55.3)	69 (77.5)	49 (71.0)		
Mean age (SD), y	64.9 (13.6)	60.1 (13.5)	56.4 (14.6)	<.001	.11
Cancer type, No. (%)					
Breast	2047 (5.9)	4 (4.5)	3 (4.3)	<.001	.05
Central nervous system	1489 (4.3)	1 (1.1)	4 (5.8)		
Colorectal	3310 (9.6)	3 (3.4)	4 (5.8)		
Esophageal/Liver/Pancreas	4166 (12.1)	6 (6.7)	3 (4.3)		
Head and neck	2506 (7.3)	24 (27.0)	16 (23.2)		
Lung	5597 (16.2)	6 (6.7)	2 (2.9)		
Lymphatic/Hematologic	4350 (12.6)	11 (12.4)	5 (7.2)		
Melanoma	1071 (3.1)	0 (0.0)	5 (7.2)		
Prostate	1397 (4.1)	12 (13.5)	3 (4.3)		
Other	8539 (24.8)	22 (24.7)	24 (34.8)		
Cancer stage, No. (%)					
1	2140 (6.2)	15 (16.9)	4 (5.8)	.002	.23
2	3046 (8.8)	10 (11.2)	9 (13.0)		
3	4503 (13.1)	15 (16.9)	15 (21.7)		
4	11 248 (32.6)	21 (23.6)	21 (30.4)		
Unstageable	1291 (3.7)	6 (6.7)	3 (4.3)		
Unknown	12 244 (35.5)	22 (24.7)	17 (24.6)		
Marital status, No. (%)					
Common law	184 (0.5)	3 (3.4)	1 (1.4)	<.001	.76
Divorced	554 (1.6)	2 (2.2)	0 (0.0)		
Married	7654 (22.2)	12 (13.5)	11 (15.9)		
Separated	296 (0.9)	2 (2.2)	0 (0.0)		
Single	1832 (5.3)	10 (11.2)	8 (11.6)		
Widowed	888 (2.6)	0 (0.0)	0 (0.0)		
Unknown	23 064 (66.9)	60 (67.4)	49 (71.0)		
Mean annual household income (SD), $	66 447.0 (30 402.8)	63 612.8 (31 479.7)	56 407.4 (27 299.1)	.18	.07
DART-SRS completion, No. (%)					
Never	31 449 (91.2)	85 (95.5)	0 (0.0%)	.15	<.001
At least once	3023 (8.8)	4 (4.5)	69 (100.0)		
Mean distress scores on DART (SD)					
Pain (ESAS-r)	3.4 (2.9)	1.8 (1.5)	4.2 (3.1)	.32	.15
Depression (ESAS-r)	2.6 (2.7)	4.0 (1.4)	5.9 (3.0)	.16	.19
Mean time to suicide (from date of first contact at PM) (SD), days	—	625.0 (648.8)	—		
Min, Max days	—	3, 2709	—		

(continued)

Table 2. (continued)

Characteristics	Nonsuicide death (n = 34 472)	Suicides (n = 89)	DART-SRS S-Int (n = 69)	P[a] (nonsuicide death vs suicide)	P[a] (suicide vs DART-SRS S-Int)
Time to suicide (from date of first contact at PM), No. (%)					
Within first 6 months	—	29 (32.6)	—		
6 months-1 year	—	15 (16.9)	—		
1 year-2 years	—	17 (19.1)	—		
2 years-3 years	—	13 (14.6)	—		
3 years-4 years	—	4 (4.5)	—		
After 4 years	—	11 (12.4)	—		

[a]P values were calculated using 2-sided Wilcoxon or χ^2 tests for continuous and categorical variables, respectively. — = represent a time period range post-diagnosis; DART-SRS = Distress Assessment and Response Tool suicide risk screening; ESAS-r = Edmonton symptom assessment system-revised; PM = Princess Margaret Cancer Center; PSO = psychosocial oncology; S-Int = suicidal intention.

Table 3. Clinician response to suicidality

Clinician response	Documented discussion	Suicides, No. (%) (n = 89)	DART-SRS S-Int, No. (%) (n = 69)	P[a]
Suicide assessment/discussion				
Is it described if suicide was discussed (frequency of suicidal ideation, description of thoughts, etc.)?	No	83 (93.3)	57 (82.6)	.04
	Yes	6 (6.7)	12 (17.4)	
Is it described whether or not the patient had a plan related to suicide?	No	85 (95.5)	64 (92.8)	.46
	Yes	4 (4.5)	5 (7.2)	
Is it described whether or not the patient had recently made a suicide attempt?	No	86 (96.6)	69 (100.0)	.12
	Yes	3 (3.4)	0 (0.0)	
Suicide intervention[b]				
Urgent referral to PM psychiatry on-call	No	88 (98.9)	67 (97.1)	.42
	Yes	1 (1.1)	2 (2.9)	
Offer for referral to PM supportive care services	No	80 (89.9)	60 (87.0)	.57
	Yes	9 (10.1)	9 (13.0)	
PSO service usage during the study period				
Any PSO discipline	Seen at least once	17 (19.1)	48 (69.6)	<.001
Psychiatry	Seen at least once	9 (10.1)	23 (33.3)	<.001
Psychology	Seen at least once	0 (0.0)	0 (0.0)	NA
Referral to social work	Referred at least once	14 (15.7)	43 (62.3)	<.001
DART-SRS				
DART-SRS completion	Never	85	0	<.001
	At least once	4	69	
DART-SRS PHQ-9	Summed Score Mean (SD)	9.0 (2.7)	16.6 (7.2)	.04
DART-SRS PHQ-9 suicidal thoughts score	0 (Not at all)	3 (75.0)	0 (0.0)	<.001
	1 (Several days)	1 (25.0) [c]	28 (40.6)	
	2 (More than half the days)	0 (0.0)	16 (23.2)	
	3 (Nearly every day)	0 (0.0)	25 (36.2)	

[a]P values were calculated using 2-sided Wilcoxon or χ^2 tests for continuous and categorical variables, respectively. DART-SRS = Distress Assessment and Response Tool suicide risk screening; ESAS-r = Edmonton symptom assessment system-revised; NA = not applicable; PHQ-9 = 9-item patient health questionnaire; PM = Princess Margaret Cancer Center; PSO = psychosocial oncology; S-Int = suicidal intention.
[b]No documentation of involuntary certifications, suicide-related emergency room visits, or admission to a psychiatric ward was found among patients in either group.
[c]1 patient in suicide group endorsing suicidal ideation on DART-SRS PHQ-9 denied S-Int.

(IPTW HR = 0.27, 95% CI = 0.25 to 0.29). Alternative statistical analyses yielded consistent results, which included stratification on propensity score (HR = 0.34, 95% CI = 0.31 to 0.37), multivariable Cox proportional hazards model (HR = 0.12, 95% CI = 0.05 to 0.34), and the multivariable Fine-Gray model (HR = 0.16, 95% CI = 0.06 to 0.44) (Table 4).

Trends in Crude Suicide Rates

Crude suicide rates decreased by a statistically significant 50.88 suicides per 100 000 patients (95% CI = 4.72 to 97.04) in patients who made first contact after DART implementation (2010-2013) compared with those who made first contact before DART implementation (2005-2009) (Table 5). Joinpoint analyses showed a statistically significant increase in crude suicide rates in Ontario over the study period (annual percent change [APC] = 1.19; P = .04), whereas there was no statistically significant change at PM (APC = -3.88; P = .52) based on final selected models of 0-Joinpoints (Supplementary Figure 3, A and B, available online). Using 1-Joinpoint models demonstrated a statistically significant increase in Ontario suicide rates beginning in 2008 (APC = 2.02; P = .01), and a decreasing trend at PM was observed beginning in 2012 (APC = -

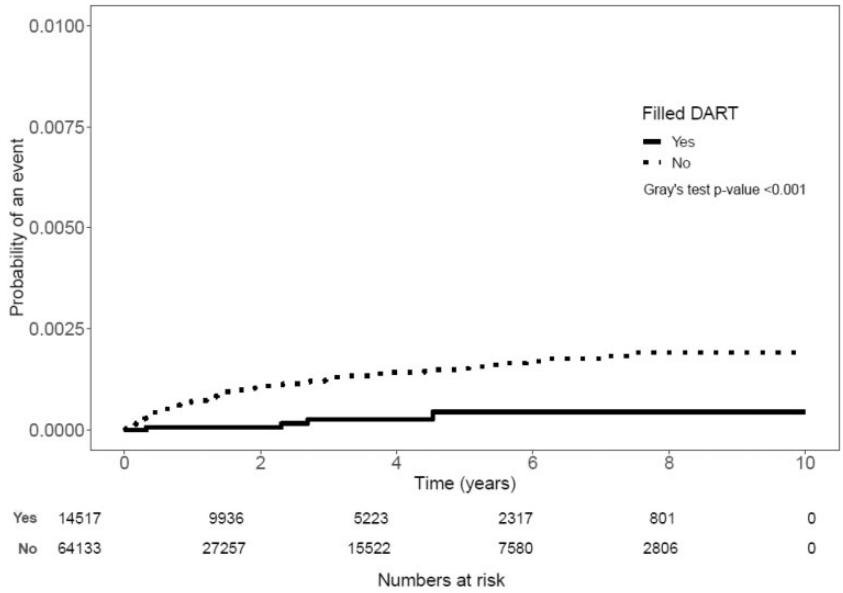

Figure 1. Cumulative incidence for suicide deaths. Univariate comparisons between cumulative suicide mortality and DART-SRS completion status (completer vs non-completer group) were made using Gray test of a 2-sided hypothesis. The cumulative incidence functions were modeled accounting for nonsuicide deaths as a competing risk. DART = Distress Assessment and Response Tool.

Table 4. Hazard ratios (HR) for suicide at PM[a]

Statistical method	Estimate	HR (95% CI)
Propensity score method		
IPTW	Naive	0.29 (0.10 to 0.89)
	Bootstrap	0.29 (0.28 to 0.31)
Sensitivity analysis methods		
IPTW (excluding AP)	Naive	0.27 (0.06 to 1.23)
	Bootstrap	0.27 (0.25 to 0.29)
Stratification on propensity scores (excluding AP)	Naive	0.31 (0.08 to 1.28)
	Bootstrap	0.29 (0.26 to 0.32)
Stratification on propensity scores	Naive	0.36 (0.13 to 0.99)
	Bootstrap	0.34 (0.31 to 0.37)
Cox proportional hazards model	Univariate	0.15 (0.06 to 0.41)
	Multivariate (adjusted)	0.12 (0.05 to 0.34)
Fine-Gray model	Univariate	0.20 (0.07 to 0.55)
	Multivariate (adjusted)	0.16 (0.06 to 0.44)

[a]AP = accidental poisonings and exposure to noxious substances; CI = confidence interval; HR = hazard ratio; IPTW = inverse probability of treatment weighting; PM = Princess Margaret Cancer Centre.

Table 5. Crude suicide rates

Cohort by first contact date	Total No. in cohort	No. of suicides	Suicide rate per 100 000	Difference in suicide rate (95% CI)[a]
2005-2009	43 393	59	136.0	50.88 (4.72 to 97.04)
2010-2013	35 257	30	85.0	

[a]CI = confidence interval.

19.36; $P = .77$), coincident with the time DART implementation approached saturation in all oncology clinics (20) (Supplementary Figure 3, C and D, available online).

Discussion

This single-institution, retrospective, cohort study of 78 650 patients with cancer confirmed that completion of a SRS is associated with more access to psychosocial care and a lower risk of suicide death. However, the report of S-Int on DART-SRS only infrequently resulted in a direct clinician response, and patients with cancer who ultimately died by suicide tended not to complete DART-SRS. Patients who died by suicide tended to be male, to have advanced stage disease, to have head and neck cancer, to be unmarried, and to be within the first year of diagnosis (2,3,31).

This study cannot determine whether DART-SRS is effective in predicting or preventing suicides because of gaps in screening implementation. Although more than half of those who did not complete DART-SRS had a first contact year prior to 2010 and therefore had less opportunity to access DART, there are other reasons for DART noncompletion, including barriers of language, literacy, discomfort with technology, or feeling too unwell, all factors associated with higher suicide risk. The low rates of direct suicide assessment and intervention by clinicians for reported S-Int is concerning in terms of missed opportunities for suicide prevention, although the protective effects of SRS have been more strongly linked to improving access to psychosocial assessment than to suicide-specific intervention (19).

The finding that DART-SRS completion was associated with a lower risk for suicide, even when it was infrequently followed by a clinical assessment or intervention, deserves consideration. This may be a case of confounding by indication, where attributes of those who complete DART-SRS (ie, younger, more affluent, female, earlier stage disease) are also associated with a lower risk of suicide, although our propensity score analyses attempted to control for these variables. However, consistent with studies showing a protective effect of psychosocial assessment by any clinician (32), it may be that the increased access to specialized PSO services among DART-SRS completers lowers their risk for suicide (Table 1). The suicide and DART-SRS S-Int groups have similar suicide risk factors, except that only 19% (17 of 89) of the suicide group had a PSO visit compared with 70% (48 of 69) in the DART-SRS S-Int group, none of whom ultimately died by suicide (Table 3).

Implementing a standardized operating procedure to link SRS with psychosocial assessment may be necessary to reduce institutional risk for suicides (16). The reduction in crude suicide rates at PM over the study period, despite sharply increasing crude suicide rates in the province during this time (Supplementary Figure 3, available online), could be related to systemic changes in both cancer care and supportive care at PM, including the implementation of DART. This includes more proactive symptom control through greater access to psychosocial and palliative care and the development of specialized clinics for older adults (33,34). The reduction in suicide rates reported here contrasts with recent evidence that suicide risk in cancer patients have doubled over the past decade (4).

This is the first study to evaluate the impact of SRS on suicide outcomes in a real-world clinical oncology or medical setting and to identify mechanisms that may diminish suicide risk, which are key research priorities of the National Institute of Mental Health (17). Strengths of the current study include the large sample size within a single institution and the study of a well-established standardized electronic SRS protocol in a comprehensive cancer treatment center. The inclusion of chart audits for clinician response to suicidality is also unique and has the potential to elucidate mechanisms that increase suicide risk.

A study limitation is the absence of data related to other medical and social determinants of health, such as living situation and preexisting psychiatric or neurocognitive disorders, which could affect the ability or willingness to complete DART-SRS and suicide outcomes. Also, chart audits that were used as a proxy for clinical encounters may underestimate the true frequency and quality of clinician response to suicidality because of differences in documentation practices.

The present study demonstrates that the completion of SRS by patients with cancer is associated with a lower risk of suicide. Those who complete such screening may be more likely to access psychosocial services and less likely to die by suicide, whereas those who ultimately die by suicide tend not to complete screening measures or to access psychosocial care. Institutional efforts should continue to prioritize physical and emotional symptom screening, timely management, and referral to supportive care services but should also pay particular attention to patients who do not complete screening and who may be at the highest risk of suicide.

Funding

Not applicable.

Notes

Role of the funder: Not applicable.

Disclosures: The authors of this study have no disclosures to declare.

Author contributions: Conceptualization: YL and ML. Data curation: BG, YL, and DC. Formal analysis: BG and OEG. Methodology: BG, OEG, ML, and YL. Supervision: ML. Writing—original draft: BG, ML, GR. Writing—review & editing: All authors.

Prior presentations: Preliminary findings from this study were presented at the 21st Annual World Congress of Psycho-Oncology (September 2019, Banff, Canada) and the National CanPROS Congress (November 2019, Calgary, Canada).

Data Availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

1. Naghavi M. Global, regional, and national burden of suicide mortality 1990 to 2016: systematic analysis for the Global Burden of Disease Study 2016. *BMJ*. 2019;364:l94.
2. Fang F, Fall K, Mittleman MA, et al. Suicide and cardiovascular death after a cancer diagnosis. *N Engl J Med*. 2012;366(14):1310–1318.
3. Henson KE, Brock R, Charnock J, Wickramasinghe B, Will O, Pitman A. Risk of suicide after cancer diagnosis in England. *JAMA Psychiatry*.2019;76(1):51.
4. Zaorsky NG, Zhang Y, Tuanquin L, Bluethmann SM, Park HS, Chinchilli VM. Suicide among cancer patients. *Nat Commun*. 2019;10(1):207.
5. Fazel S, Runeson B. Suicide. *N Engl J Med*. 2020;382(3):266–274.
6. Public Health Agency of Canada. Working together to prevent suicide in Canada: The Federal Framework for Suicide Prevention. Ottawa, ON: Public Health Agency of Canada; 2016.
7. Bernert RA, Hom MA, Roberts LW. A review of multidisciplinary clinical practice guidelines in suicide prevention: toward an emerging standard in suicide risk assessment and management, training and practice. *Acad Psychiatry*. 2014;38(5):585–592.
8. The Joint Commission. Detecting and treating suicide ideation in all settings. *Sentinel Event Alert*. 2016;(56):1–7.
9. Carter G, Page A, Large M, et al. Royal Australian and New Zealand College of Psychiatrists clinical practice guideline for the management of deliberate self-harm. *Aust N Z J Psychiatry*. 2016;50(10):939–1000.
10. National Institute for Health and Cancer Excellence. Self-harm in over 8s: long-term management. Clinical guideline. 2011. https://www.nice.org.uk/guidance/cg133/resources/selfharm-in-over-8s-longterm-management-pdf-35109508689349. Accessed November 20, 2020.
11. Cancer ACoSCo. *Cancer Program Standards: Ensuring Patient-Centered Care* 16th ed. 2016. https://www.facs.org/-/media/files/quality-programs/cancer/coc/2016-coc-standards-manual_interactive-pdf.ashx?la=en. Accessed August 1, 2019.
12. Cancer Care Standards. Accreditation Canada; 2016.
13. Graney J, Hunt IM, Quinlivan L, et al. Suicide risk assessment in UK mental health services: national mixed-methods study. *Lancet Psychiatry*. 2020;7(12):1046–1053.

14. Steeg S, Quinlivan L, Nowland R, et al. Accuracy of risk scales for predicting repeat self-harm and suicide: a multicentre, population-level cohort study using routine clinical data. *BMC Psychiatry*. 2018;18(1):113.
15. Whiting D, Fazel S. How accurate are suicide risk prediction models? Asking the right questions for clinical practice. *Evid Based Ment Health*. 2019;22(3).
16. Large MM, Ryan CJ, Carter G, Kapur N. Can we usefully stratify patients according to suicide risk? *BMJ*. 2017;359:j4627.
17. Gordon JA, Avenevoli S, Pearson JL. Suicide prevention research priorities in health care. *JAMA Psychiatry*. 2020;77(9):885.
18. Miller IW, Camargo CA Jr, Arias SA, et al. Suicide prevention in an emergency department population: the ED-SAFE study. *JAMA Psychiatry*. 2017;74(6): 563–570.
19. Kapur N, Steeg S, Webb R, et al. Does clinical management improve outcomes following self-harm? Results from the multicentre study of self-harm in England. *PLoS One*. 2013;8(8):e70434.
20. Li M, Macedo A, Crawford S, et al. Easier said than done: keys to successful implementation of the Distress Assessment and Response Tool (DART) program. *J Oncol Pract*. 2016;12(5):e513-e526.
21. Leung YW, Li M, Devins G, et al. Routine screening for suicidal intention in patients with cancer. *Psychooncology*. 2013;22(11):2537–2545.
22. Rotermann M, Sanmartin C, Carriere G, et al. Two approaches to linking census and hospital data. *Health Rep*. 2014;25(10):3–14.
23. Watanabe SM, Nekolaichuk C, Beaumont C, Johnson L, Myers J, Strasser F. A multicenter study comparing two numerical versions of the Edmonton Symptom Assessment System in palliative care patients. *J Pain Symptom Manage*. 2011;41(2):456–468.
24. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med*. 2001;16(9):606–613.
25. Fransoo RMartens P et al.; for the Need to Know Team. *The 2013 RHA Indicators Atlas*. Manitoba, Canada: Manitoba Center for Health Policy; 2013.
26. Skinner R, McFaull S, Rhodes AE, Bowes M, Rockett IRH. Suicide in Canada: is poisoning misclassification an issue? *Can J Psychiatry*. 2016;61(7): 405–412.
27. Gray RJ. A class of K-sample tests for comparing the cumulative incidence of a competing risk. *Ann Statist*. 1988;16(3):1141–1154.
28. Austin PC. The use of propensity score methods with survival or time-to-event outcomes: reporting measures of effect similar to those used in randomized experiments. *Stat Med*. 2014;33(7):1242–1258.
29. Fine JP, Gray RJ. A proportional hazards model for the subdistribution of a competing risk. *J Am Stat Assoc*. 1999;94(446):496–509.
30. R Core Team. R A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2018.
31. Aboumrad M, Shiner B, Riblet N, Mills PD, Watts BV. Factors contributing to cancer-related suicide: a study of root-cause analysis reports. *Psychooncology*. 2018;27(9):2237–2244.
32. Pitman A, Tsiachristas A, Casey D, et al. Comparing short-term risk of repeat self-harm after psychosocial assessment of patients who self-harm by psychiatrists or psychiatric nurses in a general hospital: cohort study. *J Affect Disord*. 2020;272:158–165.
33. Zimmermann C, Swami N, Krzyzanowska M, et al. Early palliative care for patients with advanced cancer: a cluster-randomised controlled trial. *Lancet*. 2014;383(9930):1721–1730.
34. Alibhai SMH, Jin R, Loucks A, et al. Beyond the black box of geriatric assessment: understanding enhancements to care by the geriatric oncology clinic. *J Geriatr Oncol*. 2018;9(6):679–682.