Examining five- and ten-year survival in older women with breast cancer using cancer-specific geriatric assessment

Kerri M. Clough-Gorr [a,b,c,*], Soe Soe Thwin [a,d], Andreas E. Stuck [e], Rebecca A. Silliman [a]

[a] Section of Geriatrics, Boston University Medical Center, 88 East Newton Street, Robinson Building, Boston, MA 02118, USA
[b] Institute of Social and Preventive Medicine (ISPM), University of Bern, Finkenhubelweg 11, CH3012 Bern, Switzerland
[c] National Institute of Cancer Epidemiology and Registration (NICER), Institute of Social and Preventive Medicine (ISPM), University of Zürich, Seilergraben 49, CH3006 Zürich, Switzerland
[d] Massachusetts Veterans Epidemiology Research and Information Center (MAVERIC), VA Healthcare System, 150 South Huntington Ave., Boston, MA 02130, USA
[e] Division of Geriatrics, Department of General Internal Medicine, Inselspital University Hospital and University of Bern, Postfach 20, CH-3010 Bern, Switzerland

ARTICLE INFO

ABSTRACT

Purpose: To examine five- and ten-year survival based on cancer-specific geriatric assessment (C-SGA) in older women with early stage breast cancer.

Methods: We evaluated 660 women $\geqslant$65-years old diagnosed with stage I–IIIA primary breast cancer and attending physician permission to contact in four geographic regions in the United States of America (USA). Data were collected over ten-years of follow-up from consenting women's medical records, telephone interviews, National Death Index and Social Security Death Index. C-SGA was described by four domains using six measures: socio-demographic (financial resources); clinical (comorbidity, obesity); function (physical function limitations); and psychosocial (general mental health, social support). Survival from all-cause and breast-cancer-specific mortality and receipt of guideline-recommended therapy was assessed for different groups of subjects with C-SGA domain deficits (cut-off $\geqslant$3 deficits).

Results: The proportion of women with $\geqslant$3 C-SGA deficits surviving ten-years was consistently statistically significantly lower (all-cause 26% versus 46% and breast-cancer-specific 76% versus 89%, $p \leqslant 0.04$). The proportion significantly decreased as number of C-SGA deficits increased (linear trend $p < 0.0001$). Receipt of guideline-recommended therapy decreased with age but not consistently by number of C-SGA deficits. The all-cause and breast-cancer-specific death rate at five- and ten-years was consistently approximately two times higher in women with $\geqslant$3 C-SGA deficits even when fully adjusted for confounding factors ($HR_{5\text{-}yrAllCauseFullyAdjusted} = 1.87$ [1.36–2.57], $HR_{10\text{-}yrAllCauseFullyAdjusted} = 1.74$ [1.35–2.15], $HR_{5\text{-}yrBreastCancerFullyAdjusted} = 1.95$ [1.18–3.20], $HR_{10\text{-}yrBreastCancerFullyAdjusted} = 1.99$ [1.21–3.28]).

Conclusion: Regardless of age and stage of disease, C-SGA predicts five- and ten-year all-cause and breast-cancer-specific survival in older women. Hence, C-SGA may provide an effective strategy to guide treatment decision-making and to identify risk factors for intervention.

© 2011 Elsevier Ltd. All rights reserved.

* Corresponding author: Address: Section of Geriatrics, Boston University Medical Center, 88 East Newton Street, Robinson 2, Boston, MA 02118, USA. Tel.: +1 617 638 6100.
E-mail address: kmclough@bu.edu (K.M. Clough-Gorr).

1. Introduction

In 2009 there were an estimated 192,370 new cases of invasive breast cancer in the United States (US) with 50% of cases diagnosed in women 61-years or older.[1] Due to the high relative survival rates in US women (89% five-years after diagnosis, 82% after ten-years) the vast majority of older women with breast cancer will become long-term survivors.[1–3] Thus, weighing the impact of treatment in relation to treatment tolerance, morbidity, quality of life and survival should play a central role in the care of older cancer patients.

However, older cancer patients are an extremely heterogeneous group, making management of their cancer care complex and challenging.[4–6] Applying geriatric principles to oncology care attempts to weigh the impact of known care-influencing factors such as comorbidity (i.e. vulnerability to adverse treatment effects) or social support (i.e. ability to get to treatments), in relation to care, quality of life and overall survival.[7–11] There is a growing evidence that these factors can be effectively assessed by cancer-specific geriatric assessment (C-SGA) and predict treatment tolerance, morbidity and mortality in older cancer patients.[12–17] Yet little is known about the accuracy of estimating survival based on C-SGA.

Taking advantage of our longitudinal study of older women with breast cancer we conducted a secondary analysis of survival using C-SGA. The current study extends previous analyses through ten-years of follow-up[12] and focuses on the predictive value of C-SGA in relation to age- and cause-specific survival after a breast cancer diagnosis. Our *a priori* hypothesis was that C-SGA would better predict all-cause and breast-cancer-specific survival than age, particularly that women with C-SGA ⩽2 domain deficits would have better survival.

2. Patients and methods

2.1. Study population

The longitudinal study design and subject recruitment procedures have been previously reported.[18] Six hundred and sixty women ⩾65-years old with stage I tumour diameter ⩾1 cm or stage II–IIIA disease and permission from attending physician to be contacted in four geographic regions (Los Angeles; California; Minnesota; North Carolina; Rhode Island) were identified through regular pathology report review at hospitals or collaborating tumour registries. Women could not have a prior primary breast cancer or simultaneously diagnosed or treated second primary tumour, and must have signed a consent form approved by the institutional review board at each site.

2.2. Analytic variables

Data were collected by medical record review (definitive surgery date, surgery type and tumour characteristics) and baseline telephone interview (socio-demographic, psychosocial, health and breast cancer therapy) at least three-months after surgery.

2.2.1. Mortality all-cause and breast-cancer-specific
Decedents were identified by first and last name, middle initial, social security number, date of birth (DOB), sex, race, marital status, and state of residence matched against National Death Index (NDI) and Social Security Death Index (SSDI) records. Survival time was number of days from date of definitive surgery until date of death (DOD). Breast-cancer-specific follow-up time was censored on DOD from another cause or at end of follow-up, whichever came first.

2.2.2. Socio-demographic characteristics
We classified patient age as 65–69, 70–79, ⩾80-years; race as white, other; education as <12-years, 12-years, >12-years; marital status as married (yes/no); and having adequate finances to meet needs (yes/no).

2.2.3. Breast cancer characteristics
We categorised stage as I–III using TNM classification.[19] Definitive primary therapy was mastectomy plus auxiliary lymph node dissection (ALND) or lumpectomy with radiation therapy plus ALND. Guideline-recommended therapy (yes/no) based on modifications of 1990 and 2000 NIH breast cancer treatment guidelines[20,21] was defined as receipt of one of the following:[22] (1) definitive primary therapy; (2) tamoxifen therapy in hormone receptor positive breast cancer; (3) chemotherapy in node positive disease; and (4) chemotherapy in breast cancers with tumour size ⩾1 cm and receptor negative status. Under-treatment was defined as no guideline-recommended therapy with breast-cancer-specific death.

2.2.4. Health-related characteristics
We determined underlying diseases present at diagnosis using the Charlson Comorbidity Index (CCI) scaled from 0 to 3 with higher scores indicating more comorbidity.[23–25] Self-rated health status before diagnosis was assessed using a single-item measure dichotomised as 'excellent/very good/good' versus 'fair/poor'. Body mass index (BMI) was derived as ⩽30 kg/m^2 versus obesity >30 kg/m^2. We calculated total number of limiting physical functions based on the ten-item Physical Function Index of the Medical Outcomes Study Short Form (MOS-SF-36) and categorised as 0 or ⩾1 limitation.[26] General mental health was assessed by the Mental Health Index (MHI5), a five-item measure of mental health from the MOS-SF-36 scored on 0–100 scale. Higher scores indicate better mental health and a score of ⩾80 considered good general mental health.[26] Social support was measured using a reduced set of eight-items derived from the 19-item Medical Outcomes Study Social Support Scale (MOS-SSS) scored from 0 to 100 with higher scores indicating more support and ⩾80 considered good social support.[27]

2.2.5. Cancer-specific geriatric assessment
C-SGA was described by four domains using six individual measures: (1) socio-demographic by adequate financial resources; (2) clinical using CCI and BMI; (3) function by number of physical function limitations; and (4) psychosocial as MHI5 and MOS-SSS. Criteria for determining domain deficits were: inadequate finances; CCI ⩾ 2 and/or obesity; number of

physical limitations $\geqslant 1$; and MHI5 and/or MOS-SSS < 80. Deficits in C-SGA domains were summed (maximum sum of four) then dichotomised as $\leqslant 2$ versus $\geqslant 3$.[12]

2.3. Analytic strategy

We first examined descriptive statistics on all study variables then evaluated bivariate distributions between independent and mortality outcome variables using Spearman correlations, the chi-square test, log-rank test and Cochran–Armitage test-of-trend. Five- and ten-year survival was analysed using the Kaplan–Meier survivor functions. Unadjusted and multivariable adjusted Cox proportional hazards regression models were fitted to predict five- and ten-year all-cause and breast-cancer-specific mortality with baseline C-SGA; reported as hazard ratio (HR) and 95% confidence interval (95% CI). Model selection was based on either a theoretical basis for, or knowledge of a relation between causal variables and effects or statistical testing (i.e. elimination of highly correlated variables, inclusion of a necessary minimum set of statistically meaningful variables and overall model fit).[28] Participants with missing data for independent or outcome variables were excluded from models ($N < 19$). Multivariable adjusted models were validated using stepwise and backward regression analyses. All analyses were performed using SAS version 9.2.

3. Results

3.1. Characteristics of the study population

Socio-demographic, breast cancer and health-related characteristics of the baseline study population ($N = 660$) are shown in Table 1. The majority of women were $\geqslant 70$-years, white and had at least 12-years education. Approximately half had stage I disease and 46% received guideline-recommended therapy. Fifty-eight percent had a CCI of 0, 85% self-reported good health and 21% were obese. More than half of the women exhibited high levels of general mental health and physical function.

3.2. C-SGA

At baseline 15.9% of women had no C-SGA deficit, 32.6% had one, 29.4% two, 19.4% three and 2.7% four. The proportion of women within C-SGA deficit categories (0–4) by age group is shown in Fig. 1. Age and C-SGA deficit count were modestly but statistically significantly correlated ($r = 0.12$, $p = 0.003$) and the proportion of women with $\geqslant 3$ C-SGA domain deficits increased for each incremental age group (65–69-years 14.5%, 70–79-years 23.7%, 80+-years 28.5%, test-of-trend $p = 0.01$). This relationship was not observed between C-SGA and stage ($r = 0.03$, $p = 0.59$; stage I 21.7%, stage II 22.4%, stage II 24%, test-of-trend $p = 0.75$).

3.3. Age and survival

As expected, the proportion of women surviving five- and ten-years of follow-up decreased with increasing age. The mean age of each group by number of C-SGA deficits (0–4) was similar (age range 72.6–75.6-years, $p = 0.12$), with the highest mean age

Characteristic at baseline	Population at baseline N (%)
Socio-demographic	
Enrolment site	
LA	150 (23)
RI	163 (25)
MN	188 (28)
NC	159 (24)
Age	
65–69 years	172 (26)
70–79 years	372 (56)
80+ years	116 (18)
Race	
White	620 (94)
Other	40 (6.1)
Education	
Less than 12 years	115 (17)
12 years	228 (35)
More than 12 years	316 (48)
Married	304 (46)
Adequate finances	587 (90)
Breast cancer	
Stage	
I	336 (51)
II	298 (45)
III	25 (3.8)
Guideline-recommended therapy	305 (46)
Health-related	
CCI	
0	380 (58)
1	232 (35)
2	48 (7.3)
Good self-rated health	564 (85)
Obesity (BMI > 30)	140 (21)
Number of physical limitations $\geqslant 1$	247 (37)
Good mental health (MHI5 $\geqslant 80$)	455 (69)
High-level of social support (MOS-SSS $\geqslant 80$)	333 (51)
Cancer-specific geriatric assessment	
Deficits in $\leqslant 2$ C-SGA domains	514 (78)

Table 1 – Baseline socio-demographic and health-related characteristics in a population of older women with breast cancer (N = 660), 1997–2007.

LA, Los Angeles, California; RI, Rhode Island; MN, Minnesota; NC, North Carolina; CCI, Charlson Comorbidity Index; BMI, Body Mass Index; MHI5, 5-item Mental Health Index; MOS-SSS, Medical Outcomes Study-Social Support Survey; C-SGA, Cancer-Specific Geriatric Assessment.

among those with three C-SGA deficits. There was a decreased probability of survival over follow-up by increasing age group (all-cause/breast-cancer-specific 65–69, 70–79, 80+-years, respectively: five-years: 79%, 76%, 52%/91%, 88%, 77%; ten-years: 55%, 43%, 15%/90%, 87%, 73%. At five-years of follow-up the mean survival time ±standard error in years by age group was: 65–69-years 4.4 ± 0.092, 70–79-years 4.3 ± 0.063 and 80+-years 3.7 ± 0.13, whereas at ten-years it was: 65–69-years 7.5 ± 0.22, 70–79-years 7.3 ± 0.16 and 80+-years 5.3 ± 0.27.

3.4. C-SGA and survival

The mean study all-cause and breast-cancer-specific survival time in years for women with $\leqslant 2$ C-SGA deficits was

4.4 ± 0.053 and 4.8 ± 0.02 at five-years and 7.4 ± 0.13 and 8.7 ± 0.08 at 10-years of follow-up, respectively. Women with ⩾3 deficits in C-SGA domains had lower mean all-cause and breast-cancer-specific survival time at both five- and ten-years. As shown in Fig. 2, the proportion of survivors significantly decreased as the number of deficits in baseline C-SGA domains increased; while the proportion of women

surviving with ⩾3 C-SGA domain deficits was consistently lower across age groups and time points.

Fig. 3 illustrates all-cause and breast-cancer-specific survival curves for C-SGA groups (⩽2 and ⩾3 C-SGA deficits) over ten-years of follow-up. The probability of ten-year survival was consistently statistically significantly lower in women with ⩾3 C-SGA deficits. Across age groups, the difference in
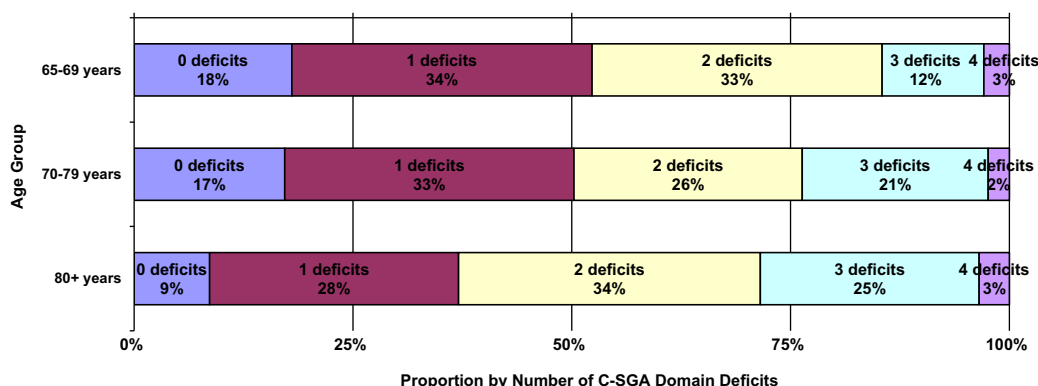

Fig. 1 – Proportion of women with zero to four cancer-specific geriatric assessment (C-SGA) domain deficits at baseline by age group in a longitudinal study of older women with breast cancer (N = 660), 1997–2007.
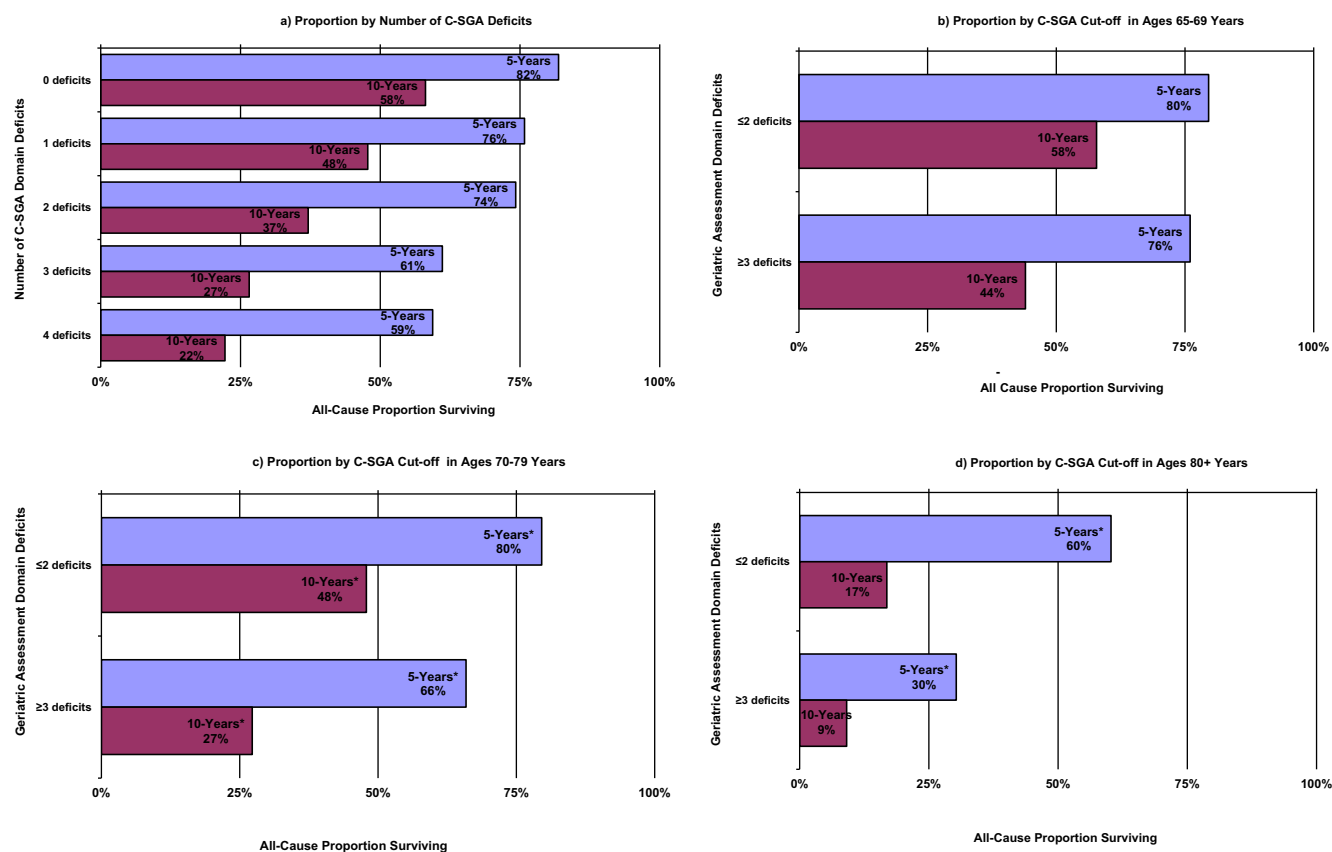

Fig. 2 – Proportion of the total population (N = 660) surviving all-cause at five- and ten-years follow-up by number of C-SGA deficits and age (65–69-years, 70–79-years, 80+-years) in a longitudinal study of older women with breast cancer, 1997–2007. (a) Proportion by number of C-SGA deficits. (b) Proportion by C-SGA cut-off in ages 65–69 years. (c) Proportion by C-SGA cut-off in ages 70–79 years. (d) Proportion by C-SGA cut-off in ages 80+ years.
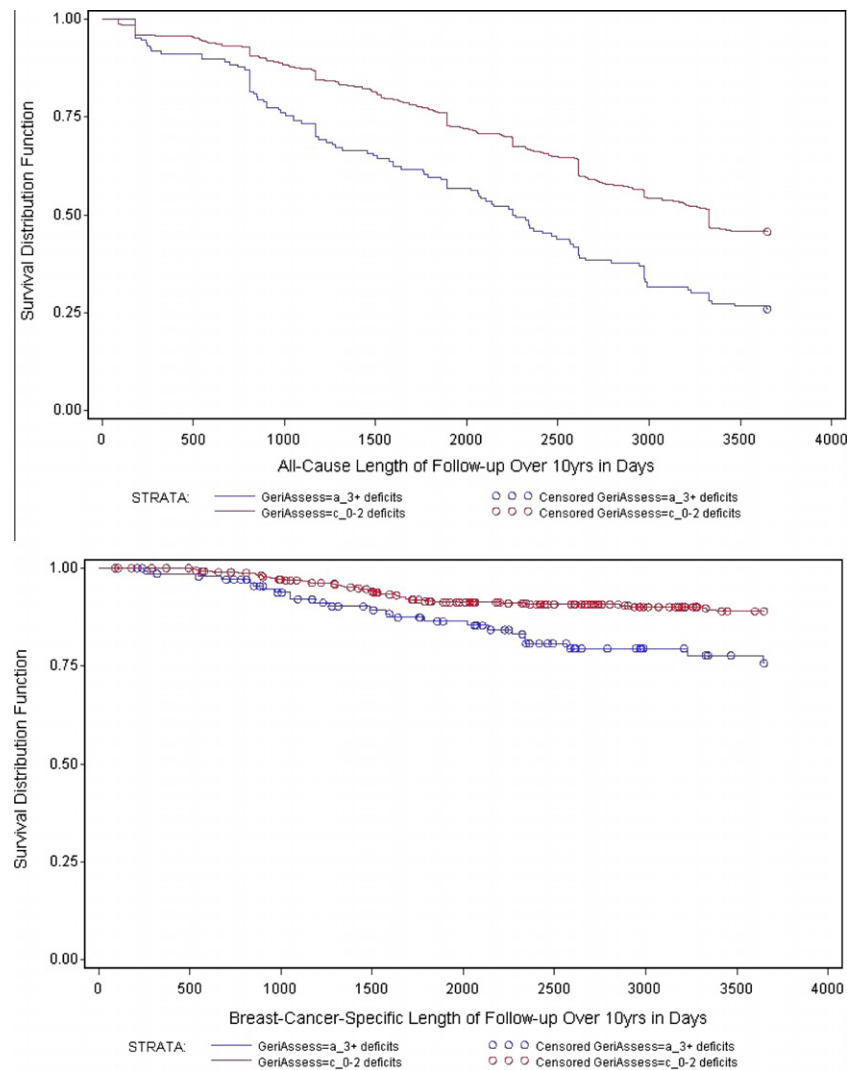
Fig. 3 – Survival plot of five- and ten-year all-cause and breast-cancer-specific survival based on C-SGA in a longitudinal study of older women with breast cancer (N = 660), 1997–2007.

probability of survival at five- and ten-years favored women with ⩽2 C-SGA deficits (range 0.3-2.1-years). As expected age was a stronger predictor of all-cause mortality and stage was a very strong predictor of breast-cancer-specific death (Models 2&3 Table 2). The all-cause and breast-cancer-specific death rates at both five- and ten-years were consistently approximately two-times higher in women with ⩾3 C-SGA deficits even when fully adjusted for confounding factors.

3.5. Guideline-recommended therapy

Receipt of guideline-recommended therapy decreased with age but not consistently with number of C-SGA deficits (Fig. 4). If treatment had been assigned by low C-SGA (⩽2 deficits), over 65% of under-treated women who died of breast cancer (N = 48) would have received guideline-recommended therapy. On the other hand, if treatment had also been assigned by a high C-SGA (⩾3 deficits), 42% of guideline-treated women who died of causes other than breast cancer

within three-years might have received less intensive treatment.

4.   Discussion

In this study of older women with breast cancer, C-SGA was a predictor of both five- and ten-year all-cause and breast-cancer-specific survival. As hypothesised, women at or above the ⩾3 C-SGA domain deficit cut-off had markedly worse survival than women below. The difference in survival based on C-SGA did not appear to be due to age or stage. The mean age by C-SGA deficit category did not notably differ. Moreover neither the proportion of C-SGA deficit categories between age groups nor the HR stratified by or adjusted for age and stage varied appreciably. The results also suggest that treatment decision-making is heavily weighted by age and decision-making informed by C-SGA might reduce under- or over-treatment with guideline-recommended therapy in older women with breast cancer.

Table 2 – Five- and ten-year hazard ratios for all-cause and breast-cancer-specific mortality based on cancer-specific geriatric assessment (C-SGA) in a longitudinal study of older women with breast cancer (N = 660), 1997–2007.

	All-cause mortality		Breast-cancer-specific mortality	
	5-years HR (95% CI)	10-years HR (95% CI)	5-years HR (95% CI)	10-years HR (95% CI)
Model 1:				
Deficits in ⩾3 C-SGA domains	1.94 (1.42–2.65)	1.81 (1.45–2.26)	2.12 (1.30–3.45)	2.19 (1.34–3.57)
Model 2:				
Age				
65–69 years	1.0	1.0	1.0	1.0
70–79 years	1.13 (0.77–1.67)	1.39 (1.07–1.81)	1.37 (0.74–2.53)	1.44 (0.78–2.66)
80+ years	2.62 (1.71–3.99)	2.91(2.15–3.93)	2.15 (1.07–4.34)	2.41 (1.19–4.88)
Stage				
I	1.0	1.0	1.0	1.0
II	1.24 (0.92–1.67)	1.07 (0.87–1.32)	3.84 (2.15–6.86)	3.8 (2.13–6.79)
III	1.26 (0.61–2.61)	1.73 (1.11–2.73)	5.40 (2.09–13.99)	5.87 (2.27–15.22)
Deficits in ⩾3 C-SGA domains	1.95 (1.42–2.67)	1.76 (1.40–2.20)	2.08 (1.27–3.39)	2.13 (1.30–3.49)
Model 3:				
Age				
65–69 years	1.0	1.0	1.0	1.0
70–79 years	1.11 (0.75–1.64)	1.37 (1.05–1.78)	1.32 (0.71–2.44)	1.38 (0.75–2.55)
80+ years	2.37 (1.53–3.69)	2.60 (1.90–3.55)	1.74 (0.84–3.60)	1.94 (0.94–4.01)
Stage				
I	1.0	1.0	1.0	1.0
II	1.21 (0.89–1.64)	1.05 (0.85–1.29)	3.76 (2.10–6.74)	3.71 (2.07–6.65)
III	1.26 (0.12–2.60)	1.74 (1.10–2.74)	5.51 (2.12–14.29)	6.01 (2.31–15.58)
Education				
Less than 12 years	1.0	1.0	1.0	1.0
12 years	0.81 (0.54–1.22)	0.78 (0.59–1.04)	0.75 (0.39–1.46)	0.72 (0.37–1.40)
More than 12 years	0.85 (0.58–1.24)	0.79 (0.61–1.03)	1.01 (0.55–1.84)	0.96 (0.53–1.75)
Married	0.82 (0.59–1.03)	0.81 (0.65–1.00)	0.57 (0.33–0.97)	0.56 (0.33–0.95)
Deficits in ⩾3 C-SGA domains	1.87 (1.36–2.57)	1.74 (1.35–2.12)	1.95 (1.18–3.20)	1.99 (1.21–3.28)

HR, Hazard Ratio; CI, Confidence Interval; C-SGA, Cancer-Specific Geriatric Assessment. *Model 1* includes only C-SGA measure, *Model 2* (age and stage adjusted) includes age, stage and C-SGA measure as individual variables, and *Model 3* (fully adjusted) includes age, stage, education, martial status and C-SGA measure as individual variables.

These findings extend and complement our previous work as well as other C-SGA studies affirming the potential of C-SGA use in older cancer patients.[12,14–16,29] Importantly, C-SGA not only predicted cancer-related outcomes, but it identified opportunities for intervention that could improve treatment tolerance, morbidity and survival (both all-cause and breast-cancer-specific) as newly suggested in this study. Even though advancing age also predicted five- and ten-year survival (all-cause more strongly than breast-cancer-specific), it is an un-modifiable risk factor and poor predictor of treatment outcomes.[6] When implemented, C-SGA can provide a unique patient-specific proactive component to the care of older cancer patients.[30,31] It overcomes the problem that age or simple performance measures insufficiently capture the complexity of older cancer patients' issues.[10] It provides a more comprehensive measure of risk and can influence the prognostic ability of the physician.[32,33] As this and other research shows, C-SGA can aid in optimising treatment because it encompasses multiple domains which help to identify and manage issues which can interfere with cancer treatment and impact survival.

Age is a known risk factor for breast cancer under-treatment.[34,35] Bickell et al. showed that breast cancer under-treat-

ment is multi-factorial with one third attributable solely to physicians' perceptions that treatment was not indicated.[36,37] In this study, under-treatment was related to age and breast-cancer-specific death; possibly indicating that physicians were relying too heavily on the wrong information (e.g. age) for cancer treatment decision-making and that C-SGA may represent an opportunity to reduce breast-cancer-specific deaths. Correspondingly, there was suggestion of potential over-treatment that may have been avoided with C-SGA based decision-making (decrease burden of therapy without benefit). This underscores the accelerated need for use of evidence-based decision-making tools like C-SGA and highlights the potential serious consequences of under-treatment on the survivorship experience of older women with breast cancer.

The C-SGA predictive value was similar for all-cause and breast-cancer-specific-mortality which may be related to good overall health, the high proportion of women not receiving guideline-recommended therapy, the pronounced relation between GA domains and all-cause mortality or even un-measurable residual confounding. It also suggests the domains and corresponding GA measures used herein might combine into a useful easy to implement (i.e. low physician/patient burden) GA instrument in more general settings as
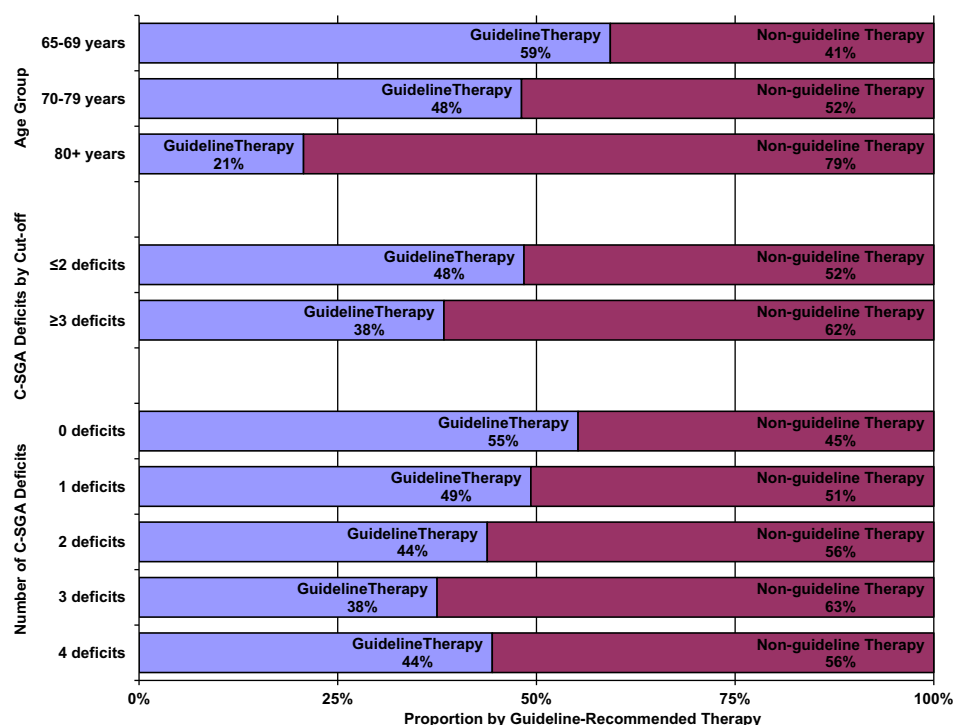
Fig. 4 – Proportion of total population (N = 660) with and without guideline-recommended therapy by age group, C-SGA cut-off and number of C-SGA deficits in a longitudinal study of older women with breast cancer, 1997–2007.

well.[4,38] At present there is no consensus on which domains and/or tools should be standardised for GA use in general practice or geriatric-oncology. We do not propose those used in this study are the optimal solution.

Furthermore, the feasibility of implementing C-SGA in everyday clinical practice, unaddressed by this research, is of practical concern. Administering C-SGA as part of routine clinical practice to all older cancer patients can be a time and resource intensive procedure. It may not be reimbursed by health insurance, oncologists and/or their staff are not often trained in GA, and there may be limited collaboration with and/or availability of geriatric specialists over the course of cancer care. These obstacles likely contribute to the slow translation of C-SGA evidence into every day practice. Nevertheless C-SGA may be a useful guide to estimate survival as recommended for medical decision-making. Ongoing C-SGA research is addressing these important questions producing a sufficient knowledge base for more rapid translation of C-SGA evidence. A compilation of such evidence is vital to the treatment and survivorship experience of the growing numbers of older cancer patients.[39]

Several limitations and strengths of this study should be considered. The measures in this study were not administered as part of C-SGA for patient care purposes and were collected by telephone interview. As such the findings cannot be directly compared with other C-SGA studies using different data collection strategies. Although there was no reporting of deficits identified by C-SGA back to physicians, their assessment could not have directly influenced patient care or outcomes. Since only early stage disease was included, it is possible that women may have been prejudged

as fit for surgical treatment. Additionally, tumour biology information was unavailable. These findings may not be generalisable because of study eligibility criteria and since the population was a largely white, well-educated and healthy group of older women. Lastly, given small numbers we had limited power to statistically meaningfully evaluate results stratified by age and C-SGA domain deficit counts. The strengths of this research include comprehensive standardised C-SGA information, unusually long follow-up of older women with breast cancer, evaluation of all-cause and breast-cancer-specific deaths, and use of NDI and SSDI for mortality outcomes maximising accuracy and minimising loss to follow-up.

In conclusion, this study provides some of the first longitudinal evidence that C-SGA can predict five- and ten-year all-cause and breast-cancer-specific survival in older women with breast cancer. Hence, C-SGA may provide an effective strategy to guide treatment decision-making and to identifying important risk factors for intervention. Further studies of C-SGA, survival and decision-making in various populations of older adults with cancer are warranted.

Role of the funding source

Conflict of interest statement

None declared.

Acknowledgements

REFERENCES

1. Breast Cancer Facts and Figures. Atlanta, GA; 2009–2010.
2. Lash TL, Silliman RA. Re: prevalence of cancer. *J Natl Cancer Inst* 1998;**90**(5):399–400.
3. Reis L, Melbert D, Krapcho M, et al. *SEER Cancer Statistics Review, 1975–2005*. Bethesda, MD: National Cancer Institute; 2008.
4. Hurria A, Lichtman SM, Gardes J, et al. Identifying vulnerable older adults with cancer: integrating geriatric assessment into oncology practice. *J Am Geriatr Soc* 2007;**55**(10):1604–8.
5. Balducci L, Beghe C. Cancer and age in the USA. *Crit Rev Oncol Hematol* 2001;**37**(2):137–45.
6. Klepin H, Mohile S, Hurria A. Geriatric assessment in older patients with breast cancer. *J Natl Compr Canc Netw* 2009;**7**(2):226–36.
7. Huss A, Stuck AE, Rubenstein LZ, Egger M, Clough-Gorr KM. Multidimensional preventive home visit programs for community-dwelling older adults: a systematic review and meta-analysis of randomized controlled trials. *J Gerontol A Biol Sci Med Sci* 2008;**63**(3):298–307.
8. Stuck AE, Siu AL, Wieland GD, Adams J, Rubenstein LZ. Comprehensive geriatric assessment: a meta-analysis of controlled trials. *Lancet* 1993;**342**(8878):1032–6.
9. Wieland D, Hirth V. Comprehensive geriatric assessment. *Cancer Control* 2003;**10**(6):454–62.
10. Stauder R, Moser K, Holzner B, et al. Six independent domains are defined by geriatric assessment in elderly cancer patients. *Crit Rev Oncol Hematol*;**74**(2):97–05.
11. Balducci L, Beghe C. The application of the principles of geriatrics to the management of the older person with cancer. *Crit Rev Oncol Hematol* 2000;**35**(3):147–54.
12. Clough-Gorr KM, Stuck AE, Thwin SS, et al. Older breast cancer survivors: geriatric assessment domains are associated with poor tolerance of treatment adverse effects and predict mortality over 7 years of follow-up. *J Clin Oncol*;**28**(3):380–6.
13. Extermann M, Hurria A. Comprehensive geriatric assessment for older patients with cancer. *J Clin Oncol* 2007;**25**(14):1824–31.
14. Brunello A, Sandri R, Extermann M. Multidimensional geriatric evaluation for older cancer patients as a clinical and research tool. *Cancer Treat Rev* 2009;**35**(6):487–92.
15. Balducci L, Colloca G, Cesari M, et al. Assessment and treatment of elderly patients with cancer. *Surg Oncol*; 2009.
16. Chen CC, Kenefick AL, Tang ST, McCorkle R. Utilization of comprehensive geriatric assessment in cancer patients. *Crit Rev Oncol Hematol* 2004;**49**(1):53–67.
17. Winkelmann N, Petersen I, Kiehntopf M, et al. Results of comprehensive geriatric assessment effect survival in patients with malignant lymphoma. *J Cancer Res Clin Oncol*.
18. Silliman RA, Guadagnoli E, Rakowski W, et al. Adjuvant tamoxifen prescription in women 65 years and older with primary breast cancer. *J Clin Oncol* 2002;**20**(11):2680–8.
19. Fleming IDC, Cooper JS, Henson DE, Hutter RVP, Kennedy BJ, Murphy GP. *AJCC cancer staging manual*. 5th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 1997.
20. Clinical Practice Guidelines in Breast Cancer: National Comprehensive Cancer Network; 2006.
21. Goldhirsch A, Wood WC, Gelber RD, et al. Meeting highlights: updated international expert consensus on the primary therapy of early breast cancer. *J Clin Oncol* 2003;**21**(17):3357–65.
22. Owusu C, Lash TL, Silliman RA. Effect of undertreatment on the disparity in age-related breast cancer-specific survival among older women. *Breast Cancer Res Treat* 2007;**102**(2):227–36.
23. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;**40**(5):373–83.
24. Charlson ME, Sax FL, MacKenzie CR, et al. Assessing illness severity: does clinical judgment work? *J Chronic Dis* 1986;**39**(6):439–52.
25. Katz JN, Chang LC, Sangha O, Fossel AH, Bates DW. Can comorbidity be measured by questionnaire rather than medical record review? *Med Care* 1996;**34**(1):73–84.
26. Ware Jr JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992;**30**(6):473–83.
27. Sherbourne CD, Stewart AL. The MOS social support survey. *Soc Sci Med* 1991;**32**(6):705–14.
28. Greenland S. Chapter 21: Introduction to regression modeling. In: Rothman KGS, editor. *Modern epidemiology*. 2nd ed. Philadelphia, PA: Lippincott-Raven; 1998. p. 401–34.
29. Pallis AG, Fortpied C, Wedding U, et al. EORTC elderly task force position paper: approach to the older cancer patient. *Eur J Cancer*;**46**(9):1502–13.
30. Rodin MB, Mohile SG. A practical approach to geriatric assessment in oncology. *J Clin Oncol* 2007;**25**(14):1936–44.
31. Pal SK, Hurria A. Impact of age, sex, and comorbidity on cancer therapy and disease Progression. *J Clin Oncol*.
32. Wedding U, Kodding D, Pientka L, Steinmetz HT, Schmitz S. Physicians' judgement and comprehensive geriatric assessment (CGA) select different patients as fit for chemotherapy. *Crit Rev Oncol Hematol* 2007;**64**(1):1–9.
33. Tucci A, Ferrari S, Bottelli C, et al. A comprehensive geriatric assessment is more effective than clinical judgment to identify elderly diffuse large cell lymphoma patients who benefit from aggressive therapy. *Cancer* 2009;**115**(19):4547–53.
34. Hurria A, Leung D, Trainor K, et al. Factors influencing treatment patterns of breast cancer patients age 75 and older. *Crit Rev Oncol Hematol* 2003;**46**(2):121–6.
35. Mandelblatt JS, Hadley J, Kerner JF, et al. Patterns of breast carcinoma treatment in older women: patient preference and clinical and physical influences. *Cancer* 2000;**89**(3):561–73.
36. Bickell NA, LePar F, Wang JJ, Leventhal H. Lost opportunities: physicians' reasons and disparities in breast cancer treatment. *J Clin Oncol* 2007;**25**(18):2516–21.
37. Bickell NA, McEvoy MD. Physicians' reasons for failing to deliver effective breast cancer care: a framework for underuse. *Med Care* 2003;**41**(3):442–6.
38. Overcash JA, Beckstead J, Moody L, Extermann M, Cobb S. The abbreviated comprehensive geriatric assessment (aCGA) for use in the older cancer patient as a prescreen: scoring and interpretation. *Crit Rev Oncol Hematol* 2006;**59**(3):205–10.
39. Clough-Gorr KM, Silliman RA. Translation requires evidence. does cancer-specific CGA lead to better care and outcomes? *Oncology (Williston Park)* 2008;**22**(8):925–8.