UNIVERSITY OF OSLO

The impact of education and social capital on treatment outcome for patients with colorectal cancer

Eline Aas and Tor Iversen

IRDES, Paris, October 2008

UNIVERSITY OF OSLO

Outline

- Background
- Objective
- Human and social capital
- Model
- Data
- Method and results
- Conclusions

Background

- In national health systems, like in the Nordic countries and in Great Britain, there are no individual contracts
- Priority assignment of patients is determined by the parliament
- The Act on Patient Rights:
  - Severity of the disease
  - Expected health gain
  - Health effect relative to cost of treatment
- The Act on Regional Health Authorities
  - Provide high quality specialist health care on equitable basis to patients in need, irrespective of *age, sex, place of residence, material resources and ethnic background*
- Potential conflicting goals

Objective

- Achieving equity in the allocation of health care resources are ambitious
- In this analysis: equity issues are discussed in relation to colorectal cancer
- Colorectal cancer is one of the most frequent types of cancer in the Western World (the most frequent in Norway)
- As less than 60 % survive more than 5 years from diagnosis, equity in the treatment is likely to be an important issue

- Our main objective is in light of priority assignment to analyse how treatment intensity, human capital and social capital contributes to survival

UNIVERSITY OF OSLO

Human capital

- OECD-definition
  - Knowledge
  - Skills
  - Competence
  - Individual attributes that facilitate the creation of personal, social and economic well-being

- In this paper a broad definition
  - Length of education
  - Employment status

Social capital

- Cognitive social capital
  - Norms, values, attitudes and beliefs
- Structural social capital
  - Social organisations (such as memberships in formal and informal networks)
- Interact
- In empirical analysis distinguish between variables at the individual level and at the community level
- In this analysis we use only individual by including marital status and employment status
- Next step is also to include variables at the community level

Model

$$s_i = F(y_i, c_i) \qquad i = (A, B)$$
$$\quad + \quad +$$

s_i - survival

y_i - treatment

c_i - individual capital (both human and social)

$$c_A > c_B$$

$$y = y_A + y_B$$

Decision-maker's optimal decision:

Rule 1:

Maximize total survival:

$s = s_A + s_B$

Rule 2:

Minimize the difference in survival between A and B:

$| s_A - s_B |$

Maximization of total survival

$$\underset{s.t.\,y_A}{Max} \;\; F(y_A, c_A) + F(y - y_A, c_B)$$

F.O.C.

$$F'_{Ay}(y_A, c_A) + F'_{By}(y - y_A, c_B) = 0 \qquad (1)$$

F.O.C. is fulfilled if the F-function is concave in treatment intensity

(1) determines treatment volume as a function of individual capital:

$$y_i = y_i(c_A, c_B) \qquad i = A, B \qquad (2)$$

Increase in c_A

Differentiating (1) and taking (2) into account:

$$\frac{\partial y_A}{\partial c_A} = \frac{F''_{Ayc}}{F''_{Ayy} + F''_{Byy}} \geq 0 \quad \Leftrightarrow \quad F''_{Ayc} \geq 0 \qquad (3)$$

Resources should be allocated to individual with more individual capital if individual capital adds to the marginal effect of treatment on survival

$\Rightarrow$ Third sub goal of Norwegian Act of Patient Rights

Minimize the survival inequality

Since $c_A > c_B$,

$\Rightarrow$ likely that s_A is greater than s_B if $y_A = y_B$

Reduce inequality, $y_A < y_B$

At most:

$s_A = F(0, c_A)$

$s_B = F(y, c_B)$

Optimal allocation

If $\theta_A \geq \theta_B$, then (0,y) is the optimal allocation

If $\theta_A < \theta_B$, then the optimal allocation, $(\hat{y}_A, 1-\hat{y}_A)$ is determed by:

$$F(\hat{y}_A, c_A) = F(y - \hat{y}_A, c_B)$$

Consequences:

- Group A benefits from Rule 1
- Group B benefits from Rule 2

- The effect of individual capital on survival from two sources:
  - Direct effect on survival
  - Indirect effect through the amount of treatment

Inequalities and colorectal cancer

- Goldwin et al (1987)
  - Unmarried patients have decreased overall survival
- Johansen et al. (1996)
  - Colon cancer
  - Married patients have longer survival
- Villingsøy et al. (2006)
  - Colon cancer
  - Married patients have longer survival
  - Increased contact with children reduce survival
- Fredriksen et al. (2008)
  - Differentiate between rectal and colon cancer
  - Reduced probability to be diagnosed with metastasis for rectal cancer in elderly patient with high income, living in own-occupied housing and living with a partner
  - Among young rectal patient having longer education reduced the risk
  - No social gradient found for colon cancer patients
- Auvinen (1992)
  - Colon cancer
  - Social class gradient important predictor for survival
- Kravdal (2000, 2001 and 2002)
  - Survival related to education, occupation, income and marital status

Treatment and survival

- Possible correlation between treatment, human and social capital
- Omitting treatment as a factor, implies biased estimates
- Grossman (1972), individual with a high stock of human capital is a more efficient health producer
  - Rule 1: More resources should be allocated to the efficient health producer
  - Rule 2: Patient with an abundance of human capital and social capital may be given relatively less intensive treatment

- In (1), survival increases with treatment
- Possible that most treatment is given to patient with the most severe disease and poor prospects of survival
- Then survival will decline with treatment

Data

- Cancer Registry of Norway
  - Date of colorectal cancer diagnosis (1999 to 2004)
  - Disease severity
- Statistics Norway
  - Date and cause of death (1999 to 2004)
  - Marital status (1999)
  - Education (1999)
  - Employed versus not employed (1999)
  - Income (1999)
- The Norwegian Patient Register
  - Inpatient stays and outpatient consultations
  - DRG – diagnosis-related groups (1999 to 2004)
- The National Insurance Administration
  - Fees for outpatients consultations at hospitals

Severity of colorectal cancer

- Localized
  - Micro invasive growth, but no infiltration to neighbouring tissue/organs, lymph node metastatis or organ metastasis. Metastatis within the same organ as the primary tumour
- Regional
  - Lymph noede metastase
  - Microscopically infiltration to neighbouring structure
  - Macroscopically infiltration to neighbouring structure
- Distant
  - Lymph noede metastase to other places
  - Organ metastasis
  - Organ metastasis to other places
- Unknown
  - Metastasis stated, but tissue/organ unknown
  - Extent of the disease at the date of diagnosis

Descriptive statistics

Stage of advancement	Total number	Proportion dead
Localized	78	0.077
Regional	198	0.187
Distant	105	0.848
Unknown	33	0.455
Total	414	0.353

Descriptive (2)

Variable	Category	Total number	Proportion dead
Gender	Men	223	0.368
	Women	191	0.340
Employment	Yes	148	0.351
	No	266	0.357
Marital status	Unmarried	177	0.379
	Married	237	0.338
Education	Low (0 -10)	95	0.442
	Intermediate (11-14)	200	0.315
	High (15 +)	119	0.353

UNIVERSITY OF OSLO

Descriptive (3)

Tabell med gjennomsnittlige
Behandlingskostnader etter individuell kapital

Estimations

- Survival (Weibull model)
  1. The effect of human capital and social capital and stage on survival
  2. The effect of human capital and social capital on survival for each stage of advancement

- Treatment costs (OLS)
  – The effect of human and social capital on inpatient and outpatient treatment costs (regression model)

Survival

Table 6: Results from the estimation of treatment intensity, human capital and social capital on survival. Number of observations 414. St.dev in brackets.

Variables	Category	Model 1	Model 2	Model 3
Constant		4.72 (1.28)***	6.99 (1.14)***	6.94 (1.13)***
Age		-0.005 (0.021)	-0.021 (0.017)	-0.018 (0.017)
Income		-3.49e-08 (2.97e-07)	-2.69e-07 (1.98e-07)	
Marital status (ref. married)	Never married	-0.156 (0.331)	-0.415 (0.259)	-0.448 (0.258)*
	Widow/widower	-0.261 (0.441)	0.085 (0.343)	0.090 (0.341)
	Divorced	-0.166 (0.234)	0.160 (0.184)	0.133 (0.185)
	Separated	-0.893 (0.427)**	0.052 (0.340)	0.013 (0.338)
Gender	Women	- 0.015 (0.247)	- 0.151 (0.158)	
Education (ref. low <11)	Intermediate(11-14)	0.421 (0.236)*	0.122 (0.185)	0.171 (0.183)
	Long (15+)	0.322 (0.259)	0.050 (0.201)	0.072 (0.198)
Employed	Yes	-0.259 (0.202)	-0.027 (0.340)	
Stage of advancement (ref. local)	Regional		-0.906 (0.398)**	-0.927 (0.400)**
	Distant		-3.103 (0.408)***	-3.103 (0.410)***
	Unknown		-1.919 (0.449)***	-1.976 (0.450)***
$1 / \ln\_ p$		*0.138 (0.072)***	*0.12 (0.068)**	*0.107 (0.068)*

**** significant at 1 % level, ** significant at 5% level and * significant at 10% level*

UNIVERSITY OF OSLO

Survival

Table 7: The effect of treatment intensity, human capital and social capital on survival according to stage of severity. St.dev in brackets.

Variables	Category	Local	Regional	Distant	Unknown
Constant		-5.16 (7.30)	7.817(1.945)***	3.994 1.945)***	-2.438 (5.893)
Age		0.127 (0.117)	-0.044 (0.032)	-0.022 (0.021)	0.058 (0.083)
Income		0.00002 (8.08e-06)**	-7.81e-07 (2.15e-06)	-1.08e-06 (1.36e-06)	0.00001 (0.00001)
Income (quadratic)		-1.75e-11 (8.62e-12)**	1.38e-12 (2.15e-12)	1.03e-12 (1.18e-12)	-2.72e-11 (1.63e-11)*
Marital status (ref. married)	Never married	-2.959(1.214)**	0.026(0.519)	-0.517 (0.299)*	-0.855 (1.276)
	Widow/widower	7.649(1044)	-0.041(0.638)	0.250 (0.414)	0.698 (1.017)
	Divorced	-1.091(1.202)	-0.597(0.323)	0.457 (0.208)**	0.125 (0.932)
	Separated	-4.448 (1.708)***	-1.101(0.625)	0.781 (0.411)*	1.615 (1.335)
Gender	Women	1.460 (1.145)	-0.102(0.032)	-0.337(0.184)*	-1.512 (0.824)
Education (ref. low)	Intermediate(11-14)	0.657 (1.270)	0.011 (0.378)	-0.038 (0.207)	3.170(0.980)***
	Long (15+)	0.937 (1.213)	-0.307 (0.459)	0.109 (0.258)	2.895(1.213)**
Employed	Yes	1.687 (1.399)		-0.017(0.193)	0.538 (0.686)
$1/\ln\_ p$		*0.284 (0.367)*	*0.207 (0.148)*	*0.275(0.083)****	*-0.029 (0.216)*

**** significant at 1% level, ** significant at 5% level and * significant at 10% level*

UNIVERSITY OF OSLO

Treatment costs

Table 8: The effect of human capital and social capital on treatment intensity, according to stage. St.dev in brackets.

Variable	Category	Outpatient	Inpatient
Constant		115,005 (50,022)**	193,482 (60,552)***
Age		-1,392 (770)*	689 (932)
Income		0.019 (0.012)*	0.008 (0.14)
Marital status	Unmarried	-23,223 (12,106)*	-13,467 (14,655)
	Widow/widower	-12,872 (16,869)	-6,183 (20,420)
	Divorced	-583 (8,487)	-4,947 (10,274)
	Separated	9,461 (17,341)	14,904 (20,992)
Gender	Women	6,283 (7,316)	-15,087 (8,856)*
Death		39,510 (9,192)***	49,904 (11,127)***
Education	Intermediate (11-14)	14,415 (8,891)	3,678 (10,763)
	Long (15+)	-6,626 (9,904)	-2,663 (11,989)
Employed	No	12,410 (7,345)*	11,720 (8,892)
Stage of advancement	Regional	26,035 (9,523)***	18,837 (11,528)*
	Distant	26,471 (12,701)**	-3,160 (15,374)
	Unknown	11,388 (15,246)	-8.838 (18,454)
$R^2(adj)$			

Equal access

- The results in the survival analysis could possibly be explained by differences in access, i.e. that human and social capital have an effect on the stage of advancement the cancer is being diagnosed on
- By means of a multinomial logit model we estimate the probability of being diagnosed at different stage of advancment.
- Reference category is Regional
- The probability of being diagnosed with a Localized cancer increases with:
  - Age at the time of diagnosis
  - If the individual is working
- No differences with regard to Distant and Unknown

Concluding remarks

- Individual capital have only an effect on survival in some of the estimations
- Death is an important predictor for treatment costs
- Unmarried get less outpatient treatment, i.e. conflict between Rule 1 and Rule 2
- Individuals not working receive more outpatient treatment, could imply that Rule 2 is being used
- Individuals working has a higher probability of being diagnosed at a less severe stage