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Research Article

Variations in Patterns of Care of Rectal Cancer Patients in South Australia According to Sociodemographic Characteristics:A Registry Study

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Objective. To explore variations in patterns of care over three decades for a subgroup of rectal cancer patients in South Australia according to sociodemographic characteristics. *Methods*. This study evaluated three decades of retrospective data from the South Australian Clinical Cancer Registry. A total of 4,131 patients diagnosed with rectal cancer between 1982 and 2015 and treated in South Australian public hospitals were included. Study outcomes were age at diagnosis, area of primary residence, cancer stage, and primary treatment (surgery, chemotherapy, or radiotherapy). *Results*. There was a significantly lower likelihood of conventional therapy for the elderly. Adjusted odds of receiving surgery or radiotherapy decreased by 70% and those of receiving chemotherapy by 90% in the 80+ age group, compared to the 50–59 age group. No significant variation was detected according to area-level socioeconomic status or remoteness. *Conclusion*. Socioeconomic factors showed little impact on the receipt of therapies for rectal cancer patients in South Australia. Variation in treatment by age, irrespective of disease stage or period of diagnosis, requires further investigation.

1. Introduction

Cancer is the second leading cause of death in Australia, with 1 in 5 people dying from a form of malignancy by age 85 [1]. Colorectal cancers (CRC) account for 27% of all diagnoses, being the second leading cancer in Australia in both incidence and mortality, while five-year survival rates have improved in the past 15 years (1985–1989 to 2010–2014), increasing from 51% to 69% [1]. These improvements can be attributed to increased population-based screening and treatment advances [2–4]. However, survival improvements are inconsistently distributed across the social determinants of health, such as socioeconomic status (SES) and remoteness of residence [1].

The incidence of CRC increases with age, and older people experience higher diagnosis and mortality rates compared to younger people [5, 6]. Like age, socioeconomically disadvantaged groups experience higher cancer incidence, which is attributed to poorer lifestyles, including higher smoking and obesity rates compared to higher SES groups [7].

People experiencing socioeconomic disadvantage face higher CRC mortality due to living more remotely, having reduced access to healthcare facilities, and having a reduced likelihood of receiving recommended treatment [1, 8]. Living regionally or remotely may also introduce additional expenses and travel time to access treatment that is more easily accessible to metropolitan residents [9, 10].

A number of Australian studies have shown the likelihood of receiving surgery, chemotherapy, or radiation therapy decreases with age for people with CRC, so higher mortality in some groups may be due to undertreatment

[6, 10–12]. Roder et al. reported that, compared to people younger than 40 years, people with CRC aged over 80 years were 54% less likely to receive surgery ($OR_{80+years} = 0.46$ (95% CI 0.26, 0.82)) [6]. The above studies included patients diagnosed between 1980 and 2010, whereas more recent patterns of care for colorectal cancer patients are unknown.

CRCs, which comprise colon and rectal neoplasms, are often grouped together for statistical purposes despite their different histopathological appearances [13]. In Australia, patterns of care specific to rectal cancer alone are lacking. Clinical registries play a critical role in monitoring healthcare inequalities in priority populations and other patient subgroups where variations could exist. By accessing data from the South Australian (SA) Clinical Cancer Registry, this study aimed to evaluate current SA patterns of care in rectal cancer according to sociodemographic characteristics and explore any variations in primary treatment within this cohort.

2. Methods

2.1. Research Design. This cohort study retrospectively analyses data collected by the SA Clinical Cancer Registry (SACCR) over 35 years. The SACCR provides continuous quality monitoring for the improvement of SA cancer services. Clinical and patient data are collected from major public hospitals within SA, including age at diagnosis, area of primary residence, cancer stage (based on the Australian clinicopathological stage categorized from A to D), and the broad primary treatment category (surgery, chemotherapy, or radiation therapy (RT)) [14, 15]. The clinical registry identifies cancer patients treated in public hospitals through hospital pathology and MDT lists. Earlier cases were also identified through paper-based sources of information. Tumour characteristics were extracted from pathology reports by registry staff. Primary site and histology were coded using ICD-O-3 and ICD-9 for earlier years and SNOMED II for earlier years. Staging was determined by hospital registry staff with extensive experience interpreting pathology and imaging reports.

Human research ethics approval, including a waiver of consent, was granted by the South Australian Department of Health and Wellbeing Human Research Ethics Committee (HREC/18/SAH109) and the University of South Australia. Governance arrangements, including data custodian approvals, were provided by the Department of Health and Wellbeing. All extracted data had names, dates of birth, and addresses of participants removed by registry staff prior to researchers' receipt of the data.

2.2. Study Population. All records of consecutive patients on the SACCR with a primary diagnosis of rectal cancer (ICD–O–3 C20.9) in South Australia between 1982 and 2015 were included [11]. Records were excluded if the patient's age at diagnosis was less than 18 years, the treatment intent was palliative, or the patient had multifocal disease.

Exposures of interest were sociodemographic characteristics, including age at diagnosis, socioeconomic status (SES), and residential remoteness. SES was measured using the Socioeconomic Indexes for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage (IRSD), an area level measure of socioeconomic status based on postcode. The SEIFA IRSD was developed and validated to rank residential areas in Australia according to socioeconomic advantage and disadvantage, based on the 5-yearly census, utilising variables including household income and employment [16].

Remoteness was measured using the Accessibility/Remoteness Index of Australia (ARIA), which provides a summary measure of the accessibility to standard goods and services. SEIFA and ARIA were derived using the patient's residential postcode at the time of diagnosis [16, 17]. The ARIA index divides areas in Australia into five levels of remoteness according to access to services along the road network compared to the nearest service centre.

The outcome of interest was the primary treatment for rectal cancer. This was classified as surgery, RT, or chemotherapy after 12 months of diagnosis.

2.3. Statistical Analysis. All variables were initially analysed using descriptive statistics. Categorical variables were described by frequency distribution and percentages. Missing data were reported as a percentage of each respective variable. Logistic regression models were used to estimate the association between dependent variables and sociodemographic characteristics in a univariable analysis first, followed by a multivariable analysis. The odds ratios (OR) with 95% confidence interval were estimated for cancer cases receiving surgery, RT, or chemotherapy, compared with a baseline category of the respective exposure variables. Statistically significant associations were identified at $\alpha = 0.05$ level.

3. Results

Initial data extraction from the SACCR retrieved 4,132 rectal cancer cases, which were reduced to 4,131 cases after the application of inclusion and exclusion criteria. Table 1 summarises key variables and missing data.

The majority of rectal cancer cases were male (62%), diagnosed between ages 60 and 69 years (31%), and 56% were diagnosed with early-stage A disease. There was an even distribution of cases across SEIFA quintiles, with the majority of cases (68%) residing in inner regional SA and the fewest cases (1%) residing in very remote areas. More than 50% of patients did not receive RT and chemotherapy; however, it is worth noting that more than half of the cases had an early-stage disease and were therefore unlikely to receive these treatments. Of those treated, surgery and chemotherapy were the most common, while only 39% of rectal cases received at least one treatment.

3.1. Univariable Analysis. This section details the univariable analysis presented in Table 2. Statistically significant variations in treatment were detected according to age and year of diagnosis, while minimal variation was present across SES and remoteness of a primary residence.

Table 1: Descriptive statistics for rectal cancer in South Australian major public hospitals from 1982–2015.

Sociodemographic characteristic		Count	Percentage (%)
Age group (years)	18–29	21	1
	30–39	81	2
	40–49	294	7
	50–59	767	19
	60–69	1,290	31
	70–79	1,123	27
	80+	555	13
Sex	Male	2,543	62
	Female	1,588	38
Diagnosis year	1982–1987	381	9
	1988–1993	454	11
	1994–1999	823	20
	2000–2005	866	21
	2006–2011	980	24
	2012–2015	627	15
ACPS	A	2,323	56
	B	603	15
	C	623	15
	D	415	10
	UNK	142	3
	Missing	25	1
SEIFA	1	917	22
	2	746	18
	3	698	17
	4	870	21
	5	812	19
	Missing	88	2
Remoteness-ARIA	Major cities	516	12
	Inner regional	2,783	68
	Outer regional	642	15
	Remote	127	3
	Very remote	49	1
	Missing	14	1
Surgery	Yes	1,281	31
	No	2,850	69
Radiation therapy	Yes	523	13
	No	3,608	87
Chemotherapy	Yes	1,148	28
	No	2,983	72

Abbreviations: ACPS = Australian Clinicopathological Stage; ARIA = Accessibility/Remoteness Index of Australia; SEIFA = Socioeconomic Index for Areas; UNK = unknown.

The relative odds of surgery, RT, or chemotherapy, compared to those aged 50–59 years, decreased with increasing age, with those aged 80+ years being 60% less likely to receive surgery (OR = 0.4 (95% CI 0.3, 0.5)), 70% less likely to receive RT (OR = 0.3 (95% CI 0.2, 0.5)), and 80% less likely to receive chemotherapy (OR = 0.2 (95% CI 0.1, 0.2)). However, those aged 18–29 years were more likely to receive surgery (OR = 2.2 (95% CI 0.9, 5.3)) and chemotherapy (OR = 1.9 (95% CI 0.8, 4.7)) and only 10% less likely to receive RT (OR = 0.9 (95% CI 0.3, 3.0)) compared to the 50–59 year group, although these were not statistically significant.

The unadjusted odds of receiving any treatment increased over 30 years, with those diagnosed between 2012 and 2015 significantly more likely to receive surgery (OR = 13 (95% CI 8.2, 20)) or chemotherapy (OR = 42 (95% CI 19, 91)) and between 2000 and 2005 for RT (OR = 11 (95% CI 5.1, 23)) compared to those diagnosed between 1982 and 1987.

Cases in the most socioeconomically advantaged areas (Quintile 5) were 40% less likely to receive surgery (OR = 0.6 (95% CI 0.5, 0.8)) and 20% less likely to receive both RT (OR = 0.8 (95% CI 0.7, 1.0)) or chemotherapy (OR = 0.8 (95% CI 0.7, 1.0)) than those in more disadvantaged areas.

Although unadjusted and not statistically significant, people residing in very remote regions in SA had 70% higher odds of receiving surgery (OR = 1.7 (95% CI 0.9, 3.0)), 20% lower odds of RT (OR = 0.8 (95% CI 0.7, 1.0)), and 50% higher odds of chemotherapy (OR = 1.5 (95% CI 0.8, 2.7)), compared with those in inner regional areas.

3.2. Multivariable Analyses. The multivariable analyses estimated odds ratios adjusted for all sociodemographic and other characteristics shown in Table 3. The primary interest was exploring the association between sociodemographic characteristics (age, SES, remoteness) and the period of diagnosis and treatment. While adjustment for relevant confounders (sex, stage) is appropriate, the odds ratios of these confounding factors were not of primary interest and are not discussed in the results.

Adjusted odds of receiving surgery or RT for people with rectal cancer aged 80 years or more both decreased by 70% (OR = 0.3 (95% CI 0.2, 0.4)) and (OR = 0.3 (95% CI 0.2, 0.4)), respectively and chemotherapy by 90% (OR = 0.1 (95% CI 0.1, 0.2)) compared to those aged 50–59 years. People aged 18–29 years had the highest odds of receiving surgery (OR = 1.7 (95% CI 0.6, 5.0)), RT (OR = 1.3 (95% CI 0.3, 4.8)) or chemotherapy (OR = 1.8 (95% CI 0.6, 5.8)) compared to 50–59 years, however, this difference was not statistically significant in this population.

Compared to 1982–1987, people diagnosed between 2012 and 2015 had increased odds of surgery (OR = 20 (95% CI 12, 32)) or chemotherapy (OR = 62 (95% CI 28, 134)), while RT odds peaked in 2006–2011 (OR = 15 (95% CI 6.9, 32)) and remained consistent throughout 2012–2015 (OR = 13 (95% CI 5.9, 29)).

Compared to those living in the most disadvantaged areas, the relative odds of surgery were 10% less in the most advantaged areas (OR = 0.9 (95% CI 0.7, 1.0)). Adjusted relative odds of surgery declined by 20% (OR = 0.8 (95% CI 0.4, 1.7)), RT by 40% (OR = 0.6 (95% CI 0.2, 1.9)), and chemotherapy by 10% (OR = 0.9 (95% CI 0.4, 1.9)) in very remote areas compared to inner regional areas, although this difference was not statistically significant in this population.

4. Discussion

This study explored patterns of care in rectal cancer according to age at diagnosis, SES, and remoteness and found that cancer management within SA has improved over time. Little variation was found for treatment (surgery, radiotherapy, or chemotherapy) across the social gradient or by residential remoteness, though we acknowledge this

Table 2: Univariable analysis for rectal cancer treatment in South Australian major public hospitals from 1982–2015.

Sociodemographic characteristic		*S*	RT	*C*
			OR (95% CI)	
Age group (years)	18–29	2.2 (0.9, 5.3)	0.9 (0.3, 3.0)	1.9 (0.8, 4.7)
	30–39	1.0 (0.6, 1.5)	1.1 (0.6, 2.0)	1.5 (1.0, 2.4)
	40–49	1.0 (0.4, 1.2)	1.1 (0.8, 1.6)	1.1 (0.9, 1.5)
	50–59	1.0	1.0	1.0
	60–69	0.8 (0.6, 1.0)	0.8 (0.6, 1.0)	**0.8 (0.6, 0.9)**
	70–79	**0.7 (0.6, 0.8)**	**0.7 (0.5, 0.9)**	**0.6 (0.5, 0.7)**
	80+	**0.4 (0.3, 0.5)**	**0.3 (0.2, 0.5)**	**0.2 (0.1, 0.2)**
Sex	Male	1.0	1.0	1.0
	Female	0.8 (0.7, 0.9)	**0.9 (0.7, 1.1)**	0.9 (0.7, 1.0)
Year of diagnosis	1982–1987	1.0	**1.0**	1.0
	1988–1993	**2.8 (1.7, 4.7)**	**2.6 (1.1, 6.2)**	**4.3 (1.8, 9.9)**
	1994–1999	**5.0 (3.1, 7.9)**	**6.4 (3.1, 14)**	**12 (5.7, 26)**
	2000–2005	**8.7 (5.5, 13)**	**11.0 (5.1, 23)**	**24 (11, 52)**
	2006–2011	**12 (7.9, 19)**	**10 (4.9, 23)**	**38 (17, 80)**
	2012–2015	**13 (8.2, 20)**	**8.9 (4.1, 19)**	**42 (19, 91)**
ACPS stage	A	1.0	1.0	1.0
	B	**1.0 (0.8, 1.2)**	0.8 (0.6, 1.1)	**0.4 (0.3, 0.6)**
	C	**2.1 (1.7, 2.5)**	**2.3 (1.8, 2.9)**	**1.6 (1.3, 1.9)**
	D	**1.5 (1.2, 1.9)**	**2.6 (2.0, 3.4)**	**1.0 (0.9, 1.3)**
	UNK	**0.6 (0.4, 0.9)**	**0.7 (0.3, 1.3)**	**0.3 (0.2, 0.6)**
SEIFA	1	1.0	1.0	1.0
	2	0.9 (0.7, 1.1)	1.1 (0.9, 1.3)	1.1 (0.9, 1.4)
	3	**0.8 (0.6, 0.9)**	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)
	4	**0.7 (0.5, 0.8)**	0.8 (0.7, 1.0)	0.9 (0.7, 1.0)
	5	**0.6 (0.5, 0.8)**	0.8 (0.7, 1.0)	0.8 (0.7, 1.0)
Remoteness-ARIA	Major cities	**0.8 (0.7, 0.9)**	1.1 (0.9, 1.4)	**0.8 (0.6, 0.9)**
	Inner regional	1.0	1.0	1.0
	Outer regional	0.9 (0.8, 1.2)	0.9 (0.7, 1.1)	0.9 (0.7, 1.2)
	Remote	0.9 (0.9, 3.0)	0.8 (0.7, 1.0)	0.8 (0.5, 1.2)
	Very remote	1.7 (0.9, 3.0)	0.8 (0.7, 1.0)	1.5 (0.8, 2.7)

Abbreviations: ACPS = Australian Clinicopathological Stage; ARIA = Accessibility/Remoteness Index of Australia; C = chemotherapy; RT = radiation therapy; SEIFA = Socioeconomic Index for Areas; S = surgery; UNK = unknown; Bold = statistically significant, Bold = at 0.05.

finding may be due to small sample sizes in the remote/very remote groups. However, there was a significant variation in treatment received according to age at diagnosis.

There was significant variation in care patterns according to patients' age at diagnosis, with adjusted relative odds decreasing significantly with increasing age. Other studies report similar findings, surmising that higher frailty and comorbidity in elderly patients reduce the likelihood of being offered and withstanding intensive treatment regimes [11, 12, 18, 19]. However, despite consensus guidelines suggesting that the elderly CRC patient can tolerate systemic and radiotherapies, treatment gaps remain [20].

Since 1982, the likelihood of receiving treatments has increased significantly, particularly surgery or chemotherapy, where those diagnosed between 2012 and 2015 had the highest relative odds. Significant advances in surgical techniques were indicated by Thompson et al., demonstrating a 19.8% increase in less invasive laparoscopic rectal cancer surgery (0.5% to 20.3%) between 2000 and 2008 [21]. As a result, patients may be more likely to agree to rectal cancer surgery due to its minimised short- and long-term morbidity compared to more invasive techniques.

Although small and nonsignificant, some variation across socioeconomic groups was evident, with lower surgery odds and increased RT and chemotherapy in disadvantaged groups. Two previous South Australian studies indicated increased RT usage in disadvantaged groups and decreased surgical odds, suggesting that low SES areas lack access to colorectal surgeons and higher volume hospitals [11, 22]. Similarly, for people living in remote areas, there was little variation in broad treatment patterns compared with people living in metropolitan areas. However, the results we present may reflect the translation of previous reports, resulting in health service improvements to reduce treatment variation as well as increased adherence to clinical practice guidelines and optimal care pathways [6].

While this study has adjusted for the main confounders, including sex and stage, it cannot be ruled out that the observed variations could be explained by other factors not included in this analysis, for example, tumour differentiation, patient frailty, and comorbidity. Furthermore, the statistical significance of detected variations may be limited by population sizes and other factors not accounted for. Greater uncertainty around point estimates for cases diagnosed at a later stage may exist due to smaller case

Table 3: Multivariable analysis for rectal cancer treatment in South Australian major public hospitals from 1982–2015.

Sociodemographic characteristic		*S*	RT	*C*
			OR (95% CI)	
Age group (years)	18–29	1.7 (0.6, 5.0)	1.3 (0.3, 4.8)	1.8 (0.6, 5.8)
	30–39	1.0 (0.6, 1.7)	1.1 (0.6, 2.1)	1.7 (1.1, 2.9)
	40–49	1.0 (0.7, 1.4)	1.2 (0.8, 1.8)	1.1 (0.8, 1.5)
	50–59	1.0	1.0	1.0
	60–69	0.9 (0.7, 1.1)	0.9 (0.7, 1.2)	**0.8 (0.7, 1.0)**
	70–79	**0.7 (0.6, 0.8)**	**0.7 (0.6, 0.9)**	**0.6 (0.5, 0.8)**
	80+	**0.3 (0.2, 0.4)**	**0.3 (0.2, 0.4)**	**0.1 (0.1, 0.2)**
Sex	Male	1.0	1.0	1.0
	Female	0.9 (0.7, 0.9)	0.9 (0.8, 1.2	0.9 (0.8, 1.1)
Diagnosis year	1982–1987	1.0	1.0	1.0
	1988–1993	**2.8 (1.7, 4.6)**	1.5 (1.0–5.9)	**4.2 (1.8, 9.7)**
	1994–1999	**5.4 (3.4, 8.7)**	**7.3 (3.3, 16.1)**	**13 (6.3, 29)**
	2000–2005	**11 (7.1, 18)**	**14 (6.6, 31)**	**32 (15, 70)**
	2006–2011	**17.5 (11, 27)**	**15 (6.9, 32)**	**54 (25, 115)**
	2012–2015	**20 (12, 31)**	**13 (5.9, 29)**	**62 (28, 134)**
ACPS stage	A	1.0	1.0	1.0
	B	**1.7 (1.3, 2.1)**	1.2 (0.8, 1.6)	**0.8 (0.6, 1.1)**
	C	**3.9 (3.1, 4.8)**	**3.5 (2.7, 4.5)**	**3.4 (2.7, 4.3)**
	D	**2.4 (1.9, 13.1)**	**3.8 (2.8, 5.0)**	1.9 (1.5, 2.5)
	UNK	**1.1 (0.7, 1.9)**	0.7 (0.4, 1.3)	0.3 (0.2, 0.6)
SEIFA	1	1.0	1.0	1.0
	2	0.9 (0.7, 1.1)	1.3 (1.0, 1.8)	1.2 (0.9, 1.5)
	3	0.9 (0.7, 1.1)	1.1 (0.8, 1.5)	1.1 (0.8, 1.3)
	4	0.8 (0.7, 1.1)	1.0 (0.7, 1.3)	1.1 (0.8, 1.4)
	5	0.9 (0.7, 1.0)	0.6 (0.2, 1.9)	0.9 (0.4, 1.9)
Remoteness-ARIA	Major cities	1.0 (0.8, 1.3)	0.9 (0.7, 1.2)	1.1 (0.7, 1.2)
	Inner regional	1.0	1.0	1.0
	Outer regional	0.9 (0.7, 1.1)	0.9 (0.7, 1.2)	0.9 (0.7, 1.2)
	Remote	0.9 (0.6, 1.5)	0.5 (0.3, 1.2)	0.7 (0.5, 1.2)
	Very remote	0.8 (0.4, 1.7)	0.6 (0.2, 1.9)	0.9 (0.4, 1.9)

Abbreviations: ACPS = Australian Clinicopathological Stage; ARIA = Accessibility/Remoteness Index of Australia; C = chemotherapy; RT = radiation therapy; SEIFA = Socioeconomic Indexes for Areas; S = surgery; UNK = unknown; Bold = statistically significant, Bold = at 0.05.

numbers. As this analysis avoided the selection of cases, we do not expect that bias has been introduced into the analysis.

There are no data from SA private hospitals, potentially reducing the generalizability of this study to the Australian population treated in the public healthcare system. Literature shows that people treated in private centres are of higher SES and have less comorbidity compared to public patients. However, most recent data from Australian Cancer Incidence and Mortality books, indicate that 8,945 rectal-only cancer cases were diagnosed within SA between 1982 and 2015, indicating this study captured approximately 46% of rectal cancer cases [23].

As our findings showed variation in care patterns according to age at diagnosis, the impact of comorbidity on patterns of care warrants further investigation. Linkage of the SACCR to hospital admission records would enable the measurement of patient comorbidities (as additional diagnostic codes) that could be used to further understand their role in the treatment received. Furthermore, combining SACCR data with cancer treatment data within the private sector would be valuable in understanding rectal cancer care patterns at a population level in SA.

The value of clinical registries is highlighted in this study, as they provide detailed treatment data supplementary to population-based registries and are useful for demonstrating system-wide implementation of treatment recommendations [24]. Clinical registries and other administrative data do have some limitations; however, they are important sources of information for monitoring service delivery and outcomes and identifying variation in treatment for priority groups [25–27]. Clinical registries can offer both quantitative and qualitative data analysis and have proven to be indispensable for evidence-based decision-making, well-designed clinical trials, and ultimately improved patient care [28].

In conclusion, this study analysed data for patients diagnosed with and treated for rectal cancer in South Australia's major public hospitals between 1982 and 2015 using clinical cancer registry data. While significant variation was found in treatment according to age at diagnosis, minimal variation was detected according to socioeconomic status and remoteness, indicative of improvement within the healthcare system's management of cancer in SA.

While the translation of past research into clinical practice is reducing this variation, it would be beneficial to

continue to investigate the care patterns across SA on a regular basis with the aim of providing equal opportunity to care for all cancer patients.

Data Availability

The data that support the findings of this study are available from the South Australian Department of Health and Wellbeing (South Australian Clinical Cancer Registry). These data have been used under license for the current study and are not publicly available. Data are available from the authors upon reasonable request and with permission of the South Australian Department of Health and Wellbeing.

Conflicts of Interest

The authors declare that they have no conflicts of interest to disclose.

Authors' Contributions

AE, MS, LP, and EB were in charge of conception and design; AE and EB handled acquisition of data; AE, MS, LP, LM, and EB were in charge of analysis and interpretation of data; AE, MS, LP, and EB drafted the article; AE, MS, LP, LM, and EB revised the manuscript for important intellectual content; AE, MS, LP, LM, and EB approved the final version of the article.

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