CLINICAL STUDY REPORT

Two cycles of adjuvant carboplatin for clinical stage 1 testicular seminoma in New Zealand centres: A retrospective analysis of efficacy and long-term events

Elias A. Chandran1 | Aaron Chindewere1 | Richard North2 | Michael B. Jameson1,3

1Department of Oncology, Waikato Hospital, Hamilton, New Zealand
2Department of Oncology, Tauranga Hospital, Tauranga, New Zealand
3Waikato Clinical Campus, University of Auckland, Hamilton, New Zealand

Correspondence
Elias A. Chandran, Cancer and Blood Research, Level 12, Building 1, Auckland City Hospital, Grafton, Auckland 1023, New Zealand.
Email: elias.chandran@gmail.com

Present address
Elias A. Chandran, Department of Medical Oncology, Auckland City Hospital, Auckland, New Zealand
Aaron Chindewere, Department of Oncology, North West Regional Hospital, Burnie, Tasmania, Australia

Abstract

Background: Adjuvant carboplatin reduces relapse risk in clinical stage 1 (CS1) seminoma, though there is a paucity of long-term safety data.

Aim: Our objective was to report long-term outcomes of two cycles of adjuvant carboplatin dosed at area under the time–concentration curve (AUC) of 7.

Methods and results: We performed a retrospective analysis on treatment and outcomes of patients with CS1 seminoma who received adjuvant carboplatin from 2000 to 2016 at our centres in the Midland Region, New Zealand. Of 159 patients, median age 39 years, 153 received two cycles of carboplatin: 147 dosed at AUC7 and 6 at AUC6. Six patients had one cycle of carboplatin AUC7. One patient relapsed at 22 months and died of bleomycin pneumonitis 2 months after achieving a complete response with BEP chemotherapy. Neither RTI (present in 21.3%) nor tumor size >4 cm (in 43.3%) was predictive of relapse. Median follow-up was 106 months. At 15 years, outcomes were: relapse-free survival 99.4%, overall survival 91.4%, disease-specific survival 100%, subsequent malignant neoplasm rate 7.6%, and second testicular germ cell tumor rate 3.85%. One patient had persistent grade 1 thrombocytopenia at 46 months.

Conclusions: These data add to the body of evidence that two cycles of carboplatin AUC7 is safe and effective adjuvant treatment for CS1 seminoma.

KEYWORDS
adjuvant chemotherapy, carboplatin, long-term safety, seminoma, testicular cancer

1 | INTRODUCTION

Seminoma accounts for more than half of testicular germ cell tumors (GCTs), with peak incidence at 35 to 45 years of age.1,2 New Zealand Ministry of Health data from 2005 to 2017 show that Maori men have consistently higher rates of testicular cancer than non-Maori men.3 About 80% of seminoma present with clinical stage 1 (CS1) disease, with an estimated relapse rate of 13% to 20% without adjuvant treatment.1,4,5 However, the high curability at relapse has led to ongoing debate about whether optimal postoperative management is adjuvant treatment or surveillance.1,4,6

Historically, adjuvant radiotherapy was given but was associated with increased incidence of subsequent malignant neoplasms (SMNs) and cardiovascular events.7,8 When the MRC TE19 study showed noninferiority of a single dose of adjuvant carboplatin chemotherapy to radiotherapy, the use of adjuvant radiotherapy diminished.7,9

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
© 2020 The Authors. Cancer Reports published by Wiley Periodicals LLC.
Adjuvant carboplatin has been further explored in nonrandomized trials, using one or two cycles dosed at an area under the time-concentration curve (AUC) of 7 and effectively reduces relapse without association with significant late toxicities or SMN.

Surveillance avoids treatment in the majority of patients and has largely become the preferred strategy. However, relapsed patients are exposed to the far greater toxicity of cisplatin-based chemotherapy. There is no consensus on duration of surveillance, which can be up to 10 years, requiring up to 10 abdominal CT scans. This exposes patients to significant doses of radiation, raising concerns of long-term SMN risk. From a psychological perspective, it is well known that patients with testicular cancer experience fear of relapse; however, it is unclear whether this is increased by surveillance.

Risk-based management is proposed by some studies and guidelines, reserving adjuvant carboplatin for patients with one or both of rete testis involvement (RTI) or tumor size more than 4 cm. However, significant heterogeneity in the predictive value of these risk factors questions the reliability of this approach.

Since 2000, the standard of care for patients with CS1 seminoma at the Waikato, Lakes and Bay of Plenty District Health Boards (DHB), New Zealand, has been to consider two cycles of adjuvant carboplatin AUC7, given 3 weeks apart. Our objectives were to analyze this cohort and determine relapse-free survival (RFS), overall survival (OS), disease-specific survival (DSS), cause-specific survival (CSS), which includes deaths from seminoma and treatment, and rates of long-term toxicity, SMN, and second GCT. We also wanted to observe the association of RTI and tumor size >4 cm with relapse.

### Methods
We retrospectively analyzed data of patients over 18 years old with CS1 seminoma who received adjuvant carboplatin from 2000 to 2016. Data were sourced from a proprietary database (Aesculapius) of Medical Oncology patients seen at the Waikato and Lakes DHBs, the Bay of Plenty DHB cancer database, and the New Zealand Health Information Service. This included age, ethnicity, disease stage, tumor size, RTI status, tumor marker levels pre chemotherapy, chemotherapy regimen including number of cycles intended and delivered, relapse, mortality, cause of death, and incidence of SMN (including contralateral GCT). Mortality and SMN data acquired from the national database were updated to December 12, 2017.

Descriptive statistics were used for patient, tumor, and treatment characteristics. Relapse according to RTI and tumor size >4 cm was analyzed using Fisher’s exact test, and actuarial survival was estimated with the Kaplan–Meier method with asymmetrical 95% confidence interval (CI) recommended as more accurate than the more commonly used symmetrical confidence intervals by GraphPad Prism version 8.4.3 (GraphPad, CA, USA), which was used for all analyses. The study was conducted under approval from the Southern Health and Disability Ethics Committee (ref: 16/STH/251).

### Results

#### 3.1 Patient characteristics
There were 159 patients with CS1 seminoma treated with adjuvant carboplatin. Three patients who developed a metachronous contralateral CS1 seminoma within the study period were treated with adjuvant carboplatin on both occasions and are counted twice.

Patient and disease characteristics are shown in Table 1. Median follow-up for survival was 106 months (interquartile range 72-159 months). Six patients had a prior history of testicular seminoma at a median of 7 (range 6-10) years earlier, three of whom had received radiotherapy. Three patients had stage S1 due to raised LDH.

#### 3.2 Treatment
One hundred forty-seven of 153 patients (96%) received their planned two cycles of carboplatin AUC7. Six patients received one cycle: one patient by intention, three due to adverse effects (one each of nausea and vomiting, neuropathy, and hypersensitivity reaction),

### Table 1 Patient characteristics

| Characteristic                     | N = 159 | %    |
|------------------------------------|---------|------|
| Age – median (range) years         | 39 (20-73) | 69.2 |
| Ethnicity                          |         |      |
| New Zealand European               | 110     | 69.2 |
| Maori                              | 46      | 28.9 |
| Other                              | 3       | 1.9  |
| AJCC staging (seventh edition)     |         |      |
| T1                                 | 130     | 81.8 |
| T2                                 | 23      | 14.5 |
| T3                                 | 6       | 3.8  |
| N0                                 | 159     | 100.0|
| N1                                 | 0       | 0.0  |
| S0                                 | 139     | 87.4 |
| S1                                 | 3       | 1.9  |
| Sx                                 | 16      | 10.1 |
| Tumor size                         |         |      |
| >4 cm                              | 69      | 43.3 |
| <4 cm                              | 78      | 49.1 |
| Not known                          | 12      | 7.5  |
| Rete testis invasion               |         |      |
| Yes                                | 34      | 21.4 |
| No                                 | 72      | 45.3 |
| Not known                          | 53      | 33.3 |

Note: Sx: serum tumor marker status unknown.
one due to attempted suicide and one due to incarceration. Six patients received two cycles of carboplatin AUC6, one due to chronic kidney disease; the other five had no documented reason for this dose. Glomerular filtration rate was largely estimated by the Cockcroft-Gault equation; however, in patients at extremes of body habitus, it was measured by $^{51}$Cr-EDTA clearance.

Acute toxicity was not systematically recorded, but there were only two acute admissions during treatment: one with nausea and vomiting and the other with headache. Persistent adverse effects were rare: there was one case of ongoing grade 1 thrombocytopenia 46 months post chemotherapy.

### 3.3 | Follow-up

After completing chemotherapy, patients had clinical examinations and tumor markers checked every 3 to 6 months for the first 2 years and up to 5 years depending on clinician preference. Most patients only had one CT scan at month 12, but, depending on estimated risk of relapse, some had up to four CT scans over the first 5 years. Fifteen (9.4%) patients were lost to follow-up due to noncompliance.

### 3.4 | Outcomes

One patient aged 47 years at initial diagnosis, of NZ European descent, relapsed in his para-aortic nodes at 22 months following two cycles of carboplatin dosed at AUC7, resulting in actuarial RFS of 99.4% (95% CI 95.6-100) at 15 years (Figure 1A). He achieved a radiological complete response after four cycles of BEP but unfortunately died 2 months later of bleomycin pneumonitis precipitated by a large

![Figure 1](image_url)

**TABLE 2** Subsequent Malignant Neoplasms

| SMN                      | Age at SMN diagnosis | Time from chemotherapy (months) | Died of SMN |
|--------------------------|----------------------|---------------------------------|-------------|
| Second germ cell tumors  |                      |                                 |             |
| Contralateral CS1 seminoma | 36                   | 80                             | No          |
| Contralateral CS1 seminoma | 37                   | 48                             | No          |
| Contralateral CS1 seminoma | 41                   | 58                             | No          |
| Contralateral CS1 seminoma | 41                   | 126                            | No          |
| Other SMNs               |                      |                                 |             |
| Neuroendocrine carcinoma of axilla | 44             | 36                             | No          |
| Melanoma                 | 48                   | 130                            | Yes         |
| Glioblastoma multiforme  | 51                   | 38                             | Yes         |
| Rectal adenocarcinoma    | 51                   | 51                             | No          |
| Myeloma                  | 56                   | 96                             | Yes         |
| Small cell lung cancer   | 64                   | 132                            | Yes         |
| Prostate adenocarcinoma  | 69                   | 102                            | No          |

Abbreviation: CS1: clinical stage 1.
### TABLE 3  Studies of CS1 seminoma treated with adjuvant carboplatin (dosed at AUC7 unless stated otherwise)

| Author          | Type of study                  | Cycles of carboplatin | Patients (N) | Population | Median F/U (months) | Relapse Rate (%)/time | Second GCT rate (%) | SMN % (site/months) | DFS (%) | 5y DSS (%) | 5y OS (%) |
|-----------------|--------------------------------|-----------------------|--------------|------------|---------------------|-----------------------|---------------------|---------------------|---------|-----------|-----------|
| Oliver 201169   | RCT                            | 1                     | 573          | pT1-3, normal post-op HCG | 78       | 5.1 (NS)           | 0.3 (NS)             | 0.9 unspecified (NS) | 94.7 (RFR) | 100       | 99        |
| Tandstad 20117  | Prospective, non-randomised    | 1                     | 188          | All comers (T > 4 cm 52.7%) | 41       | 3.9 (0.9 -32 m)    | NS                   | NS                  | 97.1      | 100 at 3y | 99.2      |
| Aparicio 201820 | Prospective, non-randomised    | 2                     | 64           | RTI        | 33       | 1.6 (20 m)         | NS                   | NS                  | 98.2 at 3y | 100 at 3y | 100 at 3y |
| Aparicio 201129 | Prospective, non-randomised    | 2                     | 74           | RTI and T > 4 cm | 74       | 1.4 (25 m)         | NS                   | NS                  | 88.1 at 3y | 100 at 3y | 100 at 3y |
| Steiner 201030  | Retrospective                  | 2 cycles              | 282          | All comers (T > 4 cm 48.2%, RTI NS) | 75.2 (mean) | 1.06 (9-22 m) | 1.9 (2-10.8y) | 1.8 (2 prostate, 2 melanoma, 1 RCC/NS) | 98.1   | 100       | NS        |
| Argirovic 200931| Prospective                    | 2 cycles              | 230          | All comers | 84       | 2.6 (median 31 m)  | 1.7 (median 20.3 m) | 0.4 (Lung/28 m) | NS      | 100 at 7y | 99.1 at 7y |
| Aparicio 200552 | Prospective, non-randomised    | 2                     | 214          | RTI 38.8%, T > 4 cm 84.6%, both 23.4% | 34       | 3.3 (4-28 m) | 0.9 (NS)             | 0.9 (1 RCC, 1 CLL/NS) | 96.2   | 100       | 100       |
| Aparicio 200533 | Prospective, non-randomised    | 2 cycles              | 60           | T2 or venous/lymphatic vascular invasion | 52       | 3.3 (median 11 m) | NS                   | 0%                  | 96.6  | 100       | NS        |
| Reiter 200110   | Prospective, non-randomised    | 2 cycles              | 107          | All comers | 74       | 0                   | 0                    | 0.9 (rectal/26 m) | 100 at 74 m | 100 at 74 m | 94.4 at 74 m |
| Krege 199734    | Phase 2 single arm             | 2 cycles              | 43           | All comers | 28       | 0                   | NS                   | NS                  | NS      | NS        | NS        |

**Carboplatin varying number of cycles or not stated**

| Ruf 201956     | Retrospective                  | 1                     | 161          | All comers | 96       | NS                   | NS                  | 5 (ALL/2, prostate/10-210, CUP/16, melanoma/19-97, NET/34, MGUS/74, RCC/111, Pancreas/164) | NS | 100       | NS        |
|                |                                | 2                     | 82           | All comers | NS       | 6.2 (NS)             | NS                  | NS                  | NS      | NS        | NS        |
| Tyrrell 201721 | Prospective, non-randomised    | NS                    | 175          | All comers | NS       | 6.2 (NS)             | NS                  | NS                  | NS      | NS        | NS        |
| Diminutto 201635| Retrospective                  | 1                     | 107          | CS1 seminoma, normal post-op HCG RTI 28.7%, T > 4 cm 17.4%, Both 35.7% | 22.1     | 5.2 (11.1-16.6 m) | 0.9 (27 m)             | 0.9 (multiple myeloma in patient with pre-existing MGUS/47.4) | 94.8 PFS at 2y | 99.5 at 2y | 99.5 at 2y |
|                |                                | 2                     | 8           | All comers | 30       | 5 (NS)               | NS                  | NS                  | NS      | 100       | NS        |
| Dieckmann 201636| Prospective, non-randomised    | 1                     | 362          | All comers | 30       | 5 (NS)               | NS                  | NS                  | NS      | 100       | NS        |
|                |                                | 2                     | 66           | All comers | 30       | 1.5 (NS)             | NS                  | NS                  | NS      | 100       | NS        |
| Glaser 201537  | Retrospective                  | NS                    | 3508         | All comers | 67       | NS                   | NS                  | NS                  | NS      | NS        | 97.7      |
pulmonary embolus requiring high-flow oxygen. Including the relapsed patient, there were five deaths, the remaining four due to SMN (Table 2), of whom one was Maori. No patients died from progressive seminoma. OS was 98.7% (95% CI 97.7-100) and 91.4% (95% CI 85.9-100) at 10 and 15 years, respectively (Figure 1B). DSS and CSS at 15 years were 100% and 99.4%, respectively.

RTI status was reported in 106 patients (Table 1): 21 patients (13.2%) had both RTI and tumor size >4 cm. The relapsed patient had both risk factors. However, neither RTI nor tumor size >4 cm significantly affected the relapse rate ($P = .32$ and .47, respectively).

### 3.5 | Subsequent malignant neoplasms

Eleven SMNs occurred, four of which were contralateral seminomas (Table 2). Actuarial GCT incidence at 15 years was 3.85% (95% CI 0-30.1). Seven non-GCT SMNs were diagnosed at a median of 96 months post chemotherapy, with actuarial incidence 7.6% at 15 years (95% CI 0.3-31.3). None occurred in patients who previously received radiotherapy for prior GCT. Median age at diagnosis of second GCT and SMN was 39 and 51 years, respectively.

### 4 | DISCUSSION

The 15-year RFS of 99.4%, OS of 91.4%, and DSS of 100% in our population provides further evidence for the efficacy of two cycles of adjuvant carboplatin for CS1 seminoma. The ideal number of cycles of carboplatin has not been defined in a randomized controlled trial (RCT), but nonrandomized studies and interstudy comparison suggest inferiority of one cycle compared to two, summarized in Table 3. Relapse rates were 0% to 8.6% vs 0% to 3.3% for one vs two cycles of carboplatin, respectively, though there was considerable heterogeneity of follow-up duration and study populations (Table 3). The absence of an adequately powered RCT is likely due to the requirement for about 5000 patients to detect superiority of two cycles vs one cycle of adjuvant carboplatin.

Controversy remains about the predictive value of tumor size >4 cm and RTI for relapse. They were not predictive of relapse in our study.

While we did not prospectively record adverse events in our study, others report relatively mild toxicity with carboplatin, excellent treatment completion rates, and no excess in overall mortality or death from cardiovascular disease. A recent study by Ruf et al with median follow-up of 142 months reported a 13.2% hypogonadism rate but no major impact on fertility among 234 patients who had received one or two cycles of carboplatin.

There has been a general shift toward surveillance to minimize treatment burden in CS1 seminoma. A 2015 meta-analysis including 12 075 patients from 13 trials found no OS benefit of chemotherapy or radiotherapy over surveillance despite an 80% reduction in relapse, justifying the role for surveillance. However surveillance requires excellent compliance with frequent clinical
surveillance.11,18 second GCT rates in other carboplatin groups have been similar to perhaps due to effects of in-situ neoplasia in the contralateral testis, TE19 trial suggested that carboplatin reduced the second GCT rate, and our follow-up is longer than in some of these studies. While the other studies (0.54%-2.5%, Table 3), though the 95% CI includes zero, of relapse risk with adjuvant carboplatin may be desirable.

In frail or older patients with CS1 seminoma who may be poor candidates for cisplatin-based chemotherapy, the significant lowering of relapse risk with adjuvant carboplatin may be desirable.

Our findings further support the efficacy of two cycles of adjuvant carboplatin AUC7 for CS1 seminoma and demonstrate its long-term safety, comparable with other published studies. The 15-year non-GCT SMN rate of 7.6% also appears higher than in other studies (0.9%-5.5%), although the 95% CI includes zero, and there are differences in follow-up duration. Prospective studies have reported similar SMN rates between patients treated with adjuvant carboplatin compared with surveillance or the general population. Our rates of prostate cancer and melanoma (both 0.6%) are lower than those reported by Ruf et al. who noted higher-than-expected incidence (both 1.2%) among patients who had adjuvant treatment. It is likely that the SMN rates reported in our smaller sample size are not significantly different to the other studies.

Despite the national incidence of testicular cancer being higher among Maori, the proportion of Maori men in our study (28.9%) was similar to regional demographic data. Similarly, there was no difference in actuarial survival between Maori and non-Maori patients (log-rank P = .854).

We acknowledge as limitations the retrospective nature of our study, lack of standardized reporting on tumor size and RTI, lack of long-term data on infertility, hypogonadism and cardiovascular disease, and the relatively small sample size.

5 | CONCLUSION

Our findings further support the efficacy of two cycles of adjuvant carboplatin AUC7 for CS1 seminoma and demonstrate its long-term safety, comparable with other published studies.

ACKNOWLEDGEMENTS

We would like to acknowledge Dr Ian Kennedy, Waikato Hospital for the use of his electronic database, Aesculapius, which greatly assisted this study. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CONFLICT OF INTEREST

Elias A. Chandran received the ANZUP/AstraZeneca Travel Fellowship 2019. The authors make no other declarations.

AUTHORS’ CONTRIBUTIONS

All authors had full access to the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Conceptualization, A.C., R.N., M.B.J.; Data curation, E.A.C., A.C., R.N., Project administration, E.A.C., R.N., M.B.J.; Methodology, A.C., M.B.J.; Investigation, M.B.J.; Formal Analysis, E.A.C., M.B.J.; Writing - Original Draft, E.A.C.; Writing - Review & Editing, E.A.C., M.B.J.; Supervision, M.B.J.

ETHICAL STATEMENT

Data collection and analysis for this study was approved by the Southern Health and Disability Ethics Committee (ref: 16/STH/251). Patient consent statement was not applicable.

DATA AVAILABILITY STATEMENT

De-identified raw data from this study will be available on request

ORCID

Elias A. Chandran https://orcid.org/0000-0002-0150-7765
Michael B. Jameson https://orcid.org/0000-0001-7068-4311

REFERENCES

1. Pearce SM, Liauw SL, Eggener SE. Management of low-stage testicular seminoma. Urol Clin North Am. 2015;42(3):287-298.
2. Rajpert-De Meyts E, McGlynn KA, Okamoto K, Jewett MA, Bokemeyer C. Testicular germ cell tumours. Lancet. 2016;387(10029):1762-1774.
3. Health. Mo. New cancer registrations. 2017. Wellington, New Zealand: Ministry of Health; 2019.
4. Lieng H, Warde P, Bedard P, et al. Recommendations for followup of patients with clinical stage 1 testicular seminoma: is long-term morbidity increased? J Cancer Res Clin Oncol. 2019;145(9):2335-2342.
5. Petrelli F, Cinque A, Cabiddu M, et al. Surveillance or adjuvant treatment with chemotherapy or radiotherapy in stage I seminoma: a systematic review and meta-analysis of 13 studies. Clin Genitourin Cancer. 2015;13(5):428-434.
6. Tandstad T, Smaaland R, Solberg A, et al. Management of seminomatous testicular cancer: a binational prospective population-based study from the Swedish norwegian testicular cancer study group. J Clin Oncol. 2011;29(6):719-725.
7. Mok G, Warde P. Management of stage I testicular seminoma. Hematol Oncol Clin North Am. 2011;25(3):503-516. viii-iii.
8. Oliver RT, Mead GM, Rustin GJ, et al. Randomized trial of carboplatin versus radiotherapy for stage I seminoma: mature results on relapse survival. J Clin Oncol. 2011;29(6):719-725.
and contralateral testis cancer rates in MRC TE19/EORTC 30982 study (ISRCTN27163214). J Clin Oncol. 2011;29(8):957-962.

10. Reiter WJ, Brodowicz T, Alavi S, et al. Twelve-year experience with two courses of adjuvant single-agent carboplatin therapy for clinical stage I seminoma. J Clin Oncol. 2001;19(1):101-104.

11. Powles T, Robinson D, Shamash J, Moller H, Tranter N. The long-term outcomes of adjuvant carboplatin treatment for stage I seminoma of the testes. Ann Oncol. 2008;19(3):443-447.

12. Mortensen MS, Lauritzen J, Gundgaard MG, et al. A nationwide cohort study of stage I seminoma patients who followed a surveillance program. Eur Urol. 2014;66(6):1172-1178.

13. Cummins S, Yau T, Huddart R, Horwich A. Surveillance in stage I seminoma patients: a long-term assessment. Eur Urol. 2010;57(4):673-678.

14. Fischer S, Tandstad T, Wheeler M, et al. Outcome of men with relapse after adjuvant carboplatin for clinical stage I seminoma. J Clin Oncol. 2017;35(2):194-200.

15. Council NR. Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2. Washington, DC: The National Academies; 2006.

16. Dahl AA, Haaland CF, Myklebust A, et al. Study of anxiety disorder and depression in long-term survivors of testicular cancer. J Clin Oncol. 2005;23(10):2389-2395.

17. Skaali T, Fossa SD, Bremnes R, et al. Fear of recurrence in long-term testicular cancer survivors. Psychooncology. 2009;18(6):580-588.

18. Aparicio J, Maroto P, García Del Muro X, et al. Prognostic factors for relapse in stage I seminoma: a new nomogram derived from three consecutive, risk-adapted studies from the Spanish germ cell cancer group (SGCCG). Ann Oncol. 2014;25(11):2173-2178.

19. Tandstad T, Stahl O, Dahl O, et al. Treatment of stage I seminoma, with one course of adjuvant carboplatin or surveillance, risk-adapted recommendations implementing patient autonomy: a report from the Swedish and Norwegian testicular cancer group (SWENOTECA). Ann Oncol. 2016;27(7):1299-1304.

20. Aparicio J, Sanchez-Munoz A, Guma J, et al. A risk-adapted approach to patients with stage I seminoma according to the status of rete testis: the fourth Spanish germ cell cancer group study. Oncology. 2018;95(1):8-12.

21. Tyrrell HEJ, Church DN, Joseph J, et al. Changing practice evaluation-stage I seminoma: outcomes with adjuvant treatment versus surveillance: risk factors for recurrence and optimizing follow-up protocols-experience from a Supraregional center. Clin Genitourin Cancer. 2018;16(9):240-244.

22. Laguna MP, Albers P, Algaba F, et al. EAU guidelines on testicular cancer 2020. In: European Association of Urology Guidelines 2020 Edition. Vol. Presented at the EAU Annual Congress Amsterdam 2020. Amhem, The Netherlands: European Association of Urology Guidelines Office; 2020.

23. Zengerling F, Kunath F, Jensen K, Ruf C, Schmidt S, Spek A. Prognostic factors for tumor recurrence in patients with clinical stage I seminoma undergoing surveillance-a systematic review. Urol Oncol. 2018;36(10):448-458.

24. Boormans JL, Mayor de Castro J, Marconi L, et al. Testicular tumour size and rete testis invasion as prognostic factors for the risk of relapse of clinical stage I seminoma tests patients under surveillance: a systematic review by the testicular cancer guidelines panel. Eur Urol. 2018;73(3):394-405.

25. Strumberg D, Brugge S, Korn MW, et al. Evaluation of long-term toxicity in patients after cisplatin-based chemotherapy for non-seminomatous testicular cancer. Ann Oncol. 2002;13(2):229-236.

26. Boer H, Proost JH, Nover J, et al. Long-term exposure to circulating platinum is associated with late effects of treatment in testicular cancer survivors. Ann Oncol. 2015;26(11):2305-2310.

27. Groot JH, Lubberts S, de Wit R, et al. Risk of solid cancer after treatment of testicular germ cell cancer in the platinum era. J Clin Oncol. 2018;36(24):2504-2513.

28. Boards MDH. Regional Services Plan 2018–2021: Strategic Direction. [Internet]. Hamilton: HealthShare Ltd for the Midland DHBs; 2018 [cited July 22, 2020]. Available from: https://healthshare.health.nz/sites/default/files/images/2018-2021%20Regional%20Services%20Plan%20-%20Strategic%20Direction.pdf

29. Aparicio J, Maroto P, del Muro XG, et al. Risk-adapted treatment in clinical stage I testicular seminoma: the third Spanish germ cell cancer group study. J Clin Oncol. 2011;29(35):4677-4681.

30. Steiner H, Scheibker K, Berger AP, et al. Retrospective multicentre study of carboplatin monotherapy for clinical stage I seminoma. BJU Int. 2011;107(7):1074-1079.

31. Argirovic D, Jelic-Radojadovic L, Argirovic A. C48 the long-term side effects of adjuvant radiotherapy vs carboplatin chemotherapy in clinical stage a seminomatosus testicular tumors. Eur Urol Suppl. 2009;8(8):674.

32. Aparicio J, Germa JR, García del Muro X, et al. Risk-adapted management for patients with clinical stage I seminoma: the second Spanish germ cell cancer cooperative group study. J Clin Oncol. 2005;23(18):8717-8723.

33. Aparicio J, García del Muro X, Maroto P, et al. Multicenter study evaluating a dual policy of postorchietomy surveillance and selective adjuvant single-agent carboplatin for patients with clinical stage I seminoma. Ann Oncol. 2003;14(6):857-872.

34. Krege S, Kalund G, Otto T, Goepel M, Rubben H. Phase II study: adjuvant single-agent carboplatin therapy for clinical stage I seminoma. Eur Urol. 1997;34(1):405-407.

35. Diminutto A, Basso U, Maruzzo M, et al. Adjuvant carboplatin treatment in 115 patients with stage I seminoma: retrospective multicenter survey. Clin Genitourin Cancer. 2016;14(2):e161-9.

36. Dieckmann KP, Dralle-Filiz I, Matthies C, et al. Testicular seminoma clinical stage 1: treatment outcome on a routine care level. J Cancer Res Clin Oncol. 2016;142(7):1599-1607.

37. Glaser SM, Vargo JA, Balasubramani GK, Beriwal S. Surveillance and radiation therapy for stage I seminoma-have we learned from the evidence? Int J Radiat Oncol Biol Phys. 2016;94(1):75-84.

38. Oliver R. Fifteen-year follow-up of the anglian germ cell cancer group and the anglian regional service plan 2018 courses of adjuvant single-agent carboplatin for clinical stage I seminoma. Int J Radiat Oncol Biol Phys. 2016;94(1):1-8.

39. Oliver RT, Edmonds PM, Ong JY, et al. Pilot studies of 2 and 1 course of carboplatin sufficient? Eur Urol. 2007;52(3):194-200.

40. Boards MDH. The Regional Services Plan 2018–2021: Strategic Direction. [Internet]. Hamilton: HealthShare Ltd for the Midland DHBs; 2018 [cited July 22, 2020]. Available from: https://healthshare.health.nz/sites/default/files/images/2018-2021%20Regional%20Services%20Plan%20-%20Strategic%20Direction.pdf

How to cite this article: Chandran EA, Chinewere A, North R, Jameson MB. Two cycles of adjuvant carboplatin for clinical stage 1 testicular seminoma in New Zealand centres: A retrospective analysis of efficacy and long-term events. Cancer Reports. 2021;4:e1310. https://doi.org/10.1002/cnr2.1310