

Updated overall survival results from a randomized phase III trial comparing gefitinib with carboplatin–paclitaxel for chemo-naïve non-small cell lung cancer with sensitive EGFR gene mutations (NEJ002)

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Received 7 March 2012; revised 26 May 2012; accepted 30 May 2012

Background: NEJ002 study, comparing gefitinib with carboplatin (CBDCA) and paclitaxel (PTX; Taxol) as the first-line treatment for advanced non-small cell lung cancer (NSCLC) harboring an epidermal growth factor receptor (EGFR) mutation, previously reported superiority of gefitinib over CBDCA/PTX on progression-free survival (PFS). Subsequent analysis was carried out mainly regarding overall survival (OS).

Materials and methods: For all 228 patients in NEJ002, survival data were updated in December, 2010. Detailed information regarding subsequent chemotherapy after the protocol treatment was also assessed retrospectively and the impact of some key drugs on OS was evaluated.

Results: The median survival time (MST) was 27.7 months for the gefitinib group, and was 26.6 months for the CBDCA/PTX group (HR, 0.887; $P = 0.483$). The OS of patients who received platinum throughout their treatment ($n = 186$) was not statistically different from that of patients who never received platinum ($n = 40$). The MST of patients treated with gefitinib, platinum, and pemetrexed (PEM) or docetaxel (DOC, Taxotere; $n = 76$) was around 3 years.

Conclusions: No significant difference in OS was observed between gefitinib and CBDCA/PTX in the NEJ002 study, probably due to a high crossover use of gefitinib in the CBDCA/PTX group. Considering the many benefits and the risk of missing an opportunity to use the most effective agent for EGFR-mutated NSCLC, the first-line gefitinib is strongly recommended.

Key words: EGFR mutation, gefitinib, individualized treatment, lung cancer

introduction

Two pivotal studies have revealed that somatic mutations in the kinase domain of the epidermal growth factor receptor

(EGFR) strongly correlate with responsiveness to gefitinib, the first EGFR tyrosine kinase inhibitor (EGFR-TKI) used to treat non-small cell lung cancer (NSCLC) [1, 2]; subsequently, several phase II studies have demonstrated the promising efficacy of individualized treatment for advanced NSCLC patients with EGFR-TKI on the basis of EGFR gene mutation status [3–10]. Subsequently, we have conducted a phase III

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study comparing gefitinib with the standard platinum doublet regimen, carboplatin (CBDCA, Nippon Kayaku, Tokyo) and paclitaxel (PTX, Bristol-Myers Squibb, Tokyo), as the first-line treatment for advanced NSCLC harboring EGFR gene mutations (NEJ002) [11]. The study revealed that gefitinib provided significantly longer progression-free survival (PFS), the primary endpoint of the study, than CBDCA/PTX. Other phase III studies also have demonstrated the superiority of EGFR-TKI over the platinum doublet regimen [12, 13]; thus EGFR-TKIs are now globally recognized as the standard first-line treatment for advanced NSCLC with sensitive EGFR mutations [14].

Regarding overall survival (OS), one of the secondary endpoints of NEJ002, the rate of events was <40% in the previous report, for which the data cutoff point was December 2009. Although our study was not powered for OS, we proceeded with this OS analysis to evaluate the long-term survival result for each treatment group. We updated the data for PFS, OS, and safety examined in a longer follow-up period and also assessed the impact of subsequent chemotherapy on OS in patients with EGFR-mutated NSCLC.

materials and methods

study design and treatment

Full details of the NEJ002 study have been published previously. Eligible patients had chemo-naïve advanced NSCLC with a sensitive EGFR mutation detected by the highly sensitive peptide nucleic acid-locked nucleic acid PCR clamp method [15]. Patients were randomly assigned (1:1) to gefitinib (250 mg/day) or CBDCA (AUC 6.0)/paclitaxel (Taxol, 200 mg/m²) on day 1 every 3 weeks (up to six cycles). The primary endpoint of NEJ002 was to evaluate the superiority of gefitinib over CBDCA/PTX in PFS. The secondary endpoints included response rate, OS, quality of life (QOL), and safety profiles (see Supplementary data, available at *Annals of Oncology* online). Patients provided a written informed consent. The study was conducted in accordance with the Helsinki Declaration of the World Medical Association. The protocol was approved by the institutional review board of each participating institution.

updated evaluation

PFS, OS, and safety data evaluated by the Common Terminology Criteria for Adverse Events version 3.0 were re-evaluated at the data cutoff point in

December 2010 for the entire intent-to-treat population ($n = 228$), which was initially unplanned. Detailed information on subsequent chemotherapy carried out after the protocol treatment was also assessed for all patients retrospectively.

statistical analysis

The Kaplan–Meier survival curves were drawn for PFS and OS and compared using a two-sided non-stratified log-rank test with a significance level of 0.05. The hazard ratio (HR, gefitinib:CBDCA/PTX) and its two-sided 95% confidence interval (CI) were calculated by Cox regression analysis including only the treatment arm as a covariate. Subgroup analyses for OS, which were shown in a forest plot, were carried out to examine the interaction effect of treatment arm with age, gender, performance status, smoking status, type of histology, and type of EGFR mutation using a Cox regression model including treatment arm, each of the clinical factors, and their interaction effects as covariates. We did not account for adjustment for multiplicity due to the repetition of subgroup analyses, because we carried out them as exploratory analyses. Other comparative analyses were evaluated on the basis of a two-sided 5% significance level and 95% CI. All analyses were carried out using SAS for Windows release 9.1 (SAS Institute Inc., Cary, NC, USA).

Results

updated PFS

Among the 224 patients assessable, the updated median PFS of the gefitinib group and that of the CBDCA/PTX group were 10.8 months and 5.4 months, respectively (HR, 0.322; 95% CI 0.236–0.438; $P < 0.001$), which was quite similar to the previous results (Table 1). The number of events for PFS at the last data cutoff (December 2010) was 98 in the gefitinib group and 101 in the CBDCA/PTX group. The rate of events for PFS slightly increased from the previous report (from 83% to 88%).

updated OS

At the last data cutoff point, the median follow-up time was 704 days (range 30–1659) and 69 death events were observed in each arm. The rate of events for OS increased from 36% in the previous report to 61% in the current study (Table 1). The MST and the 2-year survival rate were 27.7 months and 58%,

Table 1. Previous and updated results of survival

First-line treatment group	Previous results (in 2009)		Updated results (in 2010)	
	Gefitinib	CBDCA/PTX	Gefitinib	CBDCA/PTX
PFS				
Median PFS, months	10.8	5.4	10.8	5.4
Hazard ratio (95% CI)	0.296 (0.215–0.408)		0.322 (0.236–0.438)	
One-year PFS rate	42.1%	3.2%	43.8%	4.2%
Number of events (%)	87 (76%)	100 (91%)	98 (86%)	101 (92%)
Overall survival				
Median survival time, months	30.5	23.6	27.7	26.6
Hazard ratio (95% CI)	0.798 (0.517–1.232)		0.887 (0.634–1.241)	
1-year survival rate	84.7%	86.4%	85.0%	86.8%
2-year survival rate	61.4%	46.7%	57.9%	53.7%
Number of events (%)	39 (34%)	43 (38%)	69 (61%)	69 (61%)

CBDCA/PTX, carboplatin plus paclitaxel; CI, confidence interval; PFS, progression-free survival.

respectively, for the gefitinib group, and 26.6 months and 54% for the CBDCA/PTX group (HR, 0.887; 95% CI 0.634–1.241; $P = 0.483$) (Figure 1). No factor, including the type of EGFR mutation, had a substantial impact on OS between the groups (Figure 2).

safety

No additional serious adverse event (NCI-CTC grade ≥ 3) was reported in either group after the previous report. Briefly, the most common adverse events reported were rash and diarrhea with gefitinib, and appetite loss, sensory neuropathy, and myelotoxicities with CBDCA/PTX. The combined incidence of serious adverse events combined was significantly higher in the CBDCA/PTX group than in the gefitinib group (71.7% versus 41.2%; $P < 0.001$).

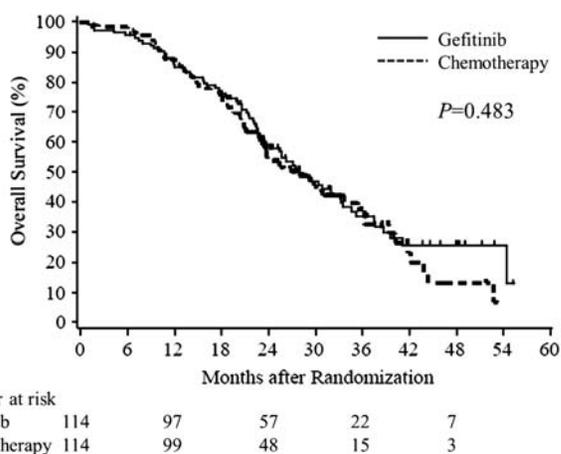


Figure 1. Kaplan–Meier curves for updated overall survival (OS) in the intent-to-treat population of NEJ002.

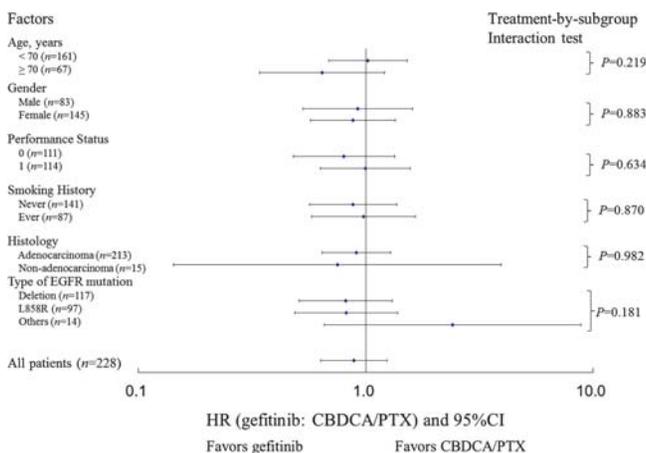


Figure 2. Forest plot of updated overall survival (OS) by clinical factors and the type of epidermal growth factor receptor (EGFR) mutation. Hazard ratio (HR) < 1 implies a lower risk of death for patients treated with first-line gefitinib.

post-protocol chemotherapy

The chemotherapy regimens employed in NEJ002 are summarized in Table 2. Regarding the number of subsequent regimens, >50% of patients had received third-line chemotherapy or more, which was quite compatible with general practice in Japan (Figure 3A).

In the gefitinib group, 82 patients (72%) received at least one subsequent regimen. Among these, 74 patients (65%) were treated with the platinum doublet regimen including a crossover use of CBDCA/TXL in 59 patients (52%). Some patients received pemetrexed (PEM) combined with a platinum agent because it became available for the treatment of NSCLC in Japan in May 2009. Twelve patients went back on gefitinib and 32 received erlotinib in one of their later-line treatments. Among the 32 patients who received no subsequent regimen, 12 (11%) had been still treated with their first-line gefitinib at the data cutoff point (8 patients had still maintained their response to gefitinib, while 4 had continued gefitinib after the documentation of disease progression, in accordance with the patient’s wishes). There were various reasons why the other 20 patients (18%) did not receive any subsequent regimens: deterioration of PS due to the progression of NSCLC ($n = 11$), interstitial lung disease due to gefitinib treatment ($n = 3$), exacerbation of co-morbidities ($n = 2$), or in accordance with the patient’s wishes ($n = 4$). On the other hand, 113 patients (99%) in the CBDCA/PTX group had received at least one subsequent regimen, of whom 112 (98%) had moved to gefitinib.

The standard second-line chemotherapeutic agents PEM or docetaxel (DOC, Sanofi-Aventis K.K., Tokyo), which are used for advanced NSCLC, were used in 29% and 25% of patients in the gefitinib group, respectively, and in 16% and 19% of those in the CBDCA/PTX group, respectively. More than >20% of patients in both the arms received other agents such as irinotecan, S-1, gemcitabine, vinorelbine, or amrubicin as third- or later-line chemotherapy.

evaluation of the impact of key drugs on OS

To examine the impact of the platinum agent on OS of patients with EGFR-mutated NSCLC, we compared the OS of patients who received both gefitinib and a platinum agent in their treatment ($n = 186$) with that of patients who had never received a platinum agent ($n = 40$) in NEJ002. We found no significant difference between the OS of each group (Figure 3B). The number of patients who received a platinum agent but had not received gefitinib was only two in NEJ002.

We then assessed the impact of standard second-line agents (PEM and DOC) on OS. We divided patients who had received third-line or more in NEJ002 ($n = 131$) into two groups: the first group received EGFR-TKI, platinum agent, and PEM or DOC (P/D group, $n = 76$), and the second group received EGFR-TKI, platinum agent, but neither PEM nor DOC (no P/D group, $n = 55$). The MST of the P/D group was significantly longer than that of the no P/D group (34.8 months versus 22.6 months, $P = 0.003$) (Figure 3C).

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Table 2. Summary of regimens for entire treatment in NEJ002

	Second-line n (%)	Third- or later-line n (%)	Total n (%)
First-line gefitinib group (n = 114)			
EGFR-TKI	8 (7.0)	34 (29.8)	114 (100)
Gefitinib	2 (1.8)	10 (8.8)	114 (100)
Erlotinib	6 (5.3)	26 (22.8)	32 (28.1)
Chemotherapy	74 (64.9)	52 (45.6)	76 (66.7)
Platinum based	71 (62.3)	11 (9.6)	74 (64.9)
CBDCA/PTX ^a	56 (49.2)	3 (2.6)	59 (51.8)
Platinum/PEM ^b	11 (9.6)	4 (3.5)	15 (13.2)
PEM (monotherapy)	2 (1.8)	16 (14.0)	18 (15.8)
DOC	0	28 (24.6)	28 (24.6)
Others ^c	1 (0.9)	26 (22.8)	27 (23.7)
First-line CBDCA/PTX group (n = 114)			
EGFR-TKI	109 (95.6)	42 (36.8)	112 (98.2)
Gefitinib	109 (95.6)	8 (7.0)	112 (98.2)
Erlotinib	0	33 (28.9)	33 (28.9)
BIBW2992	0	2 (1.8)	2 (1.8)
Chemotherapy	3 (2.7)	52 (45.6)	114 (100)
Platinum based	2 (1.8)	9 (7.9)	114 (100)
CBDCA/PTX	1 (0.9)	1 (0.9)	114 (100)
Platinum/PEM	0	4 (3.5)	4 (3.5)
PEM (monotherapy)	0	14 (12.3)	14 (12.3)
DOC	1 (0.9)	21 (18.4)	22 (19.3)
Others ^c	0	26 (22.8)	26 (22.8)

CBDCA/PTX, carboplatin plus paclitaxel; PEM, pemetrexed; EGFR-TKI, epidermal growth factor receptor tyrosine kinase inhibitor; DOC, docetaxel.

^aIncludes two CBDCA/PTX plus bevacizumab.

^bIncludes one CBDCA/PEM plus bevacizumab.

^cIncludes irinotecan, S-1, gemcitabine, vinorelbine, and amrubicine.

discussion

Although the NEJ002 study met its primary endpoint, in that gefitinib was superior to CBDCA/PTX in PFS, OS data were also important in evaluating the efficacy of the entire treatment including the regimens investigated. The current updated analysis demonstrated that the treatment course initiated with gefitinib achieved OS at least equivalent to a traditional treatment course initiated with a platinum doublet regimen for patients with advanced NSCLC harboring a sensitive EGFR mutation. Since the median follow-up time increased from 17 months in the previous report to 23 months in the current analysis, the OS results should become more accurate. We have already reported that the QOL was significantly better in the gefitinib group than in the CBDCA/PTX group in NEJ002 [16]. Moreover, gefitinib attained a high response rate, rapid improvement of symptoms, and exhibited low toxicity. Taking these factors together, we recommend the use of gefitinib as the first-line treatment.

There is a conservative opinion which states that the platinum doublet regimen should still be used as the first-line treatment for advanced NSCLC. This is because there has been no prospective study showing superiority of first-line EGFR-TKI over platinum doublet regimens for OS. Furthermore, some retrospective analyses have suggested that EGFR-TKI might be similarly effective in EGFR-mutated NSCLC regardless of the line at which it is used [17]. However, it is

very important to recognize from our study that, though almost 100% of patients in the CBDCA/PTX group crossed over to gefitinib, the OS curve of the first-line gefitinib group was not inferior to that of the CBDCA/PTX group. While the risk associated with missing the administration of platinum agents after first-line gefitinib may be of concern, our *post-hoc* analysis suggested that the impact of the platinum agent on OS would not be larger than that of EGFR-TKI for patients with EGFR-mutated NSCLC. Figure 3B shows the MST of patients treated without platinum to be >2 years, which is a quite favorable result compared with previous historical data obtained when EGFR-TKI was not available. Thus, we feel that it is a concern if the chance to use gefitinib is missed when chemotherapy is carried out as the first-line treatment. The extremely high crossover rate in NEJ002 is hard to attain in general practice. In fact, only 51.5% of patients in the first-line CBDCA/PTX group received subsequent EGFR-TKI in the IPASS study [12]. Thus, we strongly recommend that the best drug should be used in the first instance.

Patients in the first-line gefitinib group tend to be treated with PEM or DOC monotherapy more intensively; this was because we supposed that some of these did not receive platinum doublet treatment for various reasons. However, we consider that the ideal treatment strategy for appropriate patients is to make use of available standard drugs. The most important finding in the *post-hoc* analysis shown in Figure 3C was that patients treated with EGFR-TKIs, platinum, and

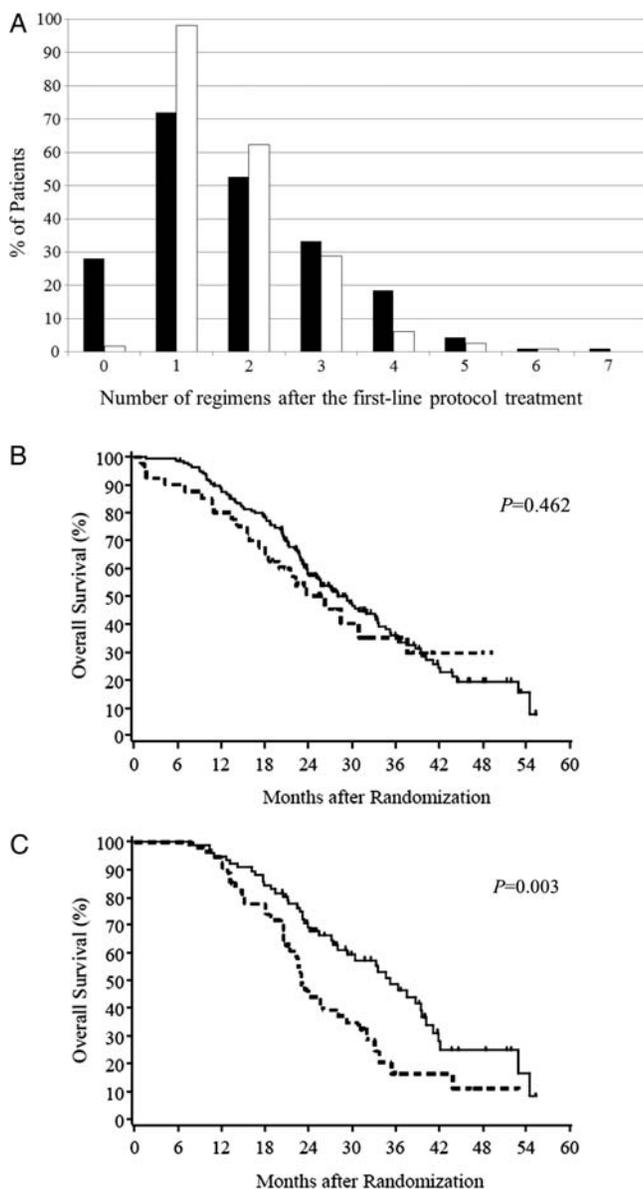


Figure 3. Evaluation of the impact of subsequent treatment on overall survival (OS) in NEJ002. The number of regimens that patients received after the first-line treatment with gefitinib (black bar) and that with chemotherapy (white bar) (A). The OS of patients treated with whichever line of gefitinib but not platinum (a dotted line) and those treated with both gefitinib and platinum (a solid line) (B). The OS of patients treated with gefitinib, platinum, with pemetrexed (PEM) and/or docetaxel (DOC; a solid line), and those treated with gefitinib, platinum but neither pemetrexed nor docetaxel (a dotted line) (C).

PEM/DOC achieved MST of around 3 years even though they had systemically advanced disease; however, the analysis may not conclusively show the difference between the two groups because they were not randomly assigned. This suggests that patients with EGFR-mutated NSCLC and with good PS enough to complete many lines of treatment may further benefit from a proper use of the above mentioned ‘key drugs’. Although PEM and DOC were equally recognized as standard second-line agents at the time of the NEJ002 study [18], we

now consider PEM to be more appropriate for EGFR-mutated NSCLC where adenocarcinoma is much common [14]. Since at least 14 patients (12%) failed to move to subsequent chemotherapy and ~20% of patients had never received platinum agents or PEM after their disease progressed in the gefitinib group, we think there may be a room for improvement of OS in these populations. Thus, we are now investigating a new treatment strategy, in which the first-line gefitinib is combined with CBDCA and PEM, for patients with EGFR-mutated NSCLC (UMIN000002789).

There are some limitations in the current analysis. First, the sample size of NEJ002 had inadequate power for evaluation of the difference in OS between the two groups. Since death events in one-third of patients have not yet occurred, the true OS curve may change slightly from that shown in this report. A meta-analysis combining several phase III studies and comparing EGFR-TKI with platinum doublet in an EGFR-mutated NSCLC population would be warranted. Second, the *post-hoc* analysis on subsequent chemotherapies may have been biased, because post-protocol treatments were not restricted under the NEJ002 protocol; however, they were very similar to those used in general practice in Japan. In addition, the unplanned comparative analysis between the subgroups shown in Figure 3B and C cannot draw definitive conclusions. It may be difficult to find whether the additive effect of platinum agents or PEM/DOC or good PS itself, that enabled patients to receive those agents irrespective of chemotherapy effects, influenced survival prolongation in the superior group more directly. However, we believe that they give us some interesting suggestions for future investigations such as that underway in our new study.

The reason there was no significant difference in OS between the first-line gefitinib group and the first-line CBDCA/PTX group in NEJ002 was very likely a high rate of crossover use of gefitinib in the CBDCA/PTX group. Considering the many benefits from EGFR-TKI use and the risk of missing an opportunity to use the most effective agent for treatment of EGFR-mutated NSCLC, the first-line gefitinib is strongly recommended in general practice for this population.

funding

This work is supported by grant-in-aids from Japan Society for Promotion of Science and Japanese Foundation for the Multidisciplinary Treatment of Cancer. This study is also supported by the Tokyo Cooperative Oncology Group.

disclosure

KK, AG, YS, and TN had received research grants from AstraZeneca. AI, KK, MM, HI, KH, and TN had received lecture fees from AstraZeneca. All remaining authors have declared no conflicts of interest.

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Annals of Oncology 24: 59–66, 2013
doi:10.1093/annonc/mds242
Published online 10 August 2012

Pemetrexed-based chemotherapy in patients with advanced, ALK-positive non-small cell lung cancer

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Received 16 May 2012; revised 11 June 2012; accepted 13 June 2012

Background: Anaplastic lymphoma kinase (ALK)-positive non-small-cell lung cancer (NSCLC) is highly responsive to crizotinib. To determine whether ALK-positive NSCLC is also sensitive to pemetrexed, we retrospectively evaluated progression-free survival (PFS) of ALK-positive versus ALK-negative patients who had been treated with pemetrexed-based chemotherapy for advanced NSCLC.

Patients and methods: We identified 121 patients with advanced, ALK-positive NSCLC in the USA, Australia, and Italy. For comparison, we evaluated 266 patients with advanced, ALK-negative, epidermal growth factor receptor (EGFR)-wild-type NSCLC, including 79 with KRAS mutations and 187 with wild-type KRAS (WT/WT/WT). We determined PFS on different pemetrexed regimens.

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