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Response to “CYP2C9 Polymorphism Is Not a Major Determinant of Bosentan Exposure in Healthy Volunteers”

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To the Editor: We appreciate the opportunity to respond to the letter by Markert et al., "CYP2C9 Polymorphism Is Not a Major Determinant of Bosentan Exposure in Healthy Volunteers."¹ In response to our study on genetic predictors of bosentan-induced liver injury in pulmonary arterial hypertension (PAH) patients, in which we demonstrated an association between the CYP2C9*2 allele, encoding the cytochrome P450 complex subunit 2C9, and liver injury,² Markert et al. report steady-state bosentan pharmacokinetics in 36 healthy volunteers. They show that plasma bosentan levels were highly variable and not associated with CYP2C9 metabolizer phenotype. Consistent with a role for CYP2C9 in the formation of the major active metabolite hydroxy bosentan (RO48-5033), levels of RO48-5033 were 68.7% greater in extensive metabolizers than in poor metabolizers.

The pharmacokinetic data obtained by Markert et al. suggest that the genetic association that we reported is not easily explained by differences in bosentan plasma concentrations between CYP2C9 genotype groups. As Markert et al. point out, CYP2C9-dependent intrahepatic bosentan concentrations may be more relevant and may not be directly related to bosentan plasma concentrations. Although hepatic transporter polymorphisms were not associated with bosentan hepatotoxicity in our study,² the possibility exists that transporter function is altered in PAH patients as a result of disease or drug treatment. Furthermore, as discussed in our paper, there is a possibility that CYP2C9*2 is not a causative single-nucleotide polymorphism (SNP) but tags a regulatory SNP.² The difference in study populations may also have influenced the reported results. The pharmacokinetic study by Markert et al. was carried out in healthy volunteers, whereas our genetic association study was performed in PAH patients receiving steady-state bosentan for clinical indications. As also noted by Markert et al., differences in pharmacokinetics between CYP2C9 metabolizer groups might be more apparent in PAH patients, especially because they may have a longer duration of exposure. Indeed, previously published bosentan pharmacokinetic data for PAH patients show that bosentan exposure is not proportional to dose and is approximately twofold higher than that in healthy subjects.³ In addition, because PAH affects expression of endothelin receptors,⁴ it may affect the tissue-to-plasma ratios of bosentan in these patients. Finally, the possibility that concurrent medications in PAH patients affect bosentan pharmacological and toxicological properties cannot be excluded.

Although studies in healthy volunteers provide important information about human pharmacokinetic characteristics, it is difficult to extrapolate this information to toxicity phenotypes in relevant and complex patient populations. We welcome further investigations to elucidate mechanisms of liver injury and the potential role of pharmacogenomics in patient groups that are candidates for bosentan therapy.

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CONFLICT OF INTEREST
The authors declared no conflict of interest.

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