水素分子の各種疾患又は疾患モデルに対する効果を報告した文献

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対象器官又は疾患	疾患又は疾患モデル	著者及び報告年	使用動物種				投与形態				
			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
脳	脳梗塞	Ohsawa et al, 2007; Ono et al, 2011; Ji et al, 2011; Liu et al, 2011b; Cui et al, 2014; Zhao et al, 2015; Ono et al, 2017	○	○		○	○	○		○	
	脳における活性酸素産生	Sato et al, 2008		○					○		
	拘束で誘発した認知障害	Nagata et al, 2009		○					○		
	脳虚血で誘発した認知障害	Ge et al, 2012		○						○	
	敗血症で誘発した認知障害	Zhou et al, 2012a; Liu et al, 2015		○				○		○	
	肝切除で誘発した認知障害	Tian et al, 2016		○				○			
	低酸素誘発認知障害	Li et al, 2018		○						○	
	外傷性脳傷害で誘発した認知欠損	Hou et al, 2012		○				○			
	認知障害改善効果の性差	Hou et al, 2018		○					○		
	アルツハイマー病	Li et al, 2010; Wang et al, 2011a; Ono et al, 2018; Zhang et al, 2019		○		○		○		○	○
	老化促進マウスにおける老年性認知障害	Gu et al, 2010		○					○		
	出血性梗塞	Chen et al, 2010b		○						○	
	脳内出血	Manaenko et al, 2011; Manaenko et al, 2013; Choi et al, 2018		○						○	

対象器官又は疾患	疾患又は疾患モデル	著者及び報告年	使用動物種				投与形態				
			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
脳	パーキンソン病	Fu et al, 2009; Fujita et al, 2009; Ito et al, 2012; Yoritaka et al, 2013; Matsumoto et al, 2013; Yoshii et al, 2017; Noda et al, 2019		○		○			○	○	
	脳外傷	Ji et al, 2010		○						○	
	外傷性脳障害	Ji et al, 2012; Yuan et al, 2015; Liu et al, 2017; Fu et al, 2018; Yuan et al, 2018		○				○	○		
	CO 中毒	Sun et al, 2011b; Wang et al, 2012a; Wang et al, 2012c; Shen et al, 2013		○				○			
	一過性で広範な脳虚血	Hugyecz et al, 2011		○						○	
	頸動脈の結紮による脳虚血	Nagatani et al, 2012		○						○	
	くも膜下出血における脳障害	Zhan et al, 2012; Zhuang et al, 2012; Zhuang et al, 2013; Hong et al, 2014; Shao et al, 2015		○	○			○		○	
	くも膜下出血における脳血管攣縮	Hong et al, 2012		○				○			
	海馬の循環停止で誘発した脳傷害	Shen et al, 2011		○				○			
	外科的に誘発した脳障害	Eckermann et al, 2011; Xin et al, 2017		○				○		○	

対象器官又は疾患	疾患又は疾患モデル	著者及び報告年	使用動物種				投与形態				
			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
脳	脳血管結紮で誘発した脳虚血	Li et al, 2012c		○				○			
	LPS で誘発した神経炎症と疾病行動	Spulber et al, 2012	○	○			○		○		
	両側総頸動脈結紮による脳障害	Nagatani et al, 2013		○						○	
	心肺バイパスによる脳障害	Chen et al, 2017		○						○	
	心停止蘇生後の脳障害	Huo et al, 2014; Cole et al, 2019		○	○			○		○	
	外傷性脳障害で誘発した神経変性	Dohi et al, 2014		○					○		
	クロルピリホスで誘発した神経毒性	Wang et al, 2014		○					○		
	脳卒中における神経学的症状	Takeuchi et al, 2015		○					○		
	脳虚血傷害	Han et al, 2015		○					○		
	低酸素/再酸素化誘発細胞死	Wei et al, 2015	○				○				
	ALS	Zhang et al, 2015		○				○			
	自己免疫性脳脊髄炎	Zhao et al, 2016; Liu et al, 2018		○					○		
	うつ	Gao et al, 2017		○						○	
	脳虚血再灌流障害	Cui et al, 2016; Li et al, 2016; Gao et al, 2017; Wang et al, 2017; Wu et al, 2018; Huang et al, 2018; Chen et al, 2019; Huang et al, 2019		○				○		○	

対象器官又は疾患	疾患又は疾患モデル	著者及び報告年	使用動物種				投与形態				
			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
脳	うつ様行動	Zhang et al, 2016		○					○		
	外傷性脳傷害後の脳障害と炎症	Tian et al, 2016		○					○		
	低酸素虚血性脳疾患	Nemeth et al, 2016			○					○	
	イソフルラン誘発認知障害	Li et al, 2017	○	○			○	○			
	不安様行動	Wen et al, 2017; Masuda et al, 2017		○				○			
	認知症	Lang et al, 2017; Nishimaki et al, 2017		○		○			○	○	
	海馬に対する酸化ストレス	Paulis et al, 2018		○					○		
	脳虚血再灌流後の神経学的アウトカム	Huang et al, 2018		○						○	
	血管性認知症	Jiang et al, 2018		○					○		
	爆風由来脳障害	Satoh et al, 2018		○						○	
	自閉症様行動異常	Guo et al, 2018		○					○		
	CO 誘発脳障害	Xu et al, 2019		○				○			
	パーキンソン病における腸内細菌の水素産生	Suzuki et al, 2019	○								○
	脳卒中モデルにおけるマクロファージとミクログリアの分極	Ning et al, 2018	○				○				
	パーキンソン病における尿中 8-OHdG 産生	Hirayama et al, 2018				○				○	

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
脳	精神的疲労	Mikami et al, 2019				○			○		
	心停止で誘発した認知欠損	Huang et al, 2019				○				○	
	放射線誘発認知機能障害	Liu et al, 2019		○				○			
	運動負荷による海馬の炎症	Nogueira et al, 2019		○						○	
	敗血症誘発記憶喪失	Jesus et al, 2020		○						○	
	敗血症誘発脳症	Zhuang et al, 2020		○						○	
	くも膜下出血後の内皮障害	Zhuang et al, 2020		○						○	
	糖尿病における外傷性脳障害	Li et al, 2020		○						○	
	肺がんの脳転移	Chen et al, 2019				○				○	
神経/脊髄	脊髄傷害	Chen et al, 2010a; Wang et al, 2015; Chen et al, 2018		○				○		○	
	脊髄の虚血再灌流障害	Huang et al, 2011b; Zhou et al, 2013			○			○		○	
	神経因性疼痛	Chen et al, 2013; Kawaguchi et al, 2014; Ge et al, 2014; Chen et al, 2015; Wang et al, 2018; Chen et al, 2019		○				○	○		
	アストログリア増殖症	Liu et al, 2014	○	○			○	○			
	レミフェンタニル誘発痛覚過敏	Zhang et al, 2014a; Shu et al, 2015		○				○			
	レミフェンタニル誘発高侵害受容作用	Zhang et al, 2014b		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
神経/脊髄	神経細胞死	Kashiwagi et al, 2014	○				○				
	末梢神経の自己移植	Zhang et al, 2016		○				○			
	神経芽細胞死	Murakami et al, 2017	○				○				
	ヘルペス後神経痛	Ma et al, 2017		○				○			
	自律神経機能	Mizuno et al, 2018				○			○		
	メタンフェタミン誘発神経毒性	Wen et al, 2019		○					○		
眼	緑内障	Oharazawa et al, 2010		○							○
	アルカリで誘発した角膜腐食	Kubota et al, 2011; Cejka et al, 2017		○	○			○			○
	網膜障害	Wei et al, 2012; Tian et al, 2013; Feng et al, 2012; Qi et al, 2015; Zhang et al, 2016		○				○			
	網膜ミクログリア細胞の LPS 誘発炎症	Liu et al, 2013	○				○				
	亜セレン酸誘発白内障	Yang et al, 2013		○				○			
	視神経クラッシュ	Sun et al, 2014		○				○			
	網膜の虚血再灌流障害	Liu et al, 2015; Wang et al, 2016; Wu et al, 2018		○				○		○	
	網膜の酸化ストレス	Yokota et al, 2015	○				○				
	光受容体変性	Chen et al, 2016		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
眼	白内障手術時の角膜内皮障害	Igarashi et al, 2016; Igarashi et al, 2019			○	○		○			
	ドライアイ	Chu et al, 2017		○				○			
	エンドトキシン誘発ぶどう膜炎	Yan et al, 2017; Yan et al, 2018		○				○		○	
	網膜色素変性症	Yan et al, 2017		○				○			
	網膜変性症	Tao et al, 2017		○					○		
	角膜光損傷	Cejka et al, 2017a			○						○
	紫外線誘発角膜障害	Cejka et al, 2017b			○				○		
	網膜静脈閉塞	Long et al, 2019		○						○	
	網膜の老化	Li et al, 2019		○				○			
耳	聴覚障害	Kikkawa et al, 2009; Taura et al, 2010; Lin et al, 2011	○	○			○		○		
	ウアバイン誘発聴器神経障害	Qu et al, 2012a		○						○	
	騒音で誘発した聴覚消失	Zhou et al, 2012b; Kurioka et al, 2014; Chen et al, 2014		○				○		○	
	シスプラチン誘発聴器毒性	Qu et al, 2012b; Kikkawa et al, 2014;	○	○			○			○	
	聴覚毒性	Frannson et al, 2017		○					○		
	虚血難聴	Ogawa et al, 2017		○				○			
	内耳障害	Pirttila et al, 2019		○						○	

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
肺	酸素誘発肺障害	Sun et al, 2011c; Huang et al, 2010; Zheng et al, 2010; Huang et al, 2011a; Kawamura et al, 2013		○				○		○	
	肺移植	Kawamura et al, 2010; Kawamura et al, 2012; Zhou et al, 2013; Haam et al, 018		○	○					○	
	パラコート誘発肺障害	Liu et al, 2011a; Li et al, 2020	○	○			○	○			
	放射線誘発肺障害	Terasaki et al, 2011; Chuai et al, 2011		○				○			
	火傷誘発肺障害	Qiu et al, 2010; Fang et al, 2011		○				○			
	腸の虚血再灌流傷害で誘発した肺障害	Mao et al, 2009		○				○			
	LPS 誘発急性肺障害	Qiu et al, 2011; Xie et al, 2012a; Liang et al, 2012; Liu et al, 2015; Zhang et al, 2015; Dong et al, 2017; Wang et al, 2019; Fu et al, 2020	○	○			○	○	○	○	
	肺の虚血再灌流障害	Li et al, 2012b; Shi et al, 2012; Takahashi et al, 2017; Zhang et al, 2019		○	○			○		○	
	敗血症ショック誘発性の肺と腸の障害	Liu et al, 2013		○						○	

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
肺	出血性ショック誘発性の肺障害	Shi et al, 2013; Du et al, 2014a; Moon et al, 2019		○				○		○	
	心肺バイパスにおける炎症反応	Fujii et al, 2013		○						○	
	慢性閉塞性肺疾患（COPD）	Ning et al, 2013; Liu et al, 2017; Liu et al, 2017; Lu et al, 2018		○				○		○	
	心臓死の後の肺灌流	Haam et al, 2015			○					○	
	肺移植のおけるドナーの遺伝子変化	Tanaka et al, 2012		○						○	
	タバコ誘発肺障害	Chen et al, 2015		○				○			
	敗血症由来の肺障害	Zhai et al, 2015; Tao et al, 2016; Yu et al, 2019; Zhai et al, 2019		○				○		○	
	出血性ショック誘発肺障害	Kohama et al, 2015		○						○	
	肺移植	Noda et al, 2014; Liu et al, 2015; Saito et al, 2019		○						○	○
	海水注入で誘発した肺障害	Diao et al, 2016			○					○	
	大気汚染で誘発された肺障害	Gong et al, 2016				○				○	
	肺気腫	Suzuki et al, 2017		○					○		
	下肢の虚血再灌流障害による肺障害	Zou et al, 2018		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
肺	敗血症で誘発した肺障害	Dong et al, 2018		○						○	
	Naphthalene 誘発急性肺障害	Terasaki et al, 2019		○					○		
	ブレオマイシン誘発肺線維症	Gao et al, 2019		○						○	
	間質性肺炎	Terasaki et al, 2019		○					○		
	PM2.5 誘発肺障害	Feng et al, 2019		○						○	
	喘息および COPD	Wang et al, 2020				○				○	
気管	OVA で誘発した喘息	Xiao et al, 2013; Zhang et al, 2018; Huang et al, 2019; Zhao et al, 2020		○				○		○	
	気道狭窄患者の気道抵抗	Zhou et al, 2018				○				○	
	閉塞性気道疾患	Ozeki et al, 2019		○					○		
心臓	急性心筋梗塞	Zhang et al, 2011; Sun et al, 2009; Hayashida et al, 2008; Yoshida et al, 2012; Sakai et al, 2012; Jing et al, 2014; Katsumata et al, 2017; Asanuma et al, 2017; Feng et al, 2018		○	○	○		○		○	
	心移植	Nakao et al, 2010a; Noda et al, 2012; Noda et al, 2013		○					○	○	○
	左心室肥大	Yu et al, 2012; Matsuoka et al, 2018		○				○		○	
	放射線誘発心筋障害	Qian et al, 2010a; Kura et al, 2019		○					○		

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
心臓	睡眠時無呼吸で誘発された心臓の低酸素症	Hayashi et al, 2011		○						○	
	心肺停止蘇生後の脳・心臓障害	Hayashida et al, 2012		○						○	
	心肺停止蘇生後の脳障害	Huang et al, 2013; Hayashida et al, 2014; Chen et al, 2019		○	○			○		○	
	虚血再灌流傷害とニトロチロシン産生	Shinbo et al, 2013		○						○	
	低酸素による左心室リモデリング	Kato et al, 2014		○						○	
	糖尿病性心筋症	Wu et al, 2015		○					○		
	心筋細胞の虚血による障害	Xie et al, 2014	○				○				
	心臓の虚血再灌流障害	Tan et al, 2013; Zhao et al, 2014; Zhang et al, 2015; Pan et al, 2015; Zalesak et al, 2017; Gao et al, 2017; Li et al, 2019; Yao et al, 2019; Li et al, 2019a; Li et al, 2019b; Li et al, 2019c; Li et al, 2020		○	○			○	○	○	○
	ドキソルビシン誘発心不全	Wu et al, 2014		○				○			
	ドキソルビシン誘発心筋障害	Gao et al, 2017		○				○			
	LPS 誘発心不全	Tao et al, 2015		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
心臓	心停止後の心機能と神経学的転帰	Wang et al, 2016		○						○	
	心停止後症候群	Tamura et al, 2016; Tamura et al, 2020				○				○	
	心停止後の心筋損傷	Wang et al, 2017			○					○	
	圧負荷で誘発した心肥大	Fan et al, 2018		○				○			
	心停止後の神経学的アウトカム	Chen et al, 2017		○						○	
	心血管代謝リスク	Korovljev et al, 2018				○				○	
	心肺バイパスで誘発された心筋障害	Chen et al, 2018		○				○			
	心筋障害とアクアポリン発現	Song et al, 2018		○				○			
	慢性心不全	Chi et al, 2018		○						○	
	低酸素誘発心機能不全	Zhao et al, 2019		○						○	
肝臓	住血吸虫に起因した慢性肝炎	Gharib et al, 2001		○						○	
	肝炎	Kajiya et al, 2009a		○							○
	非アルコール性脂肪性肝疾患	Kawai et al, 2012; Zhai et al, 2017; Jackson et al, 2018; Korovljev et al, 2019		○		○		○	○		
	閉塞性黄疸	Liu et al, 2010; Liu et al, 2016		○				○			
	四塩化炭素誘発肝障害	Sun et al, 2011a		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
肝臓	肝腫瘍治療における放射線障害	Kang et al, 2011				○			○		
	肝臓の遺伝子発現	Nakai et al, 2011		○					○		
	肝切除による肝障害	Xiang et al, 2012			○					○	
	肝切除による肝不全	Tan et al, 2014		○				○			
	肝の線維化	Koyama Y et al, 2013		○					○		
	B 型肝炎	Xia et al, 2013				○			○		
	エンドトキシン誘発肝障害	Xu and Zhang, 2013		○				○			
	肝硬変の血行動態	Lee et al, 2014		○				○			
	アセトアミノフェン誘発肝毒性	Zhang et al, 2015		○				○			
	肝再生	Yu et al, 2015		○							○
	脂肪肝の虚血再灌流障害	Li et al, 2018		○				○			
	熱傷における肝機能	Liu et al, 2014		○				○			
	低酸素/再酸素化障害	Yu et al, 2015	○	○			○		○		
	アルコール性脂肪肝	Lin et al, 2017		○					○		
	敗血症誘発肝障害	Yan et al, 2019		○						○	
腎臓	腹膜透析	Terawaki et al, 2013				○					○
	シスプラチン誘発腎症	Nakashima-Kamimura et al, 2009; Kitamura et al, 2010; Matsushita et al, 2011b		○					○	○	
	ゲンタマイシン誘発腎毒性	Matsushita et al, 2011a		○					○		

対象器官又は疾患	疾患又は疾患モデル	著者及び報告年	使用動物種				投与形態				
			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
腎臓	腎移植	Cardinal et al, 2010; Kobayashi et al, 2019		○	○			○	○		
	腎の虚血再灌流障害	Wang et al, 2011b; Shingu et al, 2010: Abe et al, 2012; Zeng et al, 2014; Li et al, 2016a; Li et al, 2016b; Nishida et al, 2018; Kawamura et al, 2020		○			○	○		○	○
	メラミン誘発尿石	Yoon et al, 2011b		○					○		
	糖尿病腎症	Katakura et al, 2012; Jiao et al, 2020		○				○	○		
	慢性腎臓病	Zhu et al, 2011		○					○		
	急性腎障害（AKI）	Chen et al, 2017		○				○			
	片側尿管結紮による腎障害	Xu et al, 2013		○				○			
	鉄ニトリロ三酢酸誘発腎毒性	Li et al, 2013		○					○		
	Dahl 食塩感受性ラットにおける心-腎障害	Zhu et al, 2013		○					○		
	横紋筋融解症における腎障害	Gu et al, 2014		○				○			
	自然発症高血圧ラット（SHR）における腎障害	Xin et al, 2014		○					○		

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
腎臓	敗血症ショック時の腎障害	Liu et al, 2014		○						○	
	造影剤誘発腎障害	Homma et al, 2015		○						○	
	腎石症	Peng et al, 2015		○						○	
	重症火傷における急性腎障害	Guo et al, 2015; Wang et al, 2018		○				○			
	肝移植後の急性腎障害	Du et al, 2016		○				○			
	腎障害と線維化	Xing et al, 2017	○	○			○		○		
	シュウ酸カルシウム誘発腎障害	Lu et al, 2018		○						○	
	多発性嚢胞腎	Yamasaki et al, 2019		○					○		
	敗血症誘発腎障害	Yao et al, 2019		○					○		
	シクロスポリン誘発腎毒性	Lu et al, 2020		○					○		
膵臓	外傷誘発膵炎	Ren et al, 2012		○				○			
	タウロコール酸誘発膵炎	Shi et al, 2015		○				○			
	急性膵炎	Chen et al, 2010c; Zhang et al, 2012; Zhang et al, 2013; Ren et al, 2014; Zhou et al, 2016; Han et al, 2016	○	○			○	○		○	
	膵臓移植後の虚血再灌流障害	Lou et al, 2015		○				○			
	急性壊死性膵炎	Shi et al, 2016		○				○			
精巣	精巣の虚血再灌流障害	Jiang et al, 2012a; Lee et al, 2012		○				○		○	
	精巣の放射線障害	Jiang et al, 2012b		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
精巣	生殖細胞の放射線障害	Chuai et al, 2012a		○				○			
	放射線誘発精子形成障害と造血機能障害	Chuai et al, 2012b		○				○			
	ニコチン誘発性精巣障害	Li et al, 2013		○				○			
	精子の生存率	Nakata et al, 2015	○				○				
	煙草煙誘発精巣障害	Chen et al, 2015		○				○			
	脊髄切断で誘発した精巣障害	Ge et al, 2017		○				○			
	精子形成と精子生存率	Ku et al, 2020		○				○			
卵巣	シスプラチン誘発卵巣障害	Meng et al, 2015		○				○			
	早発卵巣不全	He et al, 2016		○				○			
	卵巣の虚血再灌流障害	Gokalp et al, 2016		○				○			
子宮	子宮内膜症	He et al, 2016		○						○	
胃	ストレス誘発胃潰瘍	Liu et al, 2012		○				○			
	アスピリン誘発胃障害	Xue et al, 2014; Zhang et al, 2014		○					○		
腸	腸移植	Buchholz et al, 2008; Zheng et al, 2009; Buchholz et al, 2011		○			○	○		○	
	潰瘍性大腸炎	Kajiya et al, 2009b; He et al, 2013; Shen et al, 2017		○				○	○	○	
	出血性ショックにおける腸管障害	Du et al, 2015		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
腸	腸の虚血再灌流障害	Chen et al, 2011; Shigeta et al, 2015; Wu et al, 2017; Eryilmaz et al, 2019; Yao et al, 2019; Jiang et al, 2020		○				○	○		
	腸閉塞	Okamoto et al, 2016		○				○			
	胃移植	Ikeda et al, 2017		○				○			
	放射線による消化器障害	Xiao et al, 2018		○					○		
	腸内環境の改善	Higashimura et al, 2018		○					○		
	マイコトキシン誘発腸管障害	Xu et al, 2019		○					○		
	消化器症状の改善	Tanaka et al, 2018				○			○		
	放射線誘発小腸障害	Qiu et al, 2020	○	○			○	○			
食道	遊走とアポトーシス	Li et al, 2017	○						○		○
	逆流性食道炎	Franceschelli et al, 2018				○			○		
血管	動脈硬化	Ohsawa et al, 2008		○					○		
	アテローム性動脈硬化	Song et al, 2012		○				○			
	バルーンで誘発した血管の内膜傷害と内膜肥厚	Qin et al, 2012; Chen et al, 2013	○	○			○	○			
	移植血管における内膜肥厚	Sun et al, 2012a		○					○		
	血管傷害	Zheng et al, 2012		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
血管	糖化最終産物誘発性の血管内皮傷害	Jiang et al, 2013	○				○				
	塩化カルシウムで誘発した動脈瘤	Chen et al, 2013; Song et al, 2013; Chen et al, 2014		○				○			
	血管内皮機能	Sakai et al, 2014; Ishibashi et al, 2020				○			○		
	血管内皮への単球接着と血管透過性	Xie et al, 2015; Yu et al, 2015	○				○				
	動脈硬化におけるプラーク	Song et al, 2015a		○					○		
	血管平滑筋の肥大・増殖	Zhang et al, 2016	○	○			○			○	
	血管の老化	Iketani et al, 2018		○					○		
	血管のリモデリング	Kiyoi et al, 2020		○						○	
	出血性ショックにおける血管内皮グリコカリックス	Sato et al, 2020		○						○	
筋肉	炎症性及びミトコンドリア性筋炎	Ito et al, 2011				○			○		
	筋肉疲労	Aoki et al, 2012; DA Ponte et al, 2017; Botek et al, 2019				○			○		
	腓腹筋萎縮	Fujita et al, 2011		○					○		
	骨格筋の虚血再灌流障害	Huang et al, 2015		○				○			
	軟部組織障害	Ostojic et al, 2014				○					○

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
筋肉	運動負荷による酸化ストレス	Yamazaki et al, 2015; Nogueira et al, 2018		○	○			○		○	
	筋ジストロフィー	Hasegawa et al, 2016		○					○		
軟骨・骨	NO 誘発性軟骨障害	Hanaoka et al, 2011	○				○				
	微小重力による骨欠損	Sun et al, 2012b		○					○		
	骨減少症	Guo et al, 2012		○					○		
	TNF α 誘発骨芽細胞傷害	Cai et al 2013	○				○				
	骨・軟骨組織の生存率	Yamada et al, 2014	○				○				
	破骨細胞の分化	Li et al, 2014	○				○				
	ステロイド誘発大腿骨壊死	Huang et al, 2016; Li et al, 2017			○			○			
	骨の放射線障害	Chen et al, 2020	○	○			○		○		
腱	腱の接着と炎症	Meng et al, 2018		○				○			
関節	関節リウマチ	Ishibashi et al, 2012; Ishibashi et al, 2014; Meng et al, 2016		○		○		○	○		
	乾癬性関節炎	Ishibashi et al, 2015				○		○	○	○	
	変形性関節症	Cheng et al, 2020		○					○		
歯	歯周病	Kasuyama et al, 2011; Azuma et al, 2015		○		○			○		
	歯周病における大動脈の脂質沈着	Ekuni et al, 2012		○					○		
	歯周組織の老化	Tomofuji et al, 2014		○					○		
	線維芽細胞の酸化ストレス	Xiao et al, 2016	○				○				

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
歯	歯肉の酸化ストレスと歯槽骨の再吸収	Yoneda et al, 2017		○					○		
	口腔内バイオフィルム形成	Kim et al, 2017	○（微生物）			○			○		
	歯肉の酸化ストレス	Shamim, 2018	○				○				
皮膚	紫外線を照射した線維芽細胞傷害とケラチノサイトのしわ形成	Kato et al, 2012a	○			○	○				○
	紫外線誘発皮膚障害	Yoon et al, 2011a; Guo et al, 2012		○				○			○
	急性紅斑性皮膚疾患	Ono et al, 2012				○		○			
	皮膚移植における虚血再灌流障害	Zhao et al, 2013		○				○			
	紫外線誘発皮膚障害	Ignacio et al, 2013a; Zhang et al, 2018	○	○			○				○
	褥瘡	Li et al, 2013	○			○	○		○		
	アトピー性皮膚炎	Ignacio et al, 2013b; Yoon et al, 2014; Kajisa et al, 2017	○	○				○	○		
	放射線誘発皮膚炎と皮膚障害	Watanabe et al, 2014; Zhou et al, 2018		○					○	○	
	熱傷の進行	Guo et al, 2015		○				○			
	火傷による炎症	Wang et al, 2015		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
皮膚	皮膚の虚血再灌流障害	Liu et al, 2015; Fang et al, 2018; Dong et al, 2019		○				○		○	
	局所の放射線照射による皮膚炎	Mei et al, 2014		○				○			
	皮膚老化	Wu et al, 2017	○				○				
	乾癬	Zhu et al, 2018				○					○
	ケラチン栓のクレンジング効果	Tanaka et al, 2018				○					○
	褥瘡モデルにおける皮膚の虚血再灌流障害	Fang et al, 2018		○						○	
	尋常性天疱瘡	Yang et al, 2019				○			○		
代謝	Ⅰ型糖尿病	Li et al, 2011; Amitani et al, 2013		○		○	○		○		
	Ⅱ型糖尿病	Kajiyama et al, 2008; Wang et al, 2012; Zhang et al, 2018		○		○		○	○	○	
	メタボリックシンドローム	Nakao et al, 2010b; Hashimoto et al, 2011; Song et al, 2013; LeBaron et al, 2020		○		○			○		
	高コレステロール血症	Zong et al, 2012; Song et al, 2015b		○		○		○			
	糖尿病及び肥満	Kamimura et al, 2011		○					○		
	糖尿病性勃起不全	Fan et al, 2012		○				○			
	糖尿病性網膜症	Feng et al, 2012; Xiao et al, 2012		○				○			

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
代謝	肝細胞の脂肪酸取り込みと脂質蓄積	Iio et al, 2013	○				○				
	脂質代謝	Kamimura et al, 2016		○					○		
	糖尿病における骨減少	Guo et al, 2017		○				○			
	肥満	Nakasone et al, 2017; Korovljev et al, 2018				○			○		
	糖尿病性神経障害	Jiao et al, 2019		○				○			
	新生児低酸素脳症	Cai et al, 2008; Domoki et al, 2010; Cai et al, 2009; Yang et al, 2016; Varga et al, 2018; Htun et al, 2019; Wu et al, 2019		○	○	○		○	○	○	
周産期異常	子癇（妊娠高血圧腎症）	Yang et al, 2011; Ushida et al, 2016		○				○	○		
	母体低酸素による脳障害	Liu et al, 2011		○						○	
	新生児の高酸素誘発網膜症	Huang et al, 2012		○				○			
	新生児における麻酔薬吸入で誘発された認知障害	Yonamine et al, 2013		○						○	
	新生児の壊死性腸炎	Sheng et al, 2013		○				○			
	胎児の海馬障害	Mano et al, 2014		○					○		

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
周産期異常	新生児の脳室内胚芽層出血	Lekic et al, 2011		○						○	
	LPS 誘発新生児肺傷害	Hattori et al, 2015		○					○		
	新生児の神経血管障害	Oláh et al, 2015			○					○	
	新生児における麻酔薬吸入で誘発された母性行動の欠如	Takaenoki et al, 2014		○						○	
	新生児の気管支肺異形成症	Muramatsu et al, 2016		○					○		
	LPS 誘発新生児脳障害	Imai et al, 2016		○					○		
	新生児低酸素性虚血脳症	Wang et al, 2020		○						○	
炎症・アレルギー	新生児の虚血性脳障害	Bai et al, 2016; Wu et al, 2019		○				○		○	
	水制限で誘発した胎盤ストレス	Shi et al, 2018		○					○		
	妊娠性歯肉炎	Shi et al, 2018		○					○		
	Ⅰ型アレルギー	Itoh et al, 2009		○					○		
	敗血症	Xie et al, 2010a; Li et al, 2012a; Xie et al, 2012; Liu et al, 2014a; Liu et al, 2014b; Li et al, 2014; Li et al, 2015a; Li et al, 2015b; Yu et al, 2017; Iketani et al, 2016; Hong et al, 2017; Ikeda et al, 2017; Saramago et al, 2018		○				○	○	○	
	ザイモザン誘発炎症	Xie et al, 2010b; Hong et al, 2016		○						○	

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
炎症・アレルギー	LPS/IFN-γ誘発 NO 産生	Itoh et al, 2011	○	○			○		○		
	カラゲニン足浮腫およびマクロファージの TNFα産生	Xu et al, 2012	○	○			○	○			
	LPS 誘発マクロファージ炎症	Chen et al, 2013	○				○				
	アレルギー性鼻炎	Zhao et al, 2017; Yu et al, 2017; Xu FF, et al, 2017; Jin et al, 2018; Fang et al, 2018		○	○	○		○		○	
	抗炎症メカニズム	Ren et al, 2016	○				○				
癌	舌癌細胞増殖	Saitoh et al, 2008; Saitoh et al, 2009	○				○				
	肺癌細胞で誘発した血管新生	Ye et al, 2008	○				○				
	放射線誘発胸腺リンパ腫	Zhao et al, 2011		○				○			
	癌細胞殺傷作用	Kagawa et al, 2012	○								○
	抗腫瘍作用	Dole et al, 1975; Zhao et al, 2019; Chen et al, 2019c; Akagi et al, 2018		○		○				○	○
	抗癌剤の抗腫瘍作用増強	Runtuwene et al, 2015		○					○		
	大腸がん患者の肝機能	Yang et al, 2017	○					○			
	膠芽腫	Liu et al, 2019	○	○			○			○	
	胆嚢がんの縮小効果	Chen et al, 2019a; Chen et al, 2019b				○				○	

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			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
癌	肺がんに対する抗腫瘍効果と副作用軽減	Chen et al, 2020				○				○	
	子宮内膜がんに対する効果とそのメカニズム	Yang et al, 2020	○	○			○		○		
	肺がん増殖抑制効果	Wang et al, 2018	○	○			○		○		
高血圧	モノクロタリン誘発肺高血圧	Wang et al, 2011c; He et al, 2013; Kishimoto et al, 2015		○				○	○		
	低酸素誘発高血圧	Guan et al, 2018		○						○	
その他	潜水病	Ni et al, 2011		○				○			
	多能性幹細胞の生存	Kawasaki et al, 2010	○							○	
	放射線誘発細胞傷害	Qian et al, 2010b; Qian et al, 2010c	○				○				
	酸化 LDL 誘発細胞毒性	Song et al, 2011	○				○				
	高グルコース誘発酸化ストレス	Yu et al, 2011	○				○				
	AAPH 誘発酸化ストレス	Yanagihara et al, 2005		○					○		
	寿命	Yan et al, 2010; Klichko et al, 2019			○		○				
	運動負荷による酸化ストレス	Koyama et al, 2008; Tsubone et al, 2013; Dobashi et al, 2020			○	○			○		
	運動負荷による代謝性アシドーシス	Ostojic et al, 2014				○			○		

対象器官又は疾患	疾患又は疾患モデル	著者及び報告年	使用動物種				投与形態				
			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
その他	運動負荷軽減効果	LeBaron et al, 2019				○			○		
	運動能力改善	Javorac et al, 2019				○				○	
	血小板凝集	Takeuchi et al, 2012		○		○	○	○		○	
	放射線誘発アポトーシス	Yang et al, 2012	○				○				
	ラジカル産生および血液流動性	Kato et al, 2012	○						○		
	骨髄移植における GVHD（移植片対宿主病）	Qian et al, 2013		○				○			
	慢性 GVHD	Qian and Shen, 2016; Qian et al, 2016		○		○		○	○		
	再生不良性貧血	Zhao et al, 2013		○				○			
	放射線誘発免疫機能障害	Zhao et al, 2014		○				○			
	急性腹膜炎	Zhang et al, 2014		○					○		
	出血性ショック	Du et al, 2014; Matsuoka et al, 2017		○				○		○	
	血液幹細胞移植	Yuan et al, 2015		○				○			
	情報伝達	Sobue et al, 2015		○					○	○	
	組織内濃度	Liu et al, 2014; Yamamoto et al, 2019		○				○	○	○	
	ヒトリンパ球細胞に対する 12C6＋重イオン照射	Yang et al, 2013	○				○				
	膀胱下尿道閉塞	Miyazaki et al, 2015		○				○			

対象器官又は疾患	疾患又は疾患モデル	著者及び報告年	使用動物種				投与形態				
			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
その他	口蓋内創傷	Tamaki et al, 2016		○					○		
	細胞死と老化	Han et al, 2016; Han et al, 2017	○				○				
	細胞老化	Hara et al, 2016; Zhang et al, 2018; Sakai et al, 2019	○	○			○	○			
	潜在出血	Qian et al, 2017		○					○		
	放射線誘発造血幹細胞障害	Zhang et al, 2017		○					○		
	培養細胞における活性酸素消去	Hamasaki et al, 2017	○				○				
	免疫活性	Hu et al, 2017			○				○		
	酸化ストレス	Lee et al, 2017; Liu et al, 2018; Lu et al, 2019	○				○				
	術後腹腔内癒着	Liu et al, 2017		○				○			
	マイコトキシン含有飼料による成長抑制	Zheng et al, 2018			○				○		
	抗疲労効果	Ara et al, 2018; Watanabe et al, 2018		○		○			○		
	遺伝子発現のメタ解析	Nishiwaki et al, 2018		○					○		
	酸素毒性の軽減	Yu et al, 2017	○				○				
	遺伝子発現の修飾作用	Sobue et al, 2017		○					○		
	酸素グルコース欠乏とアポトーシス	Mo et al, 2018	○				○				

対象器官又は疾患	疾患又は疾患モデル	著者及び報告年	使用動物種				投与形態				
			細胞	齧歯類	その他動物	ヒト	培養液	生食	水	ガス	その他
その他	創傷治癒	Li et al, 2018	○				○				
	抗酸化活性と腸内フローラ	Sha et al, 2018				○			○		
	解毒機構への影響	Yao et al, 2019		○					○		
	フリーラジカル誘発細胞死	Iuchi et al, 2019	○				○				
	内臓脂肪と皮膚のしみ	Asada et al, 2019				○					○
	ミトコンドリア機能	Gvozdjakova et al, 2019		○					○		
	LDL 誘発炎症	Yang et al, 2018	○				○				
	足首の捻挫	Javorac et al, 2020				○			○		
	抗疲労効果	Botek et al, 2020				○			○		
	水素水の作製条件と唾液中の酸化還元電位	Tanaka et al, 2020				○			○		
	スーパーオキシド生成抑制	Ishibashi et al, 2020	○				○				

2020 年 6 月 18 日までの掲載論文を MiZ 株式会社で調査し本資料を作成した。

References

Abe T, Li XK, Yazawa K, *et al* (2012): Hydrogen-rich University of Wisconsin solution attenuates renal cold ischemia-reperfusion injury. Transplantation, **94**: 14-21.

Abedi KA, Ghorbani-Shahna F, Bahrami A, *et al* (2017): Effect of TiO₂/GAC and water vapor on chloroform decomposition in a hybrid plasma-catalytic system. Environ Technol. **18**:1-10

Akagi J, Baba H (2018): Hydrogen gas restores exhausted CD8+ T cells in patients with advanced colorectal cancer to improve prognosis. Oncol Rep, **41** (1): 301-311.

Amitani H, Asakawa A, Cheng K, *et al* (2013): Hydrogen improves glycemic control in type 1 diabetic animal model by promoting glucose upatake into skeletal muscle. PLoS One, **8**: e53913.

Aoki K, Nakao A, Adachi T, *et al* (2012): Pilot study: Effects of drinking hydrogen-rich water on muscle fatigue caused by acute exercise in elite athletes. Med Gas Res, **2**: 12.

Ara J, Fadriquela A, Ahmed MF, *et al* (2018): Hydrogen water drinking exerts antifatigue effects in chronic forced swimming mice via antioxidative and anti-inflammatory activities. Biomed Res Int. Article ID: 2571269.

Asada R, Saitoh Y, Miwa N (2019): Effects of hydrogen-rich water bath on visceral fat and skin blotch, with boiling-resistant hydrogen bubbles. Med Gas Res, **9**: 68-73.

Asanuma H and Kitakaze M. (2017): Translational Study of Hydrogen Gas Inhalation as Adjuncts to Reperfusion Therapy for Acute Myocardial Infarction. Circ J., **81**(7):936-937

Azuma T, Yamane M, Ekuni D, *et al* (2015): Drinking hydrogen-rich water has additive effects on non-surgical periodontal treatment of improving periodontitis: A pilot study. Antioxidants, **4**: 513-522.

Bai X, Liu S, Yuan L, *et al* (2016): Hydrogen-rich saline mediates neuroprotection through the regulation of endoplasmic reticulum stress and autophagy under hypoxia-ischemia neonatal brain injury in mice. Brain Res, **1646**: 410-417.

Bai G, Li H, Ge Y, *et al* (2018): Influence of hydrogen-rich saline on hepatocyte autophagy during laparoscopic liver ischemia-reperfusion combined resection injury in miniature pigs. J Vet Res, **62**: 395-403.

Botek M, Krejci J, McKune AJ, *et al* (2019): Hydrogen rich water improved ventilatory, perceptual and lactate responses to exercise. Int J Sports Med, 2019 Oct 1. doi: 10. 1055/a-0991-0268. [Epub ahead of print].

Botek M, Krejci, McKune AJ, *et al* (2020): Hydrogen-rich water supplementation and up-hill running performance: Effect of athlete performance level. Int J Sports Physiol Perform. 2020 Feb 10:1-4. doi: 10.1123/ijspp.2019-0507. Online ahead of print.

Buchholz BM, Kaczorowski DJ, Sugimoto R, *et al* (2008): Hydrogen inhalation ameliorates oxidative stress in transplantation induced intestinal graft injury. Am J Transplant, **8**: 1-10.

Buchholz BM, Masutani K, Kawamura T, *et al* (2011): Hydrogen-enriched preservation protects the isogeneic intestinal graft and amends recipient gastric function during transplantation. Transplant, **92**: 985-992.

Cai J, Kang Z, Liu WW, *et al* (2008): Hydrogen therapy reduced apoptosis in neonatal hypoxia-ischemia rat model. Neurosci Lett, **441**: 167-172.

Cai J, Kang Z, Liu K, *et al* (2009): Neuroprotective effects of hydrogen saline in neonatal hypoxia-ischemia rat model. Brain Res, **1256**: 129-137.

Cai WW, Zhang MH, Yu YS, *et al* (2013): Treatment with hydrogen molecule alleviates TNFα-indiced cell injury in osteoblast. Mol Cell Biochem, **373**: 1-9.

Cardinal JS, Zhan J, Wang Y, *et al* (2010): Oral hydrogen water prevents chronic allograft nephropathy in rats. Kidney Int, **77**: 101-109.

Cejka C, Kossl J, Hermankova B, *et al* (2017a): Molecular hydrogen effectively heals alkali-induced cornea via suppression of oxidative stress. Oxi Med Cell Longev, Article ID 8906027.

Cejka C, Kossl J, Hermankova B, *et al* (2017b): Therapeutic effect of molecular hydrogen in corneal UVB-induced oxidative stress and corneal photodamage. Sci Rep., **7**:18017.

Choi KS, Kim HJ, Do SH, *et al* (2018): Neuroprotective effects of hydrogen inhalation in an experimental rat intracerebral hemorrhage model. Brain Res Bull, **142**: 122-128.

Chen C, Chen Q, Mao Y, *et al* (2010a): Hydrogen-rich saline protects against spinal cord injury in rats. Neurochem Res. **35**: 1111-

1118.

Chen CH, Manaenko A, Zhan Y, *et al* (2010b): Hydrogen gas reduced acute hyperglycemia-enhanced hemorrhagic transformation in a focal ischemia rat model. Neuroscience. **169**: 402-414.

Chen F, Xiong J, Guo W, *et al* (2013): Suppression of experimental abdominal aortic aneurysm by saturated hydrogen saline: a preliminary study with rats. Zhonghua Wai Ke Za Zhi, **51**: 437-441. (in Chinese).

Chen F, Zhang T, Xiong J, *et al* (2014): Suppression of abdominal aortic aneurysm by hydrogen through chemokine-like factor1. Zhonghua Yi Xue Za Zhi, **94**: 59-61. (in Chinese).

Chen G, Chen B, Dai C, *et al* (2017): Hydrogen inhalation is superior to mild hypothermia for improving neurological outcome and survival in a cardiac arrest model of spontaneously hypertensive rat. Shock 2017 Dec 26. doi: 10.1097/SHK. 0000000000001092. [Epub ahead of print].

Chen G, Li J, Wang J, *et al* (2019): Inhaling hydrogen ameliorates early postresuscitation EEG characteristics in an asphyxial cardiac arrest rat model. Biomed Res Int. Article ID 6410159.

Chen H, Sun YP, Li Y, *et al* (2010c): Hydrogen-rich saline ameliorates the severity of l-arginine-induced acute pancreatitis in rats. Biochem Biophys Res Commun. **393**: 308-313.

Chen H, Sun YP, Hu PF, *et al* (2011): The effects of hydrogen-rich saline on the contractile and structural changes of intestine induced by ischemia-reperfusion in rats. J Surg Res, **167**: 316-322.

Chen H, Zhou C, Xie K, *et al* (2019): Hydrogen-rich saline alleviated the hyperpathia and microglia activation via autophagy mediated inflammasome inactivation in neuropathic pain rats. Neuroscience, **421**: 17-30.

Chen HG, Xie KL, Han HZ, *et al* (2013): Heme oxygenase-1 mediates the anti-inflammatory effect of molecular hydrogen in LPS-stimulated RAW 264.7 macrophages. Int J Surg. **11**:1060-1066.

Chen J, Zhang H, Hu J, *et al* (2017): Hydrogen-Rich Saline Alleviates Kidney Fibrosis Following AKI and Retains Klotho Expression. Front Pharmacol., **8**:499.

Chen JB, Kong XF, Lv YY, *et al* (2019): "Real world survey" of hydrogen-controlled cancer: a follow-up report of 82 advanced cancer patients. Med Gas Res, **9** (3): 115-121.

Chen J, Mu F, Lu T, *et al* (2019): Brain metastases completely disappear in non-small cell lung cancer using hydrogen gas inhalation: A case report. Onco Target Ther. **12**: 11145-11151.

Chen K, Wang N, Diao Y, *et al* (2017): Hydrogen-Rich Saline Attenuates Brain Injury Induced by Cardiopulmonary Bypass and Inhibits Microvascular Endothelial Cell Apoptosis Via the PI3K/Akt/GSK3β Signaling Pathway in Rats. Cell Physiol Biochem. **43**(4):1634-1647.

Chen K, Sun Y, Diao Y, et al (2018): Hydrogen-rich solution attenuates myocardial injury caused by cardiopulmonary bypass in rats via the Janus-activated kinase 2/signal transducer and activator of transcription 3 signaling pathway. Oncol Lett, **16**: 167-178.

Chen L, Yu N, Lu Y, *et al* (2014): Hydrogen-saturated saline protects intensive narrow band noise-induced hearing loss in guinea pigs through an antioxidant effect. PLoS One. **9** (6):e100774.

Chen L, Chao Y, Cheng P, *et al* (2019): UPLC-QTOF/MS-based metabolomics reveals the protective mechanism of hydrogen on mice with ischemic stroke. Neurochem Res, **44**: 1950-1963.

Chen Q, Chen P, Zhou S, *et al* (2013): Hydrogen-rich saline attenuated neuropathic pain by reducing oxidative stress. Can J Neurol Sci **40**: 857-863.

Chen S, Jiang W (2015): Effect of hydrogen injected subcutaneously on testicular tissues of rats exposed to cigarette smoke. Int J Clin Exp Med. **8**: 5565-5570.

Chen T, Tao Y, Yan W, *et al* (2016): Protective effects of hydrogen-rich saline against N-methyl-N-nitrosourea-induced photoreceptor degeneration. Exp Eye Res, **148**: 65-73.

Chen JB, Pan ZB, Du DM, *et al* (2019a): Hydrogen gas therapy shrinkage of metastatic gallbladder cancer: A case report. World J Clin Cases. **7**: 2065-2074.

Chen J, Mu F, Lu T, *et al* (2019b): A gallbladder carcinoma patient with pseudo-progressive remission after hydrogen inhalation. Onco Targets Ther, **12**: 8645-8651.

Chen JB, Kong XF, Mu F, *et al* (2020): Hydrogen therapy can be used to control tumor progression and alleviate the adverse events of medications in patients with advanced non-small cell lung cancer. Med Gas Res, **10**: 75-80.

Chen X, Liu Q, Wang D, et al (2015): Protective effects of hydrogen-rich saline on rats with smoke inhalation injury. Oxid Med Cell Longev. 2015:106836. doi: 10.1155/2015/106836. Epub 2015 May 21.

Chen X, Cui J, Zhai X, *et al* (2018): Inhalation of hydrogen of different concentrations ameliorates spinal cord injury in mice by protecting spinal cord neurons from apoptosis, oxidative injury and mitochondrial structure damages. Cell Physiol Biochem. **47**: 176-190.

Chen Y, Jiang J, Miao H, *et al* (2013): Hydrogen-rich saline attenuates vascular smooth muscle cell proliferation and neointimal hyperplasia by inhibiting reactive oxygen species production and inactivating the Ras-ERK1/2-MEK1/2 and Akt pathways. Int J Mol Med, **31**: 597-606.

Chen Y, Chen H, Xie K, *et al* (2015): H2 Treatment attenuated pain behavior and cytokine release through the HO-1/CO pathway in a rat model of neuropathic pain. Inflammation. **38**:1835-1846.

Chen Y, Zong C, Jia J, *et al* (2020): A study on the protective effect of molecular hydrogen on osteoradionecrosis of the jaw in rats. Int J Oral Maxillofac Surg, 2020 May 22; S0901-5027 (20) 30156-9. doi: 10. 1016/j. ijom. 2020.04.011. Online ahead of print.

Cheng S, Peng L, Xu B, *et al* (2020): Protective effects of hydrogen-rich water against cartilage damage in a rat model of osteoarthritis by inhibiting oxidative stress, matrix catabolism, and apoptosis. Med Sci Monit. 2020 Jan 12;26: e920211.

Chi J, Li Z, Hong X, *et al* (2018): Inhalation of hydrogen attenuates progression of chronic heart failure via suppression of oxidative stress and P53 related to apoptosis pathway in rats. Front Physiol, **9**: 1026.

Chu YY, Hua N, Ru YS, *et al* (2017): The protection of hydrogen-rich saline on a rat dry eye model induced by scopolamine hydrobromide. Zhonghua Yan Ke Za Zhi, **53**: 363-372. (in Chinese).

Chuai Y, Zhao L, Ni J, *et al* (2011): A possible prevention strategy of radiation pneumonitis: combine radiotherapy with aerosol inhalation of hydrogen-rich solution. Med Sci Monit, **17**: 1-4.

Chuai Y, Gao F, Li B, *et al* (2012a): Hydrogen-rich saline attenuates radiation-induced male germ cell loss in mice through reducing hydroxyl radicals. Biochem J, **442**: 49-56.

Cauai Y, Shen J, Qian L, *et al* (2012b): Hydrogen-rich saline protects spermatogenesis and hematopoiesis in irradiated BALB/c mice. Med Sci Monit, **18**: BR89-94.

Cole AR, Perry DA, Raza A, *et al* (2019): Perioperatively inhaled hydrogen gas diminishes neurologic injury following experimental circulatory arrest in swine. JACC Basic Transl Sci, **4**: 176-187.

Cui J, Chen X, Zhai X, *et al* (2016): Inhalation of water electrolysis-derived hydrogen ameliorates cerebral ischemia-perfusion injury in rats – A possible new hydrogen resource for clinical use. Neuroscience, **335**: 232-241.

Cui Y, Zhang H, Ji M, *et al* (2014): Hydrogen-rich saline attenuates neuronal ischemia-reperfusion injury by protecting mitochondrial function in rats. J Sur Res, 2014 May 24. pii: S0022-4804(14)00529-0. doi: 10. 1016/j. jss. 2014. 05. 060. [Epub ahead of print].

DA Ponte A, Giovanelli N, Nigris D, *et al* (2017): Effects of hydrogen rich water on prolonged intermittent exercise. J Sports Med Phys

Fitness. 2017 Apr 26. doi: 10. 23736/S0022-4707. 17. 06883-9. [Epub ahead of print].

Diao M, Zhang S, Wu L, *et al* (2016): Hydrogen gas inhalation attenuates seawater instillation-induced acute lung injury via the Nrf2 pathway in rabbits. Inflammation 2016 Sep 5 [Epub ahead of print].

Dobashi S, Takeuchi K, Koyama K (2020): Hydrogen-rich water suppresses the reduction in blood total antioxidant capacity induced by 3 consecutive days of severe exercise in physically active male. Med Gas Res. 2020 Jan-Mar;10(1):21-26. doi: 10.4103/2045-9912.279979.

Dohi K, Kraemer BC, Erikson MA, *et al* (2014): Molecular hydrogen in drinking water protects against neurodegenerative changes induced by traumatic brain injury. PLoS ONE, **9**: e108034.

Dole M, Wilson FR, and Fife WP (1975): Hyperbaric hydrogen therapy: A possible treatment for cancer. Science, **190**: 152-154.

Domoki F, Oláh O, Zimmermann A, *et al* (2010): Hydrogen is neuroprotective and preserves cerebrovascular reactivity in asphyxiated newborn pigs. Pediatr Res. **68**: 387-392.

Dong A, Yu Y, Wang Y, *et al* (2018): Protective effects of hydrogen gas against sepsis-induced acute lung injury via regulation of mitochondrial function and dynamics. Int Immunopharmacol, **65**: 366-372.

Dong WW, Zhang YQ, Zhu XY, *et al* (2017): Protective effects of hydrogen-rich saline against lipopolysaccharide-induced alveolar epithelial-to-mesenchymal transition and pulmonary fibrosis. Med Sci Monit, **23**: 2357-2364.

Dong XH, Liu H, Zhang MZ, *et al* (2019): Postconditioning with inhaled hydrogen attenuates skin ischemia/reperfusion injury through the RIP-MLKL-PGAM5/Drip necrotic pathway. Am J Transl Res, **11**: 499-508.

Du H, Sheng M, Wu L, *et al* (2016): Hydrogen-rich saline attenuates acute kidney injury after liver transplantation via activating p53-mediated autophagy. Transplantation, **100**: 563-570.

Du Z, Jia H, Liu J, *et al* (2014a): Effects of three hydrogen-rich liquids on hemorrhagic shock in rats. J Surg Res, 2014 Jul 3. pii: S0022-4804(14)00629-5. doi: 10. 1016/j. jss. 2014. 06. 051. [Epub ahead of print].

Du Z, Jia H, Liu J, *et al* (2014b): Protective effects of hydrogen-rich saline in uncontrolled hemorrhage shock. Exp Therap Med, **7**: 1253-1258.

Du Z, Liu J, Jia H, *et al* (2015): Three hydrogen-rich solutions protect against intestinal injury in uncontrolled hemorrhagic shock. Int J Clin Exp Med, **8**: 7620-7626.

Eckermann JM, Chen W, Jadhav V, *et al* (2011): Hydrogen is neuroprotective against surgically induced brain injury. Med gas Res, **1**:7.

Ekuni D, Tomofuji T, Endo Y, *et al* (2012): Hydrogen-rich water prevents lipid deposition in the descending aorta in a rat periodontitis model. Arch Oral Biol. May 16. [Epub ahead of print].

Eryilmaz S, Turkyilmaz Z, Karabulut R, *et al* (2019): The effects of hydrogen-rich saline solution on intestinal anastomosis performed after intestinal ischemia reperfusion injury. J Pediatr Surg, 2019 Aug 13. pii; S0022-3468 (19) 30506-8.

Fan M, Xu X, He X, *et al* (2012): Protective effects of hydrogen-rich saline against erectile dysfunction in a streptzotocin-induced diabetic rat model. J Urol, Dec 4. pii: S0022-5347(12)05812-0. doi: 10.1016/j.juro.2012.12.001. [Epub ahead of print].

Fan Z, Gao Y, Huang Z, *et al* (2018): Protective effect of hydrogen-rich saline on pressure overload-induced cardiac hypertrophy in rats: possible role of JAK-STAT signaling. BMC Cardiovasc Disord. **18**: 32. doi: 10. 1186/s12872-018-0073-9.

Fang S, Li X, Wei X, *et al* (2018): Beneficial effects of hydrogen gas inhalation on a murine model of allergic rhinitis. Exp Thera Med, **16**: 5178-5184.

Fang Y, Fu XJ, Gu C, *et al* (2011): Hydrogen-rich saline protects against acute lung injury induced by extensive burn in rat model. J Burn Care Res. **32**: e82-91.

Fang W, Wang G, Tang L, *et al* (2018): Hydrogen gas inhalation protects against cutaneous ischaemia/reperfusion injury in a model of pressure. J Cell Mol Med, **22**: 4243-4252.

Feng M, Wang XH, Yang XB, *et al* (2012): Protective effect of saturated hydrogen saline against blue light-induced retinal damage in rats. Int J Ophthalmol, **5**: 151-157.

Feng S, Duan E, Shi X, *et al* (2019): Hydrogen ameliorates lung injury in a rat model of subacute exposure to concentrated ambient PM2.5 via Aryl hydrocarbon receptor. Int Immunopharmacol, 2019 Nov 9: 105939. doi. 10. 1016/intimp 2019. 105939. [Epub ahead of print].

Feng R, Cai M, Wang X, *et al* (2018): Early aerobic exercise combined with hydrogen-rich saline as preconditioning protects myocardial

injury induced by acute myocardial infarction in rats. Appl Biochem Biotechnol, 2018 Jul 23. doi: 10. 1007/s12010-018-2841-0. [Epub ahead of print].

Feng Y, Wang R, Xu J, *et al* (2012): Hydrogen-rich saline prevents early neurovascular dysfunction resulting from inhibition of oxidative stress in STZ-diabetic rats. Curr Eye Res, 2012 Dec 19. [Epub ahead of print].

Franceschelli S, Gatta DMP, Pesce M, *et al* (2018): Modulation of the oxidative plasmatic state in gastroesophageal reflux disease with the addition of rich water molecular hydrogen: A new biological vision. J Cell Mol Med. 2018 Mar 7. doi: 10.1111/jcmm. 13569. [Epub ahead of print].

Fransson AE, Kisiel M, Pirttilä K, *et al* (2017): Hydrogen Inhalation Protects against Ototoxicity Induced by Intravenous Cisplatin in the Guinea Pig. Front Cell Neurosci., **11**:280.

Fu J, Lan Q, Wang D, *et al* (2018): Effect of hydrogen-rich water on the chondriosome damage and cytokines in brain tissue of rats with traumatic brain injury. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue, **30**: 317-321. (Chinese).

Fu Y, Ito M, Fujita Y, *et al* (2009): Molecular hydrogen is protective against 6-hydroxydopamine-induced nigrostriatal degeneration in a rat model of Parkinson's disease. Neurosci Lett, **453**: 81-85.

Fu Z, Zhang Z, Wu X, *et al* (2020): Hydrogen-rich saline inhibits lipopolysaccharide-induced acute lung injury and endothelial disfunction by regulating autophagy through mTOR/TFEB signaling pathway. Biomed Res Int. 2020 Jan 30; 2020: 9121894. doi: 10.1155/2020/9121894. eCollection 2020.

Fujii Y, Shirai M, Inamori S, *et al* (2013): Insufflation of hydrogen gas restrains the inflammatory response of cardiopulmonary bypass in a rat model. Artif Organs, **37**: 136-141.

Fujita K, Seike T, Yutsudo N, *et al* (2009): Hydrogen in drinking water reduces dopaminergic neuronal loss in the 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine mouse model of Parkinson's disease. PLoS One, **4**: e7247.

Fujita R, Tanaka Y, Saihara Y, *et al* (2011): Effect of molecular hydrogen saturated alkaline electrolyzed water on disuse muscle atrophy in gastrocnemius muscle. J Physiol Anthropol, **30**: 195-201.

Fukuda K, Asoh S, Ishikawa M, *et al* (2007): Inhalation of hydrogen gas suppresses hepatic injury caused by ischemia/reperfusion through reducing oxidative stress. Biochem Biophys Res Commun, **361**: 670-674.

Gao L, Jiang D, Geng J, *et al* (2019): Hydrogen inhalation attenuated bleomycin-induced pulmonary fibrosis by inhibiting TGF-β1 and relevant oxidative stress and EMT. Exp Physiol. 2019 Sep 18. doi: 10. 1113/EPO88028. [Epub ahead of print].

Gao Q, Song H, Wang XT, *et al* (2017): Molecular hydrogen increases resilience to stress in mice. Sci Rep., **7**(1):9625.

Gao Y, Yang H, Fan Y, *et al* (2016): Hydrogen-rich saline attenuates cardiac and hepatic injury in doxorubicin rat model by inhibiting inflammation and apoptosis. Mediators Inflamm, 2016; 2016: 1320365. doi: 10. 1155/2016/1320365. [Epub ahead of print].

Gao Y, Yang H, Chi J, *et al* (2017): Hydrogen Gas Attenuates Myocardial Ischemia Reperfusion Injury Independent of Postconditioning in Rats by Attenuating Endoplasmic Reticulum Stress-Induced Autophagy. Cell Physiol Biochem., **43**(4):1503-1514.

Gao Y, Gui Q, Jin L, *et al* (2017): Hydrogen-rich saline attenuates hippocampus endoplasmic reticulum stress after cardiac arrest in rats. Neurosci Lett, **640**: 29-36.

Gharib B, Hanna S, Abdallahi OMS, *et al* (2001): Anti-inflammatory properties of molecular hydrogen: investigation on parasite-induced liver inflammation. C R Acad Sci III,.**324**: 719-724.

Ge L, Wei LH, Du CQ, *et al* (2017): Hydrogen-rich saline attenuates spinal cord hemisection-induced testicular injury in rats. Oncotarget. 2017 Mar 3, doi: 10. 18632/oncotarget. 15876. [Epub ahead of print].

Ge P, Zhao J, Li S, *et al* (2012): Inhalation of hydrogen gas attenuates cognitive impairment in transient cerebral ischemia via inhibition of oxidative stress. Neurol Res. **34**: 187-194.

Ge Y, Wu F, Sun X, *et al* (2014): Intrathecal infusion of hydrogen-rich normal saline attenuates neuropathic pain via inhibition of activation of spinal astrocytes and microglia in rats. PLoS ONE, **9**: e109482.

Ge YS, Zhang QZ, Li H, *et al* (2019): Hydrogen-rich saline protects against hepatic injury induced by ischemia-reperfusion and laparoscopic hepatectomy in swine. Hepatobiliary Pancreat Dis Int, **18**: 48-61.

Gokalp N, Basaklar AC, Sonmez K, *et al* (2016): Protective effect of hydrogen rich saline solution on experimental ovarian ischemia reperfusion model in rats. J Pediatr Surg, 2016 Oct 21. pii; S0022-3468(16)30467-5. doi: 10. 1016/j.jpedsurg. 2016.10.006. [Epub ahead of print].

Gong ZJ, Guan JT, Ren XZ, *et al* (2016): Protective effect of hydrogen on the lung of sanitation workers exposed to haze. Zhonghua Jie

He He Hu Xi Za Zhi, **39**: 916-923. (in Chinese).

Gu H, Yang M, Zhao X, *et al* (2014): Pretreatment with hydrogen-rich saline reduces the damage caused by glycerol-induced rhabdomyolysis and acute kidney injury in rats. J Surg Res, **188**: 243-249.

Gu Y, Huang CS, Inoue T, *et al* (2010): Drinking hydrogen water ameliorated cognitive impairment in senescence-accelerated mice. J Clin Biochem Nutri, **46**: 269-276.

Guan P, Lin XM, Yang SC, *et al* (2018): Hydrogen gas reduces chronic intermittent hypoxia-induced hypertension by inhibiting sympathetic nerve activity and increasing vasodilator responses via the antioxidation. J Cell Biochem, 2018 Sep 27. doi: 10. 1002/jcb. 27684. [Epub ahead of print].

Guo J, Dong W, Jin L, *et al* (2017): Hydrogen-rich saline prevents bone loss in diabetic rats induced by streptozotocin. Int Orthop. **41**(10):2119-2128.

Guo JD, Li L, Shi YM, *et al* (2012): Hydrogen water consumption prevents osteopenia in ovariectomized rats. Br J Pharmacol, 2012 Nov 2. doi: 10. 1111/bph. 12036. [Epub ahead of print].

Guo Q, Yin X, Giao M, *et al* (2018): Hydrogen-rich water ameliorates autistic-like behavioral abnormalities in valproic acid-treated adolescent mice offspring. Front Behav Neurosci, **12**: 170.

Guo SX, Jin YY, Fang Q, *et al* (2015): Beneficial effects of hydrogen-rich saline on early burn-wound progression in rats. PLoS One. **10** (4): e0124897.

Guo SX, Fang Q, You CG, *et al* (2015): Effects of hydrogen-rich saline on early acute kidney injury in severely burned rats by suppressing oxidative stress induced apoptosis and inflammation. J Transl Med, **13**: 183.

Guo Z, Zhou B, Li W, *et al* (2012): Hydrogen-rich saline protects against ultraviolet B radiation injury in rats. J Biomed Res, **26**: 365-371.

Gvozdjakova A, Kucharska J, Kura B, *et al* (2019): A new insight into molecular hydrogen effect on coenzyme Q and mitochondrial function of rats. Can J Physiol Pharmacol, 2019 Sep 19. doi: 10. 1139/cjpp-2019-0281. [Epub ahead of print].

Haam S, Lee S, Paik HC, *et al* (2015): The effects of hydrogen gas inhalation during ex vivo lung perfusion on donor lungs obtained after cardiac death. Eur J Cardiothorac Surg. 2015 Mar 6. pii: ezv057. [Epub ahead of print]

Haam S, Lee JG, Paik HC, *et al* (2018): Hydrogen gas inhalation during ex vivo lung perfusion of donor lungs recovered after cardiac death. J Heart Lung transplant, 2018 Jun 21, pii; S1053-2498(18)31508-0. doi: 10. 1016/jhealun. 2018. 06. 007. [Epub ahead of print].

Hamasaki T, Harada G, Nakamichi N, *et al* (2017): Electrochemically reduced water exerts superior reactive oxygen species scavenging activity in HT1080 cells than the equivalent level of hydrogen-dissolved water. PLoS One, doi: 10, 1371/journal. Pone, 0171192.

Han AL, Park SH, Park MS (2016): Hydrogen treatment protects against cell death and senescence induced by oxidative damage. J Microbiol Biotechnol, 2016 Oct 25. doi: 10.4014/jmb.1608.08011. [Epub ahead of print] .

Han AL, Park SH, and Park MS (2017): Hydrogen treatment protects against cell death and senescence induced by oxidative damage.

J Microbiol Biotechnol, **27**: 365-371.

Han B, Zhou H, Jia G, et al (2016): MAPKs and Hsc 70 are critical to the protective effect of molecular hydrogen during the early phase of acute pancreatitis. FEBS J, **283**: 738-756.

Han L, Tian R, Yan H, *et al* (2015): Hydrogen-rich water protects against ischemic brain injury in rats by regulating calcium buffering proteins. Brain Res. 2015 Apr 25. pii: S0006-8993(15)00334-0. doi: 10.1016/j.brainres.2015.04.038. [Epub ahead of print]

Hanaoka T, Kamimura N, Yokota T, *et al* (2011): Molecular hydrogen protects chondrocytes from oxidative stress and indirectly alters gene expression through reducing peroxynitrite derived from nitric oxide. Med Gas Res, **1**:18.

Hara F, Tatebe J, Watanabe I, *et al* (2016): Molecular hydrogen alleviates cellular senescence in endothelial cells. Cric J, **80**: 2037-2046.

Hasegawa S, Ito M, Fukami M, *et al* (2016): Molecular hydrogen alleviates motor deficits and muscle degeneration in mdx mice. Redox Rep, **15**: 1-9.

Hashimoto M, Katakura M, Nabika T, *et al* (2011): Effects of hydrogen-rich water on abnormalities in a SHR.Cg-Lepr^{CP}/NDmcr rat – a metabolic syndrome rat model. Med Gas Res, **1**: 26.

Hattori Y, Kotani T, Tsuda H, *et al* (2015): Maternal molecular hydrogen attenuates lipopolysaccharide-induced rat fetal lung injury. Free Radic Res, 2015 May 7: 1-12. [Epub ahead of print]

Hayashida K, Sano M, Ohsawa I, *et al* (2008): Inhalation of hydrogen gas reduces infarct size in the rat model of myocardial ischemia-

reperfusion injury. Biochem Biophys Res Commun, **373**: 30-35.

Hayashida K, Sano M, Kamimura N, *et al* (2012): H2 gas improves functional outcome after cardiac arrest to an extent comparable to therapeutic hypothermia in a rat model. J Am Heart Assoc. 2012; 1: e003459 doi: 10.1161/JAHA.112.003459.

Hayashida K, Sano M, Kamimura N, *et al* (2014): Hydrogen inhalation during normoxic resuscitation improves neurological outcome in a rat model of cardiac arrest, independent of targeted temperature management. Circulation, 2014 Nov 3. pii: CIRCULATIONAHA. 114. 011848. [Epub ahead of print].

Hayashi T, Yoshioka T, Hasegawa K, *et al* (2011): Inhalation of hydrogen gas attenuates left ventricular remodeling induced by intermittent hypoxia in mice. Am J Physiol Heart Circ Physiol. **301**: H1062-1069.

He B, Zhang Y, Kang B, *et al* (2013): Protection of oral hydrogen water as an antioxidant on pulmonary hypertension. Mol Biol Rep, **40**: 5513-5221.

He J, Xiong S, Zhang J, *et al* (2013): Protective effects of hydrogen-rich saline on ulcerative rat model. J Surg Res. 2013 Jun 5. pii: S0022-4804(13)00495-2. doi: 10. 1016/j.jss.2013.05.047. [Epub ahead of print].

He X, Wang SY, Yin CH, *et al* (2016): Hydrogen-rich water exerting a protective effect on ovarian reserve function in a mouse model of immune premature ovarian failure induced by zona pellucida 3. Chin Med J (Engl); **129**: 2331-2337.

He Y, Shi JZ, Zhang RJ, *et al* (2016): Effects of hydrogen gas inhalation on endometriosis in rats. Reprod Sci, 2016 Jun 23. pii: 1933719116655622. [Epub ahead of print].

Hirayama M, Ito M, Minato T, *et al* (2018): Inhalation of hydrogen gas elevates urinary 8-hydroxy-2'-deoxyguanine in Parkinson's disease. Med Gas Res, **8**: 144-149.

Higashimura Y, Baba Y, Inoue R, *et al* (2018): Effects of molecular hydrogen-dissolved alkaline electrolyzed water on intestinal environment in mice. Med Gas Res. 2018, Jan-Mar. **8**: 6-11.

Hong Y, Guo S, Chen S, *et al* (2012): Beneficial effect of hydrogen-rich saline on cerebral vasospasm after experimental subarachnoid hemorrhage in rats. J Neurosci Res. **90**: 1670-1680.

Hong Y, Shao A, Wang J, *et al* (2014): Neuroprotective effect of hydrogen-rich saline against neurologic damage and apoptosis in early brain injury following subarachnoid hemorrhage: Possible role of the Akt/GSK3β signaling pathway. PLoS ONE, **9**: e96212. doi. 10. 1371.

Hong Y, Sun L, Sun R, *et al* (2016): Combination therapy of molecular hydrogen and hyperoxia improves survival rate and organ damage in a zymosan-induced generalized inflammation model. Exp Ther Med, **11**: 2590-2596.

Hong Y, Chen H, Yu Y, *et al* (2017): Effect of combination therapy with propofol and hydrogen-rich saline on organ damage and cytokines in a murine model of sepsis. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue, **29**: 316-320. (in Chinese).

Homma K, Yoshida T, Yamashita M, *et al* (2015): Inhalation of hydrogen gas is beneficial for preventing contrast-induced acute kidney injury in rats. Nephron Exp Nephrol. 2015 Jan 9. [Epub ahead of print].

Hou C, Peng Y, Qin C, *et al* (2018): Hydrogen-rich water improves cognitive impairment gender-dependently in APP/PS1 mice without affecting Aβ clearance. Free Radic Res, **23**: 1-12.

Hou Z, Luo W, Sun X, *et al* (2012): Hydrogen-rich saline protects against oxidative damage and cognitive deficits after mild traumatic brain injury. Brain Res Bull, **88**: 560-565.

Htun Y, Nakamura S, Nakao Y, *et al* (2019): Hydrogen ventilation combined with mild hypothermia improves short-term neurological outcomes in a 5-day neonatal hypoxia-ischemia piglet model. Sci Rep, **9**: 4088.

Hu Z, Wu B, Meng F, *et al* (2017): Impact of molecular hydrogen treatments on the innate immune activity and survival of zebrafish (Danio rerio) challenged with Aeromonas hydrophila. Fish Shellfish Immunol., **67**:554-560.

Huang CS, Kawamura T, Lee S, *et al* (2010): Hydrogen inhalation ameliorates ventilator-induced lung injury. Crit Care **14**: R234.

Huang CS, kawamura T, Peng X, *et al* (2011a): Hydrogen inhalation reduced epithelial apoptosis in ventilator-induced lung injury via a mechanism involving nuclear factor-kappa B activation. Biochem Biophys Res Commun, **408**: 253-258.

Huang G, Zhou J, Zhan W, *et al* (2013): The neuroprotective effects of intraperitoneal injection of hydrogen in rabbits with cardiac arrest. Resuscitation **84**: 690-695.

Huang JL, Liu WW, and Sun XJ (2018): Hydrogen inhalation improves mouse neurological outcomes after cerebral ischemia/reperfusion independent of anti-necroptosis. Med Gas Res. **8**: 1-5.

Huang JL, Liu WW, Manaenko A, *et al* (2019): Hydrogen inhibits microglial activation and regulates microglial phenotype in a mouse middle cerebral artery occlusion model. Med Gas Res, **9** (3): 127-132.

Huang L, Zhao S, Zhang JH, *et al* (2012): Hydrogen saline treatment attenuates hyperoxia-induced retinopathy by inhibition of oxidative stress and reduction of VEGF expression. Ophthalmic Res, **47**: 122-127.

Huang L, Richard L, Applegate II, *et al* (2018): Inhalation of high concentration hydrogen gas improves short-term outcomes in a rat model of asphyxia induced-cardiac arrest. Med Gas Res, **8**: 73-78.

Huang L, Richard L, Applegate II, *et al* (2019): Inhalation of high-concentration hydrogen gas attenuates cognitive deficits in a rat model of asphyxia induced-cardiac arrest. Med Gas Res, **9**: 122-126.

Huang P, Wei S, Huang W, *et al* (2019): Hydrogen gas inhalation enhances alveolar macrophage phagocytosis in an ovalbumin-induced asthma model. Int Immunopharmacol, 2019 Sep. **74**: 105646.

Huang SL, Jiao J, Yan HW (2016): Hydrogen-rich saline attenuates steroid-associated femoral head necrosis through inhibition of oxidative stress in a rabbit model. Exp Ther Med, **11**: 177-182.

Huang T, Wang W, Tu C, *et al* (2015): Hydrogen-rich saline attenuates ischemia-reperfusion injury in skeletal muscle. J Surg Res. 194:471-80.

Huang Y, Xie K, Li J,*et al* (2011b): Beneficial effects of hydrogen gas against spinal cord ischemia-reperfusion injury in rabbits. Brain Res. **1378**: 125-136.

Hugyecz M, Mracsko E, Hertelendy P, *et al* (2011): Hydrogen supplemented air inhalation reduces changes of prooxidant enzyme and gap iunction protein levels after transient global cerebral ischemia in the rat hippocampus. Brain Res, **1404**: 31-38.

Huo TT, Zeng Y, Liu XN, *et al* (2014): Hydrogen-rich saline improves survival and neurological outcome after cardiac arrest and cardiopulmonary resuscitation in rats. Anesth Analg, **119**: 368-380.

Igarashi T, Ohsawa I, Kobayashi M, *et al* (2016): Hydrogen prevents corneal endothelial damage in phacoemulsification cataract surgery. Sci Rep, **6**: 31190.

Igarashi T, Ohsawa I, Kobayashi M, *et al* (2019): Effects of hydrogen in prevention of corneal endothelial damage during phacoemulsification: A prospective randomized clinical trial. Am J Ophthalmol, **207**: 10-17.

Ignacio RM, Yoon YS, Sajo MEJ, *et al* (2013a): The balneotherapy effect of hydrogen reduced water on UVB-mediated skin injury in hairless mice. Mol Cell Toxicol, **9**: 15-21.

Ignacio RM, Kwak HS, Yun YU, *et al* (2013b): The drinking effect of hydrogen water on atopic dermatitis induced by *Dermatophagoides farina* allergen in NC/Nga mice. Evid Based Complement Alternat Med, 2013, Article ID 538673, doi: 10.1155/2013/538673. Epub 2013 Nov 20.

Iio A, Ito M, Itoh T, *et al* (2013): Molecular hydrogen attenuates fatty acid uptake and lipid accumulation through downregulating CD36 expression in HepG2 cells. Med Gas Res, **3**: 6

Ikeda M, Shimizu K, Ogura H, *et al* (2017): Hydrogen-rich saline regulates intestinal barrier dysfunction, dysbiosis and bacterial translocation in a murine model of sepsis. Shock, 2017 Dec 29. doi: 10.1097/SHK.0000000000001098. [Epub ahead of print]

Iketani M, Ohshiro J, Urushibara T, *et al* (2016): Preadministration of hydrogen-rich water protect against lipopolysaccharide-induced sepsis and attenuates liver injury. Shock, 2016 Dec 1. [Epub ahead of print].

Iketani M, Sekimoto K, Igarashi T, *et al* (2018): Administration of hydrogen-rich water prevents vascular aging of the aorta in LDL receptor-deficient mice. Sci Rep, **8**: 16822.

Imai K, Kotani T, Tsuda H, *et al* (2016): Neuroprotective potential of molecular hydrogen against perinatal brain injury via suppression of activated microglia. Free Radic Bio Med, **91**: 154-163.

Ishibashi T, Sato B, Rikitake M, *et al* (2012): Consumption of water containing a high concentration of molecular hydrogen reduces oxidative stress and disease activity in patients with rheumatoid arthritis: an open-label pilot study. Med Gas Res, 2012, **2**: 27.

Ishibashi T, Sato B, Shibata S, *et al* (2014): Therapeutic efficacy of infused molecular hydrogen in saline on rheumatoid arthritis: A randomized, double-blind placebo-controlled pilot study. Int Immunopharmacol, **21**: 468-473.

Ishibashi T, Ichikawa M, Sato B, *et al* (2015): Improvement of psoriasis-associated arthritis and skin lesions by treatment with molecular hydrogen: A report of three cases. Mol Med Rep, 2015 Apr 30. doi: 10.3892/mmr.2015.3707.

Ishibashi T, Kawamoto K, Komori N, *et al* (2020): Molecular hydrogen suppresses superoxide generation in the mitochondrial complex I and reduces mitochondrial membrane potential. Biochem Biophys Res Commun, **522**: 965-970.

Ishibashi T, Kawamoto K, Matsuno K, *et al* (2020): Peripheral endothelial function can be improved by daily consumption of water containing over 7 ppm of dissolved hydrogen: A randomized controlled trial. PLoS ONE, **15**: e0233484.

Itoh T, Fujita Y, Itoh M, *et al* (2009): Molecular hydrogen suppresses FcepsilonRI-mediated signal transduction and prevents degranulation of mast cells. Biochem Biophys Res Commun, **389**: 651-656.

Itoh T, Hamada N, Terazawa R, *et al* (2011): Molecular hydrogen inhibits lipopolysaccharide/interferon γ-induced nitric oxide production through modulation of signal transduction in macrophages. Biochem Biophys Res Commun. **411**: 143-149.

Ito M, Ibi T, Sahashi K, *et al* (2011): Open-label trial and randomized, double-blind, placebo-controlled, crossover trial of hydrogen-enriched water for mitochondrial and inflammatory myopathies. Med Gas Res, **1**: 24.

Ito M, Hirayama M, Yamai K, *et al* (2012): Drinking hydrogen water and intermittent hydrogen gas exposure, but not lactulose or continuous hydrogen gas exposure, prevent 6-hydorxydopamine-induced Parkison's disease in rats. Med gas Res, **2**: 15.

Iuchi K, Nishimaki K, Kamimura N, *et al* (2019): Molecular hydrogen suppresses free radical-induced cell death by mitigating fatty acid peroxidation and mitochondrial dysfunction. Can J Physiol Pharmacol, 2019 Jul 11. doi: 10. 1139/cipp-2018-0741. [Epub ahead of print].

Jackson K, Dressler N, Ben-Shushan RS, *et al* (2018): Effects of alkaline-electrolyzed and hydrogen-rich water, in a high-fat-diet nonalcoholic fatty liver disease mouse model. World J Gastroenterol, **24**: 5095-5108.

Javorac D, Stajer V, Ratgeber L, *et al* (2019): Short-term H2 inhalation improves running performance and torso strength in healthy adults. Biol Sport, **36**: 333-339.

Javorac D, Stajer V, Ostojic S, Case report: Acute hydrotherapy with super-saturated hydrogen-rich water for ankle sprain in a professional athlete. F1000Res. 2020 Apr 8;9:245. doi: 10.12688/f1000research.22850.1. eCollection 2020.

Jesus AA, Passaglia P, Santos BM, et al (2020): Chronic molecular hydrogen inhalation mitigates short and long-term memory loss in polymicrobial sepsis. Brain Res, 2020 Jul 15; 1739. 146857. doi; 10. 1016/j. brainres. 2020. 146857. Epub 2020. Apr 27.

Jiang D, Wu D, Zhang Y, *et al* (2012a): Protective effects of hydrogen rich saline solution on experimental testicular ischemia-reperfusion injury in rats. J Urol. **187**: 2249-2253.

Jiang S, Fan Q, Xu M, *et al* (2020): Hydrogen-rich saline protects intestinal epithelial tight junction barrier in rats with intestinal ischemia-reperfusion injury by inhibiting endoplasmic reticulum stress-induced apoptosis pathway. J Pediatr Surg. 2020 Feb 22: S0022-3468(20)30153-6. doi: 10.1016/j.jpedsurg.2020.01.061. Online ahead of print.

Jiang H, Yu P, Qian DH, *et al* (2013): Hydrogen-rich medium suppresses the generation of reactive oxygen species, elevates the Bcl-2/Bax ratio and inhibits advanced glycation end product-induced apoptosis. Int J Mol Med, **31**: 1381-1387.

Jing L, Wang Y, Zhao XM, *et al* (2014): Cardioprotective Effect of Hydrogen-rich Saline on Isoproterenol-induced Myocardial Infarction in Rats. Heart Lung Circ. 2014 Dec 4. pii: S1443-9506(14)00800-2. doi: 10.1016/j.hlc.2014.11.018. [Epub ahead of print]

Jiang X, Niu X, Guo Q, *et al* (2018): FoxO1-mediated autophagy plays an important role in the neuroprotective effects of hydrogen in a rat model of vascular dementia. Behav Brain Res, 2018 Jun 7. pii: S0166-4328(18)30010-X. doi: 10. 1016/j.bbr. 2018.05.023 [Epub ahead of prints].

Jiang Z, Xu B, Yang M, *et al* (2012b): Protective by hydrogen against gamma ray-induced testicular damage in rats. Basic Clin Pharmacol Toxicol. 2012 Sep 23. doi:10.1111/bcpt. 12016. [Epub ahead of print]

Jiao Y, Yu Y, Li B, *et al* (2019): Protective effects of hydrogen-rich saline against experimental diabetic peripheral neuropathy via activation of the mitochondrial ATP-sensitive potassium channel channels in rats. Mol Med Rep. 2019 Nov 5. doi. 10. 3892/mmr. 2019. 10795. [Epub ahead of print].

Ji X, Liu W, Xie K, *et al* (2010): Beneficial effects of hydrogen gas in a rat model of traumatic brain injury via reducing oxidative stress. Brain Res. **1354**: 196-205.

Ji X, Hui K, Zhang L, *et al* (2011): The effect of hydrogen-rich saline on the brain of rats with transient ischemia. J Surgical Res, **168**: e95-e101.

Ji X, Tian Y, Xie K, *et al* (2012): Protective effects of hydrogen-rich saline in a rat model of traumatic brain injury via reducing oxidative stress. J Surg Res. 2012 Mar 22. [Epub ahead of print]

Jin L, Yu SQ, Zhang X, *et al* (2018): Clinical study of hydrogen-rich saline in the treatment of moderate to severe allergic rhinitis. Lin Chung Er Bi Yan Hou Tou Jing Wei Ke Za Zhi, **32**: 493-496. (Chinese).

Kagawa A, Katsura K, Mizumoto M, *et al* (2012): Influence of hydrogen discharged from palladium base hydrogen storage alloys on cancer cells. Materials Science Forum, **706-709**: 520-525.

Kajisa T, Yamaguchi T, Hu A, *et al* (2017): Hydrogen water ameliorates the severity of atopic dermatitis-like lesions and decreases interleukin-1β, interleukin-33, and mast cell infiltration in NC/Nga mice. Saudi Med J.; **38**(9): 928–933.

Kamimura N, Ichimiya H, Iuchi K, *et al* (2016): Molecular hydrogen stimulates the gene expression of transcriptional coactivator PGC-1α to enhance fatty acid metabolism. Aging Mechanisms Disease, **2**: 16008.

Kato R, Nomura A, Sakamoto A, *et al* (2014): Hydrogen gas attenuates embroyonic gene expression and prevents left ventricular remodeling induced by intermittent hypoxia in cardiomyopathic hamsters. Am J Physiol Heart Circ Physiol, 2014 Oct 3; ajheart. 00228. 2014. doi: 10. 1152/ajpheart. 00228. 2014. [Epub ahead of print].

Katsumata Y, Sano F, Abe T, *et al* (2017): The effects of hydrogen gas inhalation on adverse left ventricular remodeling after percutaneous coronary intervention for ST-elevated myocardial infraction. First pilot study in humans. Circ J, 2017. Mar 17. doi. 10. 1253/circj. CJ-17-0105. [Epub ahead of print].

Kikkawa YS, Nakagawa T, Taniguchi M, *et al* (2014): Hydrogen protects auditory hair cells from cisplatin-induced free radicals. Neurosci Lett, **579**: 125-129.

Kajiyama S, Hasegawa G, Asano M, *et al* (2008): Supplementation of hydrogen-rich water improves lipid and glucose metabolism in patients with type 2 diabetes or impaired glucose tolerance. Nutr Res, **28**: 137-143.

Kajiya M, Sato K, Silva MJ, *et al* (2009a): Hydrogen from intestinal bacteria is protective for Concanavalin A-induced hepatitis. Biochem Biophys Res Commun **386**: 316-321.

Kajiya M, Silva MJ, Sato K, *et al* (2009b): Hydrogen mediates suppression of colon inflammation induced by dextran sodium sulfate. Biochem Biophys Res Commun **386**: 11-15.

Kamimura N, Nishimaki K, Ohsawa I, *et al* (2011): Molecular hydrogen improves obesity and diabetes by inducing hepatic FGF21 and stimulating energy metabolism in db/db mice. Obesity (Silver Spring), **19**: 1396-1403.

Kang KM, Kang YN, Choi IB, *et al* (2011): Effects of drinking hydrogen-rich water on the quality of life of patients treated with radiotherapy for liver tumors. Med Gas Res, **1**: 11.

Kashiwagi T, Yan H, Hamasaki T, *et al* (2014): Electrochemically reduced water protects neural cells from oxidative damage. Oxid Med Cell Longev. 2014:869121. doi: 10.1155/2014/869121. Epub 2014 Oct 14.

Kasuyama K, Tomofuji T, Ekuni D, *et al* (2011): Hydrogen-rich water attenuates experimental periodontitis in a rat model. J Clin Periodontol. **38**: 1085-1090.

Katakura M, Hashimoto M, Tanabe Y, *et al* (2012): Hydrogen-rich water inhibits glucose and α,β-dicarbonyl compound-induced reactive oxygen species production in the SHR,Cg-Leprcp/NDmcr rat kidney. Med Gas Res, **2**: 18.

Kato R, Nomura A, Sakamoto A, *et al* (2014): Hydrogen gas attenuates embryonic gene expression and prevents left ventricular remodeling induced by intermittent hypoxia in cardiomyopathic hamsters. Am J Physiol Heart Circ Physiol. 307:H1626-1633.

Kato S, Saitoh Y, Iwai K, *et al* (2012a): Hydrogen-rich electrolyzed warm water represses wrinkle formation against UVA ray together with type-I collagen production and oxidative-stress diminishment in fibroblasts and cell-injury prevention in keratinocytes. J Photochem Photobiol B. **106**: 24-33.

Kato S, Hokama R, Okayasu H, *et al* (2012b): Colloidal platinum in hydrogen-rich water exhibits radical-scavenging activity and improves blood fluidity. J Nanosci Nanotechnol, **12**: 4019-4027.

Kawaguchi M, Satoh Y, Otsubo Y, *et al* (2014): Molecular hydrogen attenuates neuropathic pain in mice. PLoS ONE, **9**: e100352.

Kawai D, Takaki A, Nakatsuka A, *et al* (2012): Hydrogen-rich water prevents progression of non-alcoholic steatohepatitis and accompanying hepatocarcinogenesis in mice. Hepatology. Apr 13. [Epub ahead of print].

Kawamura T, Huang CS, Tochigi N, *et al* (2010): Inhaled hydrogen gas therapy for prevention of lung transplant-induced ischemia/reperfusion injury in rats. Transplantation, **90**: 1344-1351.

Kawamura T, Huang CS, Peng X, *et al* (2011): The effect of donor treatment with hydrogen on lung allograft function in rats. Surgery, **150**: 240-249.

Kawamura T, Wakabayashi N, Shigemura N, *et al* (2013): Hydrogen gas reduced hyperoxic lung injury via the Nrf2 pathway *in vivo*. Am J Physiol Lung Cell Mol Physiol, **304**: L646-L656.

Kawamura M, Imamura R, Kobayashi Y, *et al* (2020): Oral administration of Si-based agent attenuates oxidative stress and ischemia-

reperfusion injury in a rat model: A novel hydrogen administration method. Front Med, **7**: 95.

Kawasaki H, Guan J, tamama K (2010): Hydrogen gas treatment prolongs replicative lifespan of bone marrow multipotential stromal cells in vitro while preserving differentiation and paracrine potentials. Biochem Biophys Res Commun, **397**: 608-613.

Kikkawa YS, Nakagawa T, Horie RT, *et al* (2009): Hydrogen protects auditory hair cells from free radicals. NeuroReport, **20**: 689-694.

Kim J, Lee H, and Hong SH (2017): Inhibition of streptococcal biofilm by hydrogen water. J Dent, 2017 Mar. 58: 34-39. doi: 10. 1016/jdent. 2017. 01.004. Epub 2017 Jan 10.

Kishimoto Y, Kato T, Ito M, *et al* (2015): Hydrogen ameliorates pulmonary hypertension in rats by anti-inflammatory and antioxidant effects. J Thorac Cardiovasc Surg, **150**: 645-654.

Kitamura A, Kobayashi S, Matsushita T, *et al* (2010): Experimental verification of protective effect of hydrogen-rich water against cisplatin-induced nephrotoxicity in rats using dynamic contrast-enhanced CT. Br J Radiol, **83**: 509-514.

Kiyoi T, Liu S, Takemasa E, *et al* (2020): Constitutive hydrogen inhalation prevents vascular remodeling via reduction of oxidative stress. PLoS ONE; **15**: e0227582.

Klichko VI, Safonov VI, Safonov MU, *et al* (2019): Supplementation with hydrogen-producing composition confers beneficial effects on physiology and life span in Drosophila. Heliyon, **5**: e01679.

Kobayashi E, Sano M (2019): Organ preservation solution containing dissolved hydrogen gas from a hydrogen-absorbing alloy canister

improves function of transplanted ischemic kidneys in miniature pigs. PLoS ONE, **14** (10): e0222863.

Kohama K, Yamashita H, Aoyama-Ishikawa M, *et al* (2015): Hydrogen inhalation protects against acute lung injury induced by hemorrhagic shock and resuscitation. Surgery, **158**: 399-407.

Korovljev D, Stajer V, Javorac D, *et al* (2018): Hydrogen inhalation positively affects cardiometabolic risk factors in men and women aged 65 years or older: a preliminary report. Eur Geriat Med, doi 10. 1007/s41999-018-0087-6.

Korovljev D, Trivic T, Drid P, *et al* (2018): Molecular hydrogen affects body composition, metabolic profiles, and mitochondrial function in middle-aged overweight women. Ir J Med Sci, **187**: 85-89.

Korovljev D, Stajer V, Ostojic J, *et al* (2019): Hydrogen-rich water reduces liver fat accumulation and improves liver enzyme profiles in patients with non-alcoholic fatty liver disease: a randomized controlled pilot trial. Clin Res Hepatol Gastroenterol, 2019 Apr 11. pii; S2210-7401(19)30085-3. doi: 10. 1016/j. clinre. 2019. 03. 008. [Epub ahead of print].

Koyama K, Tanaka Y, Saihara Y, *et al* (2008): Effect of hydrogen saturated alkaline electrolyzed water on urinary oxidative stress makers after an acute severe exercise: A randomized controlled trial. Anti-aging Med, **4**: 117-122. (in Japanese).

Koyama Y, Taura K, Hatano E, *et al* (2013): Effects of oral intake of hydrogen water on liver fibrogenesis in mice. Hepatol Res, 2013 May 20. doi: 10. 1111/hepr. 12165. [Epub ahead of print].

Ku JY, Park MJ, Park HJ, *et al* (2020): Combination of Korean Red Ginseng extract and hydrogen-rich water improves spermatogenesis and sperm motility in male mice. Chin J Integr Med. 2020 May;26(5):361-369. doi: 10.1007/s11655-019-3047-1. Epub 2020 Jan 10.

Kubota M, Shimura S, Kubota S, *et al* (2011): Hydrogen and N-acetyl-L-cysteine rescue oxidative stress-induced angiogenesis in a mouse corneal alkali-burn model. Invest Ophthalmol Vis Sci, **52**: 427-433.

Kura B, Kalocayova B, LeBaron TW, *et al* (2019): Regulation of microRNAs by molecular hydrogen contributes to the prevention of radiation-induced damage in the rat myocardium. Mol Cell Biochem 2019 Mar 4. doi: 10. 1007/s 1010-019-03512-z [Epub ahead of print].

Kurioka T, Matsunobu T, Satoh Y, *et al* (2014): Inhaled hydrogen gas therapy for prevention of noise-induced hearing loss through reducing reactive oxygen species. Neurosci Res, 2014 Sep 6. pii: S0168-0102(14)00185-0. doi: 10. 1016/j. neures. 2014. 08. 009. [Epub ahead of print].

LeBaron TW, Larson AJ, Ohta S, *et al* (2019): Acute supplementation with molecular hydrogen benefits submaximal exercise indices. Randomized, double-blinded, placebo-controlled crossover pilot study. J Lifestyle Med, 9: 36-43.

LeBaron TW, Singh RB, Fatima G, *et al* (2020): The effects of 24-week, high-concentration hydrogen-rich water on body composition, blood lipid profiles and inflammation biomarkers in men and women with metabolic syndrome: A randomized controlled trial. Diabetes Metab Syndr Obes, **13**:889-896.

Lee J, Yang G, Kim YJ, *et al* (2017): Hydrogen-rich medium protects mouse embryonic fibroblasts from oxidative stress by activating LKB1-AMPK-FoxO1 signal pathway. Biochem Biophys Res Commun., **491**(3):733-739

Lee JW, Kim JI, Lee YA, *et al* (2012): Inhaled hydrogen gas therapy for prevention of testicular ischemia/reperfusion injury in rats. J

Pediatr Surg, **47**: 736-742.

Lee PC, Yang YY, Huang CS, *et al* (2014): Concomitant inhibition of oxidative stress and angiogenesis by chronic hydrogen-rich saline and N-acetylcyteine treatments improves systemic, splanchnic and hepatic hemodynamics of cirrhotic rats. Hepatol Res, 2014 Jun 24. doi: 10. 1111/hepr. 12379. [Epub ahead of print].

Lekic T, Manaenko A, Rolland W, *et al* (2011): Protective effect of hydrogen gas therapy after germinal matrix hemorrhage in neonatal rats. Acta Neurochir Suppl, **111**: 237-241.

Li L, Liu T, Li X, *et al* (2019a): Protein chip and bioinformatic analyses of differentially expressed proteins involved in the effect of hydrogen-rich water on myocardial ischemia-reperfusion injury. Int J Med Sci, **16**: 1254-1259.

Li L, Li X, Zhang Z, *et al* (2019b): Effects of hydrogen-rich water on the PI3K/AKT signaling pathway in rats with myocardial ischemia-reperfusion injury. Curr Mol Med, 2019 Nov 5. doi; 10.2174/1566524019666191105150709. [Epub ahead of primt].

Li Q, Tanaka Y, Miwa N. (2017): Influence of hydrogen-occluding-silica on migration and apoptosis in human esophageal cells *in vitro*. Med Gas Res. **7**(2):76-85.

Li R, Liu Y, Xie J, *et al* (2019a): Sirt3 mediates the protective effect of hydrogen in inhibiting ROS-induced retinal senescence. Free Radic Biol Med, **135**: 116-124.

Li TT, Yang WC, Wang YZ, *et al* (2020): Effects of a high concentration of hydrogen on neurological function after traumatic brain injury in diabetic rats. Brain Res, 2020 Mar 1; 1730: 146651. doi: 10. 1016/j. brainres. 2020. 146651. Epub 2020 Jan 8.

Li W, Yang S, Yu FY, *et al* (2018): Hydrogen ameliorates chronic intermittent hypoxia-induced neurocognitive impairment via inhibiting oxidative stress. Brain Res Bull. 2018 Sep 20. pii: S0361-9230(18)30519-7. doi: 10. 1016/j. brainresbull. 2018. 09. 012

Liang CX, Liu XW, Liu L, *et al* (2012): Effect of hydrogen inhalation on p38 MAPK activation in rats with lipopolysaccharide-induced acute lung injury. Nan Fang Yi Ke Xue Bao, **32**: 1211-1213. (in Chinese).

Li C, Hou L, Chen D, *et al* (2017): Hydrogen-rich saline attenuates isoflurane-induced caspase-3 activation and cognitive impairment via inhibition of isoflurane-induced oxidative stress, mitochondrial dysfunction, and reduction in ATP levels. Am J Transl Res, **9**: 1162-1172.

Li DZ1, Zhang QX, Dong XX, *et al* (2014): Treatment with hydrogen molecules prevents RANKL-induced osteoclast differentiation associated with inhibition of ROS formation and inactivation of MAPK, AKT and NF-kappa B pathways in murine RAW264.7 cells. J Bone Miner Metab, **32**:494-504.

Li FY, Zhu SX, Wang ZP, *et al* (2013): Consumption of hydrogen-rich water protects against ferric nitrilotriacetate-induced nephrotoxicity and early tumor promotional events in rats. Food Chem Toxicol, 2013 Oct 16. pii: S0278-6915(13)00679-0. doi: 10. 1016/j. fct. 2013. 10. 004. [Epub ahead of print].

Li GM, Ji MH, Sun XJ, *et al* (2012a): Effects of hydrogen-rich saline treatment on polymicrobial sepsis. J Surg Res. Jul 7. [Epub ahead of print].

Li H, Bai G, Ge Y, et al (2017): Hydrogen-rich saline protects against small-scale liver ischemia-reperfusion injury by inhibiting

endoplasmic reticulum stress. Life Sci. pii: S0024-3205(17)30660-4.

Li H, Zhou R, Liu J, *et al* (2012b): Hydrogen-rich saline attenuates lung ischemia-reperfusion injury in rabbits. J Surg Res. **174**: e11-16.

Li H, Chen O, Ye Z, *et al* (2017): Inhalation of high concentration of hydrogen ameliorates liver ischemia/reperfusion injury through A2A receptor mediated PI3K-Akt pathway. Biochem Pharmacol, **130**: 83-92.

Li J, Dong Y, Chen H, *et al* (2012c): Protective effects of hydrogen-rich saline in a rat model of permanent focal cerebral ischemia via reducing oxidative stress and inflammatory cytokines. Brain Res. 2012 Sep 23. pii: S0006-8993 (12) 01537-5. doi: 10. 1016/j. brainres. 2012. 09. 031. [Epub ahead of print].

Li J, Wang C, Zhang JH, *et al* (2010): Hydrogen-rich saline improves memory function in a rat model of amyloid-beta-induced Alzheimer's disease by reduction of oxidative stress. Brain Res, **1328**: 152-161.

Li J, Hong Z, Liu H, et al (2016a): Hydrogen-rich saline promotes the recovery of renal function after ischemia/reperfusion injury in rats via anti-apoptosis and anti-inflammation. Front Pharmacol, 2016 Apr 22;7; 106. doi; 10. 00106. eCollection 2016.

Li J, Hong Z, Liu H, *et al* (2016b): Hydrogen-rich saline promotes the recovery of renal function after ischemia/reperfusion injury in rats via anti-apoptosis and anti-inflammation. Front Pharmacol, 2016 Apr 22; 7: 106. doi: 10.3389/fphar 2016.00106.eCollection 2016.

Li J, Ge Z, Fan L, *et al* (2017): Protective effect of molecular hydrogen on steroid-induced osteonecrosis in rabbits via reducing oxidative stress and apoptosis. BMC Musculoskelet Disord, **18**: 58.

Li L, Liu T, Li X, *et al* (2019b): Protein chip and bioinformatic analyses of differentially expressed proteins involved in the effect of hydrogen-rich water on myocardial ischemia-reperfusion injury. Int J Med Sci. 16: 1254-1259.

Li L, Liu T, Liu L, *et al* (2019c): Effect of hydrogen-rich water on the Nrf2/ARE signaling pathway in rats with myocardial ischemia-reperfusion injury. J Bioenerg Biomembr. 2019 Nov 25. doi: 10. 1007/s10863-019-09814-7 [Epub ahead of print].

Li L, Liu T, Liu L, *et al* (2020): Metabolomics analysis of the effect of hydrogen-rich water on myocardial ischemia-reperfusion injury in rats. J Bioenerg Biomembr, 2020 May 29. doi. 10. 1007/s 10863-020-09835-7. Online ahead of print.

Li Q, Kato S, Matsuoka D, *et al* (2013): Hydrogen water intake via tube-feeding for patients with pressure ulcer and its reconstructive effects on normal human skin cells *in vitro*. Med Gas Res, **3**:20.

Li Q, Yu P, Zeng Q, *et al* (2016): Neuroprotective effect of hydrogen-rich saline in global cerebral ischemia/reperfusion rats: Up-regulated tregs and down-regulated miR-21, miR-210 and NF-kB expression. Nurochem Res, 2016 Jul 7. [Epub ahead of print].

Li Q, Tanaka Y, and Miwa N. (2017): Influence of hydrogen-occluding-silica on migration and apoptosis in human esophageal cells *in vitro*. Med Gas Res., **7**(2):76-85.

Li Q, Tanaka Y, and Miwa N. (2018): Effects of hydrogen-occluding-silica microparticles on wound repair and cell migration behavior of normal human esophageal epitheliocytes. Med Gas Res, **8**: 57-63.

Li S, Lu D, Zhang Y, *et al* (2013): Long-term treatment of hydrogen-rich saline abates testicular oxidative stress induced by nicotine

in mice. J Assist Reprod Genet, 2013 Nov 13. [Epub ahead of print].

Li S, Fujino M, Ichimaru N, *et al* (2018): Molecular hydrogen protects against ischemia-reperfusion injury in a mouse fatty liver model via regulating HO-1 and Sirt1 expression. Sci Rep, **8**: 14019.

Li T, Deng S, Lei W, *et al* (2020): Hydrogen water alleviates paraquat-induced lung fibroblast injury in vitro by enhancing Nrf2 expression. Nan Fang Yi Ke Da Xue Xue Bao, **40**: 233-239. (in Chinese).

Li X, Li L, Liu X, *et al* (2019): Attenuation of cardiac ischemia-reperfusion injury by treatment with hydrogen-rich water. Curr Mol Med, 2019 Mar 20. doi; 10.2174/15665240 19666190321113544. [Epub ahead of print].

Li Y, Hamasaki T, Nakamichi N, *et al* (2011): Suppressive effects of electrolyzed reduced water on alloxan-induced apoptosis and type 1 diabetes mellitus. Cytotecnol, **63**: 119-131.

Li Y, Xie K, Chen H, *et al* (2014): The role of Nrf2 in the hydrogen treatment for intestinal injury caused by severe sepsis. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue, **26**: 415-419. (in Chinese).

Li Y, Xie K, Chen H, *et al* (2015a): Hydrogen gas inhibits high-mobility group box 1 release in septic mice by upregulation of heme oxygenase 1. J Surg Res. **196**:136-48.

Li Y, Li Q, Chen H, *et al* (2015b): Hydrogen gas alleviates the intestinal injury caused by severe sepsis in mice by increasing the expression of heme oxygenase-1. Shock. **44**: 90-98.

Lin CP, Chuang WC, Lu FJ, *et al* (2017): Anti-oxidant and anti-inflammatory effects of hydrogen-rich water alleviate ethanol-induced fatty liver in mice. World J Gastroenterol. **23**(27):4920-4934

Lin Y, Kashio A, Sakamoto T, *et al* (2011): Hydrogen in drinking water attenuates noise-induced hearing loss in guinea pigs. Neurosci Lett. **487**: 12-16.

Liu C, Kurokawa R, Fujino M, *et al* (2014): Estimation of the hydrogen concentration in rat tissue using an airtight tube following the administration of hydrogen via various routes. Sci Rep, **4**: 5485, doi: 10. 1038/srep05485

Liu D, Wang X, Yang Y, *et al* (2014): Effects of hydrogen-rich saline on liver of severely scalded rats with delayed resuscitation. Zhonghua Shao Shang Za Zhi. **30**: 506-511. (in Chinese).

Liu FT, Xu SM, Xiang ZH, *et al* (2014): Molecular hydrogen suppresses reactive astrogliosis related to oxidative injury during spinal cord injury in rats. CNS Neurosci Ther. 2014 Mar 31. doi: 10.1111/cns. 12258. [Epub ahead of print].

Liu GD, Zhang H and Liu P (2013): Molecular hydrogen regulates the expression of miR-9, miR-21 and miR-199 in LPS-activated retinal microglia cell. Int J Ophthalmol **6**: 280-285.

Liu H, Hua N, Xie K, *et al* (2015): Hydrogen-rich saline reduces cell death through inhibition of DNA oxidative stress and overactivation of poly (ADP-ribose) polymerase-1 in retinal ischemia-reperfusion injury. Mol Med Rep. 2015 May 5. doi: 10.3892/mmr.2015.3731. [Epub ahead of print]

Liu H, Liang X, Wang D, *et al* (2015): Combination therapy with nitric oxide and molecular hydrogen in a murine model of acute lung

injury. Shock. 43:504-511.

Liu L, Xie K, Chen H, *et al* (2014a): Inhalation of hydrogen gas attenuates brain injury in mice with cecal ligation and puncture via inhibiting neuroinflammation, oxidative stress and neuronal apoptosis. Brain Res, 2014 Sep 22. pii: S0006-8993(14)01251-7. doi: 10.1016/j.brainres. 2014. 09. 030. [Epub ahead of print].

Liu L, Xie K, Chen H, *et al* (2014b): Role of Nrf2 in the protective effects of hydrogen against cerebral dysfunction in septic mice. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue, **26**: 629-633. (in Chinese).

Liu L, Xie K, Chen H, *et al* (2015): Protective effects of inhaled hydrogen gas on cognitive function in mice with sepsis-associated encephalopathy. DeZhonghua Yi Xue Za Zhi, **94**:3179-3183.

Liu MU, Xie F, Zhang Y, *et al* (2019): Molecular hydrogen suppresses glioblastoma growth via inducing the glioma stem-like cell differentiation. Stem Cell Res Thera, **10**: 145.

Liu M, Yuan H, Yin J, *et al* (2019): Effect of hydrogen-rich water on radiation-induced cognitive dysfunction in rats. Radiat Res, 2019 Oct 21. 10. 1667/RR-15464. 1. [Epub ahead of print].

Liu Q, Shen W-F, Sun H-Y, *et al* (2010): Hydrogen-rich saline protects against liver injury in rats with obstructive jaundice. Liver International, **30**: 958-968.

Liu Q, Li BS, Song YJ, *et al* (2016): Hydrogen-rich saline protects against mitochondrial dysfunction and apoptosis in mice with obstructive jaundice. Mol Med Rep, **4**: 3588-3596.

Liu R, Fang X, Meng C, *et al* (2015): Lung inflation with hydrogen during the cold ischemia phase decreases lung graft injury in rats. Exp Biol Med (Maywood), **240**:1214-1222.

Liu S, Liu K, Sun Q, *et al* (2011a): Consumption of hydrogen water reduces paraquat-induced acute lung injury in rats. J Biomed Biotechnol, **2011**:305086. Epub 2011 Jan 24.

Liu S, Oshita S, Thuyet DQ, *et al* (2018): Antioxidant activity of hydrogen nanobubbles in water with different reactive oxygen species both in vivo and in vitro. Langmuir, **34**: 11878-11885.

Liu W, Chen O, Chen C, *et al* (2011): Protective effects of hydrogen on fetal brain injury during maternal hypoxia. Acta Neurochir Suppl, **111**: 307-311.

Liu W, Shan LP, Dong XS, *et al* (2013): Combined early resuscitation and hydrogen inhalation attenuates lung and intestine injury. World Gastroenterol, **19**: 492-502.

Liu W, Dong XS, Sun YQ, *et al* (2014): A novel fluid resuscitation protocol: provide more protection on acute kidney injury during septic shock in rats. Int J Clin Exp Med, **7**: 919-926.

Liu X, Chen Z, Mao N, *et al* (2012): The protective of hydrogen on stress-induced gastric ulceration. Int Immunopharmacol, **13**: 197-203.

Liu X, Ma C, Wang X, *et al* (2017): Hydrogen coadministration slows the development of COPD-like lung disease in a cigarette smoke-

induced rat model. Int J COPD, **12**: 1309-1324.

Liu Y, Lan Q, Wang D, *et al* (2017) [Effect of hydrogen-rich water on the CD34 expression in lesion boundary brain tissue of rats with traumatic brain injury]. **29**(3):260-264. doi: 10.3760/cma.j.issn.2095-4352.2017.03.013. Chinese.

Liu Y, Liu W, Sun X, *et al* (2011b): Hydrogen saline offers neuroprotection by reducing oxidative stress in a focal cerebral ischemia-reperfusion rat model. Med Gas Res, **1**: 15.

Liu Y, Yang L, Tao K, *et al* (2014): Protective effects of hydrogen enriched saline on liver ischemia reperfusion injury by reducing oxidative stress and HMGB1 release. BMC Gastroenterol. 2014 Jan 12;14:12. doi: 10.1186/1471-230X-14-12.

Liu Y, Dong F, Guo R, *et al* (2018): Hydrogen-rich saline ameliorates experimental autoimmune encephalomyelitis in C57BL/6 mice via the Nrf2-ARE signaling pathway. Inflammation, 2018 Oct 20. doi: 10. 1007/s10753-018-0915-3 [Epub ahead of print].

Liu YQ, Liu YF, Ma XM, *et al* (2015): Hydrogen-rich saline attenuates skin ischemia/reperfusion induced apoptosis via regulating Bax/Bcl-2 ratio and ASK-1/JNK pathway. J Plast Reconstr Aesthet Surg. **68**:e147-156.

Liu Z, Cheng S, Gu C, *et al* (2017): Effect of Hydrogen-Rich Saline on Postoperative Intra-Abdominal Adhesion Bands Formation in Mice. Med Sci Monit. **11**; 23: 5363-5373.

Liu Z, Geng W, Jiang C, *et al* (2017): Hydrogen-rich saline inhibits tobacco smoke-induced chronic obstructive pulmonary disease by alleviating airway inflammation and mucus hypersecretion in rats. Exp Biol Med (Maywood)., **242**(15):1534-1541

Long P, Yan W, He M, et al (2019): Protective effects of hydrogen gas in a rat model of branch retinal vein occlusion via decreasing VEGF-α expression. BMC Ophthalmology, **19**: 112.

Lu H, Ding J, Liu W, *et al* (2018): UPLC/MS-based metabolomics investigation of the protective effect of hydrogen gas inhalation on mice calcium oxalate-induced renal injury. Biol pharm Bull, **41**: 1652-1658.

Lu R, Liu Y, Wang D. (2019): Protective effect of hydrogen-rich water on oxidative stress cell model and the impact of the phosphatidylinositol 3 kinase/protein kinase B pathway. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue, **31**: 762-767. (in Chinese).

Lu W, Li D, Hu J, *et al* (2018): Hydrogen gas inhalation protects against cigarette smoke-induced COPD development in mice. J Thorac Dis, **10**: 3232-3243.

Lu Y, Li CF, Ping NN, *et al* (2020): Hydrogen-rich water alleviates cyclosporine A-induced nephrotoxicity via the keap1/Nrf2 signaling pathway. J Biochem Mol Toxicol. 2020 May;34(5):e22467. doi: 10.1002/jbt.22467. Epub 2020 Feb 10.

Lu Z, Lin Y, Peng B, *et al* (2017): Hydrogen-Rich Saline Ameliorates Hepatic Ischemia-Reperfusion Injury Through Regulation of Endoplasmic Reticulum Stress and Apoptosis. Dig Dis Sci.,**62**(12):3479-3486

Luo ZL, Cheng L, Ren JD, *et al* (2015): Hydrogen-Rich Saline Protects against Ischemia/Reperfusion Injury in Grafts after Pancreas Transplantations by Reducing Oxidative Stress in Rats. Mediators Inflamm. 2015:281985. doi: 10.1155/2015/281985. Epub 2015 Mar 22

Ma H, Chen H, Dong A, *et al* (2017): Hydrogen-rich saline attenuates hyperalgesia and reduces cytokines in rats with post-herpetic neuralgia via activating autophagy. Xi Bao Yu Fen Zi Mian Yi Xue Za Zhi, **33**: 155-158. (in Chinese).

Maly O, Zajak J, Hyspler R, *et al* (2019): Inhalation of molecular hydrogen prevents ischemia-reperfusion liver damage during major liver resection. Ann Transl Med, 2019; 7 (23): 774. doi. 10. 21037/atm. 2019. 11. 43.

Manaenko A, Lekic T, Ma Q, *et al* (2011): Hydrogen inhalation is neuroprotective and improves functional outcomes in mice after intracerebral hemorrhage. Acta Neurochir Suppl. **111**: 179-83.

Manaenko A, Lekic T, Ma Q, *et al* (2013): Hydrogen inhalation ameliorated mast cell-mediated brain injury after intracerebral hemorrhage in mice. Crit Care Med, **41**:1266-1275.

Mano Y, Kotani T, Ito M, *et al* (2014): Maternal molecular hydrogen administration ameliorates rat fetal hippocampal damage caused by in utero ischemia-reperfusion. Free Radic Bio Med, **69**: 324-330.

Mao YF, Zheng XF, Cai JM, *et al* (2009): Hydrogen-rich saline reduces lung injury induced by intestinal ischemia/reperfusion in rats. Biochem Biophys Res Commun. **381**: 602-605.

Masuda K, Tanaka Y, Kanehisa M,*et al* (2017): Natural reduced water suppressed anxiety and protected the heightened oxidative stress in rats. Neuropsychiatr Dis Treat. **8**;13: 2357-2362.

Matsumoto A, Yamafuji M, Tachibana T, *et al* (2013): Oral 'hydrogen water' induces neuroprotective ghrelin secretion in mice. Sci Rep, **3**: 3273. doi: 10. 1038. Srep03273.

Matsuno N, Watanabe R, Kimura M, *et al* (2014): Beneficial effects of hydrogen gas on porcine liver reperfusion injury with use of total vascular exclusion and active venous bypass. Transplant Proc, **46**:1104-1106.

Matsuoka T, Suzuki M, Sano M, *et al* (2017): Hydrogen gas inhalation inhibits progression to the "irreversible" stage of shock after severe hemorrhage in rats. J Trauma Acute Care Surg., **83**(3):469-475.

Matsushita T, Kusakabe Y, Kitamura A, *et al* (2011a): Protective effect of hydrogen-rich water against gentamicin-induced nephrotoxicity in rats using blood oxygenation level-dependent MR imaging. Magn Reson Med Sci. **10**: 169-176.

Matsushita T, Kusakabe Y, Kitamura A, *et al* (2011b): Investigation of protective effect of hydrogen-rich water against cisplatin-induced nephrotoxicity in rats using blood oxygenation level-dependent magnetic resonance imaging. Jpn J Radiol. **29**: 503-512.

Mei K, Zhao S, Qian L, *et al* (2014): Hydrogen protects rats from dermatitis caused by local radiation. J Dermatolog Treat. **25**: 182-188.

Memeth J, Toth-szuki V, Varga V, *et al* (2016): Molecular hydrogen affords neuroprotection in a translational piglet model of hypoxic-ischemic encephalopathy. J Physiol Pharmacol. **67**: 677-689.

Meng J, Yu P, Jiang H, *et al* (2016): Molecular hydrogen decelerates rheumatoid arthritis progression through inhibition of oxidative stress. Am J Transl Res, **8**: 4472-4477.

Meng J, Yu P, Tong J, *et al* (2018): Hydrogen treatment reduces tendon adhesion and inflammatory response. J Cell Biochem, 2018 Oct 26. doi. 10. 1002/jcb. 27441. [Epub ahead of print].

Meng X, Chen H, Wang G, *et al* (2015): Hydrogen-rich saline attenuates chemotherapy-induced ovarian injury via regulation of oxidative stress. Exp Ther Med, **10**: 2277-2282.

Mikami T, Tano K, Lee H, *et al* (2019): Drinking hydrogen water enhances and relieves psychometric fatigue: a randomized, double-blind, placebo-controlled study. Can J Physiol Pharmacol, **97**: 857-862.

Miyazaki N, Yamaguchi O, Nomiya M, *et al* (2015): Preventive effect of hydrogen water on the development of detrusor overactivity in a rat model of bladder outlet obstruction. J Urol. 2015 Oct 27. pii: S0022-5347(15)05137-X. doi: 10.1016/j.juro.2015.10.117. [Epub ahead of print]

Mizuno K, Sasaki AT, Ebisu K, *et al* (2018): Hydrogen-rich water for improvements of mode, anxiety, and autonomic nerve function in daily life. Med Gas Res, **7**: 247-255.

Mo XY, Li XM, She CS, *et al* (2018): Hydrogen-rich saline protects from oxygen glucose deprivation and reperfusion-induced apoptosis through VDAC1 via Bcl-2. Brain Res, 2018 Oct 1. pii: S0006-8993 (18) 30503-1. doi: 10. 1016/j. brainres. 2018. 09. 037. [Epub ahead of print].

Moon DH, Kang DY, Haam SJ, *et al* (2019): Hydrogen gas inhalation ameliorates lung injury after hemorrhagic shock and resuscitation. J Thorac Dis, **11**: 1519-1527.

Murakami Y, Ito M, and Ohsawa I (2017): Molecular hydrogen protects against oxidative stress-induced SH-SY5Y neuroblastoma cell death through the process of mitohormesis. PLoS One. **12**: e0176992.

Muramatsu Y, Ito M, Oshima T, *et al* (2016): Hydrogen-rich water ameliorates bronchopulmonary dysplasia (BPD) in newborn rats. Pediatr Pulmonol, 2016 Feb 4. doi: 10. 1002/ppul. 23386. [Epub ahead of print]

Nagata K, Kamimura N, Mikami T, *et al* (2009): Consumption of molecular hydrogen prevents the stress-induced impairments in hippocampus-dependent learning tasks during chronic physical restraint in mice. Neuropsychopharmacology, **34**: 501-508.

Nagatani K, Wada K, Takeuchi S, *et al* (2012): Effect of hydrogen gas on the survival rate of mice following global cerebral ischemia. Schock, **37**: 645-652.

Nagatani K, Takeuchi S, Kobayashi H, *et al* (2013): The effect of hydrogen gas on a mouse bilateral common carotid artery occlusion. Acta Neurochir Suppl, **118**: 61-63.

Nakai, Y, Sato B, Ushiama S, *et al* (2011): Hepatic oxidoreduction-related genes are upregulated by administration of hydrogen-saturated drinking water. Biosci Biotechnol Biochem, **75**: 774-776.

Nakao A, Kaczorowski DJ, Wang Y, *et al* (2010a): Amelioration of rat cardiac cold ischemia/reperfusion injury with inhaled hydrogen or carbon monoxide, or both. J Heart Lung Transplant , **29**: 544-553.

Nakao A, Toyoda Y, Sharma P, *et al* (2010b): Effectiveness of hydrogen rich water on antioxidant status of subjects with potential

metabolic syndrome: an open label pilot study. J Clin Biochem Nutr, **46**: 140-149.

Nakashima-Kamimura N, Mori T, Ohsawa I, *et al* (2009): Molecular hydrogen alleviates nephrotoxicity induced by an anti-cancer drug cisplatin without compromising anti-tumor activity in mice. Cancer Chemother Pharmacol, **64**: 753-761.

Nakasone Y, Oozono J, Suzuki E, *et al* (2017): Effect of intake of molecular hydrogen-infused water on the status of obesity in adult subjects. Jpn Pharmacol Ther, 45: 1821-1830. (in Japanese)

Nakata K, Yamashita N, Noda Y, *et al* (2015): Stimulation of human damaged sperm motility with hydrogen molecule. Med Gas Res, **5** (1): 2.

Nakayama M, Kabayama S, Terawaki H, *et al* (2007): Less-oxidative hemodialysis solution rendered by cathode-side application of electrolyzed water. Hemodialysis Int, **11**: 322-327.

Nakayama M, Kabayama S, Nakano H, *et al* (2009): Biological effects of electrolyzed water in hemodialysis. Nephron **112**: C9-C15.

Nakayama M, Nakano H, Hamada H, *et al* (2010): A novel bioactive haemodialysis system using dissolved dihydrogen (H2) produced by water electrolysis: a clinical trial. Nephrol Dial Transplant, **25**: 3026-3033.

Nakayama M, Itami N, Suzuki H, *et al* (2017): Possible clinical effects of molecular hydrogen (H2) delivery during hemodialysis in chronic dialysis patients: Interim analysis in a 12 month observation. PLoS One.,**12**(9):e0184535.

Ni XX, Cai ZY, Fan DF, *et al* (2011): Protective effect of hydrogen-rich saline on decompression sickness in rats. Aviat Space Environ

Med. **82**: 604-609.

Ning K, Liu WW, Huang JL, *et al* (2018): Effects of hydrogen on polarization of macrophages and microglia in a stroke model. Med Gas Res, **8**: 154-159.

Ning Y, Shang Y, Huang H, *et al* (2013): Attenuation of cigarette smoke-induced airway mucus production by hydrogen-rich saline in rats. PLoS ONE, **8**: e83429. doi:10. 1371.

Nishida T, Hayashi T, Inamoto T, *et al* (2018): Dual gas treatment with hydrogen and carbon monoxide attenuates oxidative stress and protects from renal ischemia-reperfusion injury. Transplant Proc, **50**: 250-258.

Nishimaki K, Asada T, Ohsawa I, *et al* (2017): Effects of molecular hydrogen assessed by an animal model and a randomized clinical study on mild cognitive impairment. Curr Alzheimer Res. 2017 Nov 6. doi: 10.2174/1567205014666171106145017. [Epub ahead of print]

Nishiwaki H, Ito M, Negishi S, *et al* (2018): Molecular hydrogen upregulates heat shock response and collagen biosynthesis, and downregulates cell cycles – Meta-analysis of gene expression profiles. Free Radic Res. 2018 Feb 9: 1-311. doi: 10. 1080/10715762. 2018. 1439166. [Epub ahead of print].

Noda K, Tanaka Y, Shigemura N, *et al* (2012): Hydrogen-supplemented drinking water protects cardiac allografts from inflammation-associated deterioration. Transpl Int, 2012 Aug 14. doi: 10. 1111/j. 1432-2227. 2012. 01542. x. [Epub ahead of print].

Noda K, Shigemura N, Tanaka Y, *et al* (2013): A novel methods of preserving cardiac grafts using a hydrogen-rich water bath. J Heart

Lung Transplant, **32**: 241-250.

Noda K, Shigemura N, Tanaka Y, *et al* (2014): Hydrogen preconditioning during ex vivo lung perfusion improves the quality of lung grafts in rats. Transplantation, **98**:499-506.

Noda M, Uemura Y, Yoshii Y, *et al* (2019): Circulating messenger for neuroprotection induced by molecular hydrogen. Can J Physiol Pharmacol, 2019 May 17. doi: 10. 1139/cipp-2019-0098 [Epub ahead of print].

Nogueira JE, Passaglia P, Mota CMD, *et al* (2018): Molecular hydrogen reduces acute exercise-induced inflammatory and oxidative stress status. Free Radic Biol Med, **129**: 186-193.

Nogueira JE, de Deus JL, Amorim MR, *et al* (2019): Inhaled molecular hydrogen attenuates intense acute exercise-induced hippocampal inflammation in sedentary rats. Neurosci Lett, Nov 9. 134577, dio; 10. 1016/j. neulet 2019. 134577 [Epub ahead of print].

Ogawa H, Okada M, Shudou M, *et al* (2017): Prevention of ischemia-induced hearing loss by intravenous administration of hydrogen-rich saline in gerbil. Neurosci Lett. **6**; 665:195-199.

Oharazawa H, Igarashi T, Yokota T, *et al* (2010): Protection of the retina by rapid diffusion of hydrogen: administration of hydrogen-loaded eye drops in retinal ischemia-reperfusion injury. Invest Ophthalmol Vis Sci, **51**: 487-492.

Ohsawa I, Ishikawa M, Takahashi K, *et al* (2007): Hydrogen acts as a therapeutic antioxidant by selectively reducing cytotoxic oxygen radicals. Nat Med, **13**: 688-694.

Ohsawa I, Nishimaki K, Yamagata K, *et al* (2008): Consumption of hydrogen water prevents atherosclerosis in apolipoprotein E knockout mice. Biochem Biophys Res Commun, **377**: 1195-1198.

Okamoto A, Kohama K, Aoyama-ishikawa M, *et al* (2016): Intraperitoneally administered, hydrogen-rich physiologic solution protects against postoperative ileus and is associated with reduced nitric oxide production. Surgery, **160**: 623-631.

Oláh O, Tóth-Szűki V, Temesvári P, *et al* (2013): Delayed neurovascular dysfunction is alleviated by hydrogen in asphyxiated newborn pigs. Neonatology. **104**:79-86.

Ono H, Nishijima Y, Adachi N, *et al* (2011): Improved brain MRI indices in the acute brain stem infarct sites treated with hydroxyl radical scavengers, Edaravone and hydrogen, as compared to Edaravone alone. A non-controlled study. Med Gas Res, **1**: 12.

Ono H, Nishijima Y, Adachi N, *et al* (2012): Hydrogen (H2) treatment for acute erythymatous skin disease. A report of 4 patients with safety data and a non-controlled feasibility study with H2 concentration measurement on two volunteers. Med Gas Res, **2**: 14.

Ono H, Nishijima Y, Ohta S, *et al* (2017): Hydrogen Gas Inhalation Treatment in Acute Cerebral Infarction: A Randomized Controlled Clinical Study on Safety and Neuroprotection. J Stroke Cerebrovasc, **26** (11): 2587-2594.

Ono H, Nishizima Y, Sakamoto M, *et al* (2018): Pilot study on therapeutic inhalation of hydrogen gas for improving patients with Alzheimer's disease assessed by cognitive subscale scores and magnetic resonance diffusion tensor imaging. Int J Alzheimers Neuro Disorder, **1**: 004.

Ostojic SM and Stojanovic MD (2014): Hydrogen-rich water affected blood alkalinity in physically active men. Res Sports Med, **22**: 49-

60.

Ostojic SM, Vukomanovic B, Calleja-Gonzalez J, *et al* (2014): Effectiveness of oral and topical hydrogen for sports-related soft tissue injuries. Postgrad Med. 126:187-195.

Ozeki N, Yamawaki-Ogata A, Narita Y, *et al* (2019): Hydrogen water alleviates obliterative airway disease in mice. Gen Thorac Cardiovasc Surg, 68: 158-163.

Pirttila K, Videhult Pierre P, Haglof J, *et al* (2019): An LCMS-based untargeted metabolomics protocol for cochlear perilymph: highlighting metabolic effects of hydrogen gas on the inner ear of noise exposed guinea pigs. Metabolomics, **15** (10): 138.

Pan Z, Zhao Y, Yu H, *et al* (2015): Effect of hydrogen-rich saline on cardiomyocyte autophagy during myocardial ischemia-reperfusion in aged rats. Zhonghua Yi Xue Za Zhi, **95**: 2022-2026. (in Chines).

Paulis MG, Hassan OA, Abbass MF, *et al* (2018): Structural and lipid peroxidation effects of lead on rat hippocampus and its attenuation by hydrogen rich water. J Chem Neuroanat. **91**: 55-62.

Peng Z, Chen W, Wang L, *et al* (2015): Inhalation of hydrogen gas ameliorates glyoxylate-induced calcium oxalate deposition and renal oxidative stress in mice. Int J Clin Exp Pathol, 8: 2680-2689.

Qi LS, Yao L, Liu W, *et a*l (2015): Sirtuin type 1 mediates the retinal protective effect of hydrogen-rich saline against light-induced damage in rats. Invest Ophthalmol Vis Sci, **56**: 8268-8269.

Qian H, Yuan T, Tong J, *et al* (2017): Antioxidants attenuate oxidative stress-induced hidden blood loss in rats. Turk J Haematol, 2017 Mar 8. doi: 10. 4274/tjh. 2016. 0469. [Epub ahead of print].

Qian L, Cao F, Cui J, *et al* (2010a): The potential cardioprotective effects of hydrogen in irradiated mice. J Radiat Res. **51**: 741-747.

Qian L, Cao F, Cui F, *et al* (2010b): Radioprotective effect of hydrogen in cultured cells and mice. Free Rad Res. **44**: 275-282.

Qian L, Li B, Cao F, *et al* (2010c): Hydrogen-rich PBS protects cultured human cells from ionizing radiation-induced cellular damage. Nucl Technol Rad Protec. **25**: 23-29.

Qian L, Mei K, Shen J, *et al* (2013): Administration of hydrogen-rich saline protects mice from lethal acute graft-versus-host-disease (aGVHD). Transplantation, **95**: 658-662.

Qian L, Liu X, Shen J, *et al* (2017): Therapeutic effects of hydrogen on chronic graft-versus-host-disease. J Cell Mol Med, **20**: 1-4.

Qian LR and Shen JL (2016): Successful treatment with hydrogen rich water in a case of chronic graft-versus-host-disease. Med Gas Res, **6**: 177-179.

Qiu XC, Jin YC, Sun Y, *et al* (2010): Effect of hydrogen-rich saline on blood pressure and antioxidant ability of lung tissue in scalded rats following delayed resuscitation. Zhonghua Shao Shang Za Zhi, **26**: 435-438. (in Chinese).

Qiu X, Li H, Tang H, *et al* (2011): Hydrogen inhalation ameliorates lipopolysaccharide-induced acute lung injury in mice. Int Immunopharmacol. **11**: 2130-2137.

Qiu X, Dong K, Guan J, *et al* (2020): Hydrogen attenuates radiation-induced intestinal damage by reducing oxidative stress and inflammatory response. Int Immunopharmacol, 2020 Apr 28; 84: 106517, doi: 10. 1016/j. intimp. 2020. 106517. Online ahead of print.

Qin ZX, Yu P, Qian DH, *et al* (2012): Hydrogen-rich saline prevents neointima formation after carotid balloon injury by suppressing ROS and the TNF-α/NF-κB pathway. Atherosclerosis. **220**: 343-350.

Qu J, Gan YN, Xie KL, *et al* (2012a): Inhalation of hydrogen gas attenuates ouabain-induced auditory neuropathy in gerbils. Acta Pharmacol Sin. **33**: 445-451.

Qu J, Li X, Wang J, *et al* (2012b): Inhalation of hydrogen gas attenuates cisplatin-induced ototoxicity via reducing oxidative stress. Int J Pediatr Otorhinolaryngol. **76**: 111-115.

Ren J, Luo Z, Tian F, *et al* (2012): Hydrogen-rich saline reduces the oxidative stress and relieves the severity of trauma-induced acute pancreatic in rats. J Trauma Acute Care Surg, **72**: 1555-1561.

Ren JD, Ma J, Hou J, *et al* (2014): Hydrogen-rich saline inhibits NLRP3 inflammasome activation and attenuates experimental acute pancreatitis in mice. Med Inflamm, **2014**: Article ID 930894.

Ren JD, Wu XB, Jiang R, *et al* (2016): Molecular hydrogen inhibits lipopolysaccharide-triggered NLRP3 inflammasome activation in macrophages by targeting the mitochondrial reactive oxygen species. Biochim Biophys Acta, **1863**: 50-55.

Runtuwene J, Amitani H, Amitani M, *et al* (2015): Hydrogen-water enhances 5-fluorouracil-induced inhibition of colon cancer. PeerJ,

3: e859; DOI 10.7717/peerj.859.

Saito M, Chen-Yoshikawa TF, Takahashi M, *et al* (2019): Protective effects of a hydrogen-rich solution during cold ischemia in rat lung transplantation. J Thorac Cardiovasc Surg. 2019 Oct 30. pii: S0022-5223(19)32355-4. doi: 10.1016/j.jtcvs.2019.09.175. [Epub ahead of print]

Saitoh Y, Okayasu H, Xiao L, *et al* (2008): Neutral pH hydrogen-enriched electrolyzed water achieves tumor-preferential clonal growth inhibition over normal cells and tumor invasion inhibition concurrently with intracellular oxidant repression. Oncol Res. **17**: 247-255.

Saitoh Y, Yoshimura Y, Nakano K, *et al* (2009): Platinum nanocolloid-supplemented hydrogen-dissolved water inhibits growth of human tongue carcinoma cells preferentially over normal cells. Exp Oncol, **31**: 156-162.

Sakai K, Cho S, Shibata I, *et al* (2012): Inhalation of hydrogen gas protects against myocardial stunning and infarction in swine. Scand Cardiovasc J, **46**: 183-189.

Sakai T, Sato B, Hara K, *et al* (2014): Consumption of water containing over 3.5 mg of dissolved hydrogen could improve vascular endothelial function. Vas Health Risk Manage, **2014**: 10:591-597.

Sakai T, Kurokawa R, Hirano S, *et al* (2019): Hydrogen indirectly suppresses increases in hydrogen peroxide in cytoplasmic hydroxyl radical-induced cells and suppresses cellular senescence. Int J Mol Sci, **20**, 456; doi: 10. 3390/ijms20020456.

Saramago EA, Borges GS, Singolani-Jr CG, *et al* (2018): Molecular hydrogen potentiates hypothermia and prevents hypertension and fever in LPS-induced systemic inflammation. Brain Behav Immuno, 2018 Sep 24. pii: S0889-1591(18)30629-9. doi: 10. 1016/j. bbi. 2018.

09. 027. [Epub ahead of print].

Sato Y, Kajiyama S, Amano A, *et al* (2008): Hydrogen-rich pure water prevents superoxide formation in brain slices of vitamin C-depleted SMP30/GNL knockout mice. Biochem Biophys Res Commun. **375**: 346-350.

Sato T, Mimuro S, Katoh T, *et al* (2020): 1.2% hydrogen gas inhalation protects the endothelial glycocalyx during hemorrhagic shock: A prospective laboratory study in rats. J Anesth, 34: 268-275.

Satoh Y, Araki Y, Kishitani M, *et al* (2018): Molecular hydrogen prevents social deficits and depression-like behaviors induced by low-intensity blast in mice. J Neuropathol Exp Neurol, **77**: 827-836.

Sha JB, Zhang SS, Lu YM, *et al* (2019): Effects of long-term consumption of hydrogen-rich water on the antioxidant activity and the gut flora in female juvenile soccer players from Suzhou, China. Med Gas Res, **8**: 135-143. doi: 10. 4103/2045-9912. 248263.

Shamim T (2018): Hydrogen rich water in oral pathology: an update. Med Gas Res. 8: 34. doi: 10.4103/2045-9912. 229602.

Shao A, Wu H, Hong Y, *et al* (2015): Hydrogen-Rich Saline Attenuated Subarachnoid Hemorrhage-Induced Early Brain Injury in Rats by Suppressing Inflammatory Response: Possible Involvement of NF-κB Pathway and NLRP3 Inflammasome. Mol Neurobiol. 2015 Jun 20. [Epub ahead of print]

Shen L, Wang J, Liu K, *et al* (2011): Hydrogen-rich saline is cerebroprotective in a rat model of deep hypothermic circulatory arrest. Neurochem Res, **36**: 1501-1511.

Shen MH, Cai JM, Sun Q, *et al* (2013): Neuroprotective effect of hydrogen-rich saline in acute carbon monoxide poisoning. CNS Neurosci Ther. **19**: 361-363.

Shen NY, Bi JB, Zhang JY, *et al* (2017): Hydrogen-rich water protects against inflammatory bowel disease in mice by inhibiting endoplasmic reticulum stress and promoting heme oxygenase-1 expression. World J Gastroentenol, **23**: 1375-1386.

Sheng Q, Lv Z, Cai W, *et al* (2013): Protective effects of hydrogen-rich saline on necrotizing enterocolitis in neonatal rats. J Pediatr Surg, **48**: 1697-1706.

Shi HM, Zhou HC, Jia YR, *et al* (2013): The effect of hydrogen on hemorrhagic shock induced acute lung injury in rats. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue, **25**:347-350. (in Chinese).

Shi J, Yao F, Zhong C, *et al* (2012): Hydrogen saline is protective for acute lung ischemia/reperfusion injuries in rats. Heart Lung Circ, **21**: 556-563.

Shi Q, Liao KS, Zhao KL, *et al* (2015): Hydrogen-rich saline attenuates acute renal Injury in sodium taurocholate-induced severe acute pancreatitis by inhibiting ROS and NF-κB pathway. Mediators Inflamm. 2015:685043. doi: 10.1155/2015/685043. Epub 2015 Mar 23

Shi Q, Chen C, Deng WH, *et al* (2016): Hydrogen-rich saline attenuates acute hepatic injury in acute necrotizing pancreatitis by inhibiting inflammation and apoptosis, involving JNK and p38 mitogen-activated protein kinase-dependent reactive oxygen species. Pancreas, **45**: 1424-1431.

Shi YZ, Jin S, Qin H, *et al* (2018): Hydrogen-rich water ameliorates rat placental stress induced by water restriction. Med Gas Res, **8**: 79-84.

Shi YZ, Jin S, Zheng HH, *et al* (2018): Hydrogen rich water attenuates pregnancy gingivitis induced by ligation in SD rats. Shanghai Kou Qiang Yi Xue, **3**: 252-256. (in Chinese).

Shigeta T, Sakamoto S, Li XK, *et al* (2015): Luminal injection of hydrogen-rich solution attenuates intestinal ischemia-reperfusion injury in rats. Transplantation. **99**: 500-507.

Shinbo T, Kokubo K, Sato Y, *et al* (2013): Breathing nitric oxide plus hydrogen gas reduces ischemia-reperfusion injury and nitrotyrosine production in murine heart. Am J Physiol Heart Circ Physiol, **305**: H542-H550.

Shingu C, Koga H, Hagiwara S, *et al* (2010): Hydrogen-rich saline solution attenuates renal ischemia-reperfusion injury. J Anesth. **24**: 569-574.

Shu RC, Zhang LL, Wang CY, *et al* (2015): Spinal peroxynitrite contributes to remifentanil-induced postoperative hyperalgesia via enhancement of divalent metal transporter 1 without iron-responsive element-mediated iron accumulation in rats. Anesthesiology. **122**: 908-920.

Sobue S, Yamai K, Ito M, *et al* (2015): Simultaneous oral and inhalational intake of molecular hydrogen additively suppresses signaling pathways in rodents. Mol Cell Biochem. 2015 May;403(1-2):231-41. doi: 10.1007/s11010-015-2353-y. Epub 2015 Feb 24.

Sobue S, Inoue C, Hori F, *et al* (2017): Molecular hydrogen modulates gene expression via histone modification and induces the mitochondrial unfolded protein response. Biochem Biophys Res Commun, **493**: 318-324.

Song D, Liu X, Diao Y, *et al* (2018): Hydrogen-rich solution against myocardial injury and aquaporin expression via the PI3K/Akt signaling pathway during cardiopulmonary bypass in rats. Mol Med Rep, **18**: 1925-1938.

Song G, Tian H, Liu J, *et al* (2011): H_2 inhibits TNF-α-induced lectin-like oxidized LDL receptor-1 expression by inhibiting nuclear factor κB activation in endothelial cells. Biotechnol Lett, **33**: 1715-1722.

Song G, Tian H, Qin S, *et al* (2012): Hydrogen decreases athero-susceptibility in apolipoprotein B-containing lipoproteins and aorta of apolipoprotein E knockout mice. Atherosclerosis, **221**: 55-65.

Song G, Li M, Sang H, *et al* (2013): Hydrogen-rich water decrease serum low-density lipoprotein cholesterol levels and improves high-density lipoprotein function in patients with potential metabolic syndrome. J Lipid Res, 2013 Apr 22. [Epub ahead of print].

Song G, Zong C, Zhang Z, *et al* (2015a): Molecular hydrogen stabilizes atherosclerotic plaque in low-density lipoprotein receptor-knockout mice. Free Radic Biol Med. 2015 Oct; 87:58-68. doi: 10.1016/j.freeradbiomed.2015.06.018. Epub 2015 Jun 25.

Song G, Lin Q, Zhao H, *et al* (2015b): Hydrogen activates ATP-binding cassette transporter A1-dependent efflux ex vivo and improves high-density lipoprotein function in patients with hypercholesterolemia: A double-blinded, randomized, and placebo-controlled trial. J Clin Endocrinol Metab. **100**: 2724-2733.

Song Y, Chen F, Xiong J, *et al* (2013): A study on residual strain of abdominal aortic aneurysm after intraperitoneal administration of

saturated hydrogen saline in rats. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi, **27**: 881-884. (in Chinese).

Spulber S, Edoff K, Hong L, *et al* (2012): Molecular hydrogen reduces LPS-induced neuroinflammation and promotes recovery from sickness behaviour in mice. PLoS One, **7**: e42078.

Sun JC, Xu T, Zuo Q, *et al* (2014): Hydrogen-rich saline promotes survival of retinal ganglion cells in a rat model of optic nerve crush. PLoS ONE, **9**: e99299.

Sun Q, Kang Z, Cai J, *et al* (2009): Hydrogen-rich saline protects myocardium against ischemia/reperfusion injury in rats. Exp Biol Med, **234**: 1212-1219.

Sun H, Chen L, Zhou W, *et al* (2011a): The protective role of hydrogen-rich saline in experimental liver injury in mice. J Hepatol, **54**: 471-480.

Sun Q, Cai J, Zhou J, *et al* (2011b): Hydrogen-rich saline reduces delayed neurologic sequelae in experimental carbon monoxide toxicity. Crit Care Med. **39**: 765-769.

Sun Q, Cai J, Liu S, *et al* (2011c): Hydrogen-rich saline provides protection against hyperoxic lung injury. J Surg Res. **165**: e43-49.

Sun Q, Kawamura T, Masutani K, *et al* (2012a): Oral intake of hydrogen-rich water inhibits intimal hyperplasia in arterialized vein grafts in rats. Cardiovasc Res. **94**: 144-153.

Sun Y, Shuang F, Chen DM, *et al* (2012b): Treatment of hydrogen molecule abates oxidative stress and alleviates bone loss induced by

modeled microgravity in rats. Osteoporos Int, May 31. [Epub ahead of print].

Suzuki Y, Sato T, Sugimoto M, *et al* (2017): Hydrogen-rich pure water prevents cigarette smoke-induced pulmonary emphysema in SMP30 knockout mice. Biochem Biophys Res Commun. 7;**492**(1):74-81.

Suzuki A, Ito M, Hamaguchi T, *et al* (2019): Quantification of hydrogen production by intestinal bacteria that are specifically dysregulated in Parkinson's disease. PLoS ONE, **13**: e0208313.

Takaenoki Y, Satoh Y, Araki Y, *et al* (2014): Neonatal exposure to sevoflurane in mice causes deficits in maternal behavior later in adulthood. Anesthesiology. **120**: 403-415.

Takahashi M, Chen-Yoshikawa TF, Saito M, *et al* (2017): Immersing lungs in hydrogen-rich saline attenuates lung ischemia-reperfusion injury. Eur J Cardiothoratic Surg, 51: 442-448.

Takeuchi S, Wada K, Nagatani K, *et al* (2012): Hydrogen may inhibit collagen-induced platelet aggregation: An *ex vivo* and *in vivo* study. Intern Med, **51**: 1309-1313.

Takeuchi S, Nagatani K, Otani N, et al (2015): Hydrogen improves neurological function through attenuation of blood-brain barrier disruption in spontaneously hypertensive stroke-prone rats. BMC Neurosci, Apr 20;16 (1):22. doi: 10.1186/s12868-015-0165-3.

Tamaki N, Orihuela-Campos RC, Fukui M, *et al* (2016): Hydrogen-rich water intake accelerates oral palatal wound healing via activation of the Nrf2/antioxidant defense pathways in a rat model. Oxid Med Cell Long, **2016**: Article ID 5679040.

Tanaka Y, Teraoka F, Nakagawa M, *et al* (2020): Dependencies of hydrogen-water on mineral-based hardness, temperatures and the container materials, and effects of the oral washing and drinking. Med Gas Res, **10**: 67-74.

Tamaki I, Hata K, Okamura Y, *et al* (2018): Hydrogen flush after cold storage (HyFACS), as a new end-ischemia ex vivo treatment for liver grafts against ischemia/reperfusion injury. Liver transpl, **24**: 1589-1602.

Tamura T, Hayashida K, Sano M, *et al* (2016): Feasibility and safety of hydrogen gas inhalation for post-cardiac arrest syndrome. – First-in-human pilot study - . Circ J, **80**: 1870-1873.

Tamura T, Suzuki M, Hayashida K, *et al* (2020): Hydrogen gas inhalation alleviates oxidative stress in patients with post-cardiac arrest syndrome. J Clin Biochem Nutr, published online: 3 April 2020: 1-8. doi. 10. 3164/jcbn. 19-101.

Tan M, Sun X, Guo L, *et al* (2013): Hydrogen as additive of HTK solution fortifies myocardial preservation in grafts with prolonged cold ischemia. Int J Cardiol, **167**: 383-390.

Tan YC, Xie F, Zhang HL, *et al* (2014): Hydrogen-rich saline attenuates postoperative liver failure after major hepatectomy in rats. Clin Res Hepatol Gastroenterol, 2014 Feb 3. pii: S2210-7401(13)00265-9. doi: 10. 1016/j. clinre. 2013.11.007. [Epub ahead of print].

Tanaka Y, Saitoh Y, Miwa N, *et al* (2018): Electrolytically generated hydrogen warm water cleanses the keratin-plug-cogged hair-pores and promotes the capillary blood-streams, more markedly than normal warm dose. Med Gas Res. **8**: 12-18.

Tange Y, Takesawa S, Yoshitake S (2015): Dialysate with high dissolved hydrogen facilitates dissociation of indoxyl sulfate from albumin. Nephrourol Mon. **7**: e26847.

Tanaka Y, Shigemura N, Kawamura T, *et al* (2012): Profiling molecular changes induced by hydrogen treatment of lung allografts prior to procurement. Biochem Biophys Res Commun, **425**:873-879.

Tanaka Y, Saihala Y, Izumotani K, *et al* (2019): Daily ingestion of alkaline electrolyzed water containing hydrogen influences human health, including gastrointestinal symptoms. Med Gas Res, **8**: 160-166.

Tao B, Liu L, Wang N, *et al* (2015): Hydrogen-rich saline attenuates lipopolysaccharide-induced heart dysfunction by restoring fatty acid oxidation in rats by mitigating C-Jun N-terminal kinase activation. Shock, **44**: 593-600.

Tao B, Liu L, Wang N, *et al* (2016): Effects of hydrogen-rich saline on aquaporin 1, 5 in septic rat lungs. J Surg Res, **202**: 291-298.

Tao Y, Chen T, Fang W, et al (2017): The Comparative Efficiency of Intraperitoneal and Intravitreous Injection of Hydrogen Rich Saline against N-Methyl-N-Nitrosourea Induced Retinal Degeneration: A Topographic Study. Front Pharmacol., **29**;8:587.

Taura A, Kikkawa YS, Nakagawa T, *et al* (2010): Hydrogen protects vestibular hair cells from free radicals. Acta Otolaryngologica, **130**: 95-100.

Terasaki Y, Ohsawa I, Terasaki M, *et al* (2011): Hydrogen therapy attenuates irradiation-induced lung damage by reducing oxidative stress. Am J Physiol, **301**: L415-L426.

Terasaki Y, Suzuki T, Tonaki K, et al (2019): Molecular hydrogen attenuates gefitinib-induced exacerbation of naphthalene-evoked acute lung injury through a reduction in oxidative stress and inflammation. Lab Invest, 2019 Feb 1. doi; 10.1038/s41374-019-018-0187-

z. [Epub ahead of print].

Terasaki Y, Terasaki M, Kanazawa S, *et al* (2019): Effect of H2 treatment in a mouse model of rheumatoid arthritis-associated interstitial lung disease. J Cell Mol Med, 2019 Oct; **23** (10): 7043-7053.

Terawaki H, Hayashi Y, Zhu WJ, *et al* (2013): Transperitoneal administration of dissolved hydrogen for peritoneal dialysis patients: a novel approach to suppress oxidative stress in the peritoneal cavity. Med Gas Res, **3**: 14.

Terawaki H, Zhu WJ, Matsuyama Y, *et al* (2014): Effect of hydrogen (H2)-enriched solution on the albumin redox of hemodialysis patients. Hemodial Int, **18**: 459-466.

Terawaki H, Nakano H, Zhu WJ, *et al* (2015): Successful treatment of encapsulating peritoneal sclerosis by hemodialysis and peritoneal lavage using dialysate containing dissolved hydrogen. Perit Dial Int, **35**:107-112.

Tian L, Zhang L, Xia F, *et al* (2013): Hydrogen-rich saline ameliorates the retina against light-induced damage in rats. Med Gas Res, **3**: 19.

Tian R, Hou Z, Hao S, *et al* (2016): Hydrogen-rich water attenuates brain damage and inflammation after traumatic brain injury in rats. Brain Res, **1637**: 1-13.

Tian Y, Guo S, Zhang Y, *et al* (2016): Effects of hydrogen-rich saline on hepatectomy-induced postoperative cognitive dysfunction in old mice. Mol Neurobiol, 2016 Mar 19. [Epub ahead of print]

Tomofuji T, Kawabata Y, Kasuyama K, *et al* (2014): Effects of hydrogen-rich water on aging periodontal tissues in rats. Sci Rep, **4**: 5534, doi: 10. 1038/srep05534.

Tsubone H, Hanafusa M, Endo M, *et al* (2013): Effect of treadmill exercise and hydrogen-rich water intake on serum oxidative and anti-oxidative metabolites in serum of thoroughbred horses. J Equine Sci, **24**: 1-8.

Ushida T, Kotani T, Tsuda H, *et al* (2016): Molecular hydrogen ameliorates several characteristics of preeclampsia in the reduced uterine perfusion pressure (RUPP) rat model. Free Radic Biol Med, 2016 Oct 24. pii: S0891-5849(16)30978-9.doi; 10.1016/freeradbiomed.2016. 10.481. [Epub ahead of print].

Uto K, Sakamoto S, Que W, *et al* (2019): Hydrogen-rich solution attenuates cold ischemia-reperfusion injury in rat liver transplantation. BMC Gastroenterology, **19**: 25.

Varga V, Nemeth J, Olah O, *et al* (2018): Molecular hydrogen alleviates asphyxia-induced neural cyclooxygenase-2 expression in newborn pigs. Acta Pharmacol Sin. 2018 Mar 22. doi: 10.1038/aps. 2017. 148. [Epub ahead of print].

Wang C, Li J, Liu Q, *et al* (2011a): Hydrogen-rich saline reduces oxidative stress and inflammation by inhibit of JNK and NF-κB activation in a rat model of amyloid-beta-induced Alzheimer's disease. Neurosci Lett. **491**: 127-132.

Wang D, Wang L, Zhang Y, *et al* (2018): Hydrogen gas inhibits lung cancer progression through targeting SMC3. Biomed Pharmacol, **104**: 788-797.

Wang F, Yu G, Liu SY, *et al* (2011b): Hydrogen-rich saline protects against renal ischemia/reperfusion injury in rats. J Surg Res. **167**:

e339-344.

Wang H, Hou X, Chen H, *et al* (2018): Hydrogen-rich saline activated autophagy via HIF-1α pathways in neuropathic pain model. Biomed Res Int, Article ID: 4670834.

Wang J, Lin J, Zhang M, *et al* (2017): [Hydrogen can alleviate post-cardiac arrest myocardium injury in rabbits]. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue., (10):911-915.

Wang JL, Zhang QS, Zhu KD, *et al* (2015): Hydrogen-rich saline injection into the subarachnoid cavity within 2 weeks promotes recovery after acute spinal cord injury. Neural Regen Res, **10**: 958-964.

Wang LL, Guo SX, Wu P, *et al* (2018): Influences of hydrogen-rich saline on acute kidney injury in severely burned rats and mechanism. Zhonghua Shao Shang Za Zhi, **34**: 629-636. (in Chinese).

Wang P, Jia L, Chen B, *et al* (2016): Hydrogen inhalation is superior to mild hypothermia in improving cardiac function and neurological outcome in an asphyxia cardiac arrest model of rats. Shock, 2016 Feb 3. [Epub ahead of print].

Wang P, Zhao M, Chen Z, *et al* (2020): Hydrogen gas attenuates hypoxic-ischemic brain injury via regulation of the MAPK/HO-1/PGC-1a pathway in neonatal rats. Oxid Med Cell Longev, 2020 Feb 13; 2020: 6978784. doi: 10. 1155/2020/6978784. eCollection 2020.

Wang R, Wu J, Chen Z, et al (2016): Postconditioning with inhaled hydrogen promotes survival of retinal ganglion cells in a rat model of retinal ischemia/reperfusion injury. Brain Res, 2016 Feb 1; 1632: 82-90. doi: 10. 1016/j. brainres, 2015. 12. 015. Epub 2015 Dec 17.

Wang ST, Bao C, He Y, et al (2020): Hydrogen gas (XEN) inhalation ameliorates airway inflammation in asthma and COPD patients. QJM, 2020 May 14; hcaa 164. doi. 10: 1093/qimed/hcaa 164. Online ahead of print.

Wang T, Zhao L, Liu M, *et al* (2014): Oral intake of hydrogen-rich water ameliorated chlorpyrifos-induced neurotoxicity in rats. Toxicol App Pharmacol, **280**: 169-176.

Wang Y, Jing L, Zhao XM, *et al* (2011c): Protective effects of hydrogen-rich saline on monocrotaline-induced pulmonary hypertension in a rat model. Respir Res. **12**: 26.

Wang W, Tian L, Li Y, *et al* (2012a): Effects of hydrogen-rich saline on rats with acute carbon monoxide poisoning. J Emerg Med. 2012 Aug 14. [Epub ahead of print].

Wang QJ, Zha XJ, Kang ZM, *et al* (2012b): Therapeutic effects of hydrogen saturated saline on rat diabetic model and insulin resistant model via reduction of oxidative stress. Chin Med J (Engl): **125**: 1633-1637.

Wang W, Li Y, Ren J, *et al* (2012c): Hydrogen rich saline reduces immune-mediated brain injury in rats with acute carbon monoxide poisoning. Neurol Res, **34**: 1007-1015.

Wang X, Yu P, Yong Y, *et al* (2015): Hydrogen-rich saline resuscitation alleviates inflammation induced by severe burn with delayed resuscitation. Burns, **41**: 379-85.

Wang X, Zhang L, Zhao W, *et al* (2017): The protective effects of hydrogen on HO-1 expression in the brain after focal cerebral ischemia reperfusion in rats. Turk J Med Sci, **46**: 1534-1539.

Wang X and Wang J (2017): High-content hydrogen water-induced downregulation of miR-136 alleviates non-alcoholic fatty liver disease by regulating Nrf2 via targeting MEG3. Biol Chem. doi: 10.1515/hsz-2017-0303.

Wang Y, Zhang J, Bo J, *et al* (2019): Hydrogen-rich saline ameliorated LPS-induced acute lung injury via autophagy inhibition through the ROS/AMPK/m TOR pathway in mice. Exp Biol Med (Maywood), 2019 May 1: 1535370219847941. doi. 1177/1535370219847941. [Epub ahead of print].

Watanabe S, Fujita M, Ishihara M, *et al* (2014): Protective effects of inhalation of hydrogen gas on radiation-induced dermatitis and skin injury in rats. J Rad Res, 2014: 1-7, doi: 10. 1093/jrr067.

Watanabe K, Tsuji S, Hiramatsu N, *et al* (2018): Effects of hydrogen-rich water on attenuating fatigue induced by daily activities or mental tasks. Jpn Pharmacol Ther, 46: 581-597. (in Japanese)

Wei L, Ge L, Qin S, *et al* (2012): Hydrogen-rich saline protects retina against glutamate-induced excitotoxic injury in guinea pig. Exp Eye Res. **94**: 117-127.

Wei R, Zhang R, Xie Y, *et al* (2015): Hydrogen suppresses hypoxia/reoxygenation-induced cell death in hippocampal neurons through reducing oxidative stress. Cell Physiol Biochem. **36**: 585-598.

Wen D, Zhao P, Hui R, *et al* (2017): Hydrogen-rich saline attenuates anxiety-like behaviors in morphine-withdrawn mice. Neuropharmacology, **118**: 199-208.

Wen D, Hui R, Wang J, *et al* (2019): Effects of molecular hydrogen on methamphetamine-induced neurotoxicity and spatial memory impairment. Front Pharmacol, 2019 Jul 23; 10: 823.

Wu CY, Hsu WL, Tsai MH, *et al* (2017): Hydrogen gas protects IP3Rs by reducing disulfide bridges in human keratinocytes under oxidative stress. Sci Rep., **7**(1):3606.

Wu F, Qiu Y, Ye G, *et al* (2015): Treatment with hydrogen molecule attenuates cardiac dysfunction in streptozotocin-induced diabetic mice. Cardiovasc Pathol., 24:294-303.

Wu G, Chen Z, Wang P, *et al* (2019): Hydrogen inhalation protects hypoxic-ischemic brain damage by attenuating inflammation and apoptosis in neonatal rats. Exp Biol Med (Maywood), **244**: 1017-1027.

Wu J, Wang R, Yang D, *et al* (2018): Hydrogen postconditioning promotes survival of rat retinal ganglion cells against ischemia/reperfusion injury through the PI3K/Akt pathway. Biochem Biophys Res Commun, **495**: 2462-2468.

Wu MJ, Chen M, Sang S, *et al* (2017): Protective effects of hydrogen rich water on the intestinal ischemia/reperfusion injury due to intestinal intussusception in a rat model. Med Gas Res. **30**;7(2):101-106.

Wu S, Zhu L, Yang J, *et al* (2014): Hydrogen-containing saline attenuates doxorubicin-induced heart failure in rats. Pharmazie, **69**: 633-636.

Wu X, Li X, Liu Y, *et al* (2018): Hydrogen exerts neuroprotective effects on OGD/R damaged neurons in rat hippocampal by protecting mitochondrial function via regulating mitophagy mediated by PINK1/Parkin signaling pathway. Brain Res, **1698**: 89-98.

Xiang L, Tan JW, Huang LJ, *et al* (2012): Inhalation of hydrogen gas reduces liver injury during major hepatotectomy in swine. World J Gastroentenol **18**: 5197-5204.

Xiao HW, Li Y, Luo D, et al (2018): Hydrogen-water ameliorates radiation-induced gastrointestinal toxicity via MyD88's effects on the gut microbiota. Exp Mol Med. **50**: e433. doi: 10. 1038/emm.2017.246.

Xie K, Wang W, Chen H, *et al* (2015): Hydrogen-Rich medium attenuated lipopolysaccharide-induced monocyte-endothelial cell adhesion and vascular endothelial permeability via rho-associated coiled-coil protein kinase. Shock. **44**: 58-64.

Xin Y, Liu H, Zhang P, *et al* (2017): Molecular hydrogen inhalation attenuates postoperative cognitive impairment in rats. Neuroreport., **28**(11):694-700.

Xing Z, Pan W, Zhang J, *et al* (2017): Hydrogen rich water attenuates renal injury and fibrosis by regulation transforming growth factor-β induced Sirt1. Biol Pharm Bull, **40**: 610-615.

Xu B, Zhang YB, Li ZZ, *et al* (2013): Hydrogen-rich saline ameliorates renal injury induced by unilateral ureteral obstruction in rats. Int Immunopharmacol. **17**: 447-452.

Xu F, Yu S, Qin M, *et al* (2017): Hydrogen-Rich Saline Ameliorates Allergic Rhinitis by Reversing the Imbalance of Th1/Th2 and Up-Regulation of CD4+CD25+Foxp3+Regulatory T Cells, Interleukin-10, and Membrane-Bound Transforming Growth Factor-β in Guinea Pigs. Inflammation. 2017 Sep 11. doi: 10.1007/s10753-017-0666-6.

Xu J, Zhang Q, Zheng W, *et al* (2019): Morphological and molecular response of small intestine to lactulose and hydrogen-rich water in female piglets fed Fusarium mycotoxins contaminated diet. J Anim Sci Biotechnol, 2019 Feb 13; 10.1186/s40104-019-0320-2. eCollection 2019.

Xu H, Meng X, Cui Y, *et al* (2019): The neuroprotective hyperoxygenate hydrogen-rich saline on CO-induced brain injury in rats. Environ Toxicol Pharmacol. **67**: 117-123.

Xu XF, and Zhang J (2013): Saturated hydrogen saline attenuates endotoxin-induced acute liver dysfunction in rats. Physiol Res, **62**: 395-403.

Xu Z, Zhou J, Cai J, *et al* (2012): Anti-inflammation effects of hydrogen saline in LPS activated macrophages and carrageenan induced paw edema. J Inflammation, **9**: 2.

Xue J, Shang G, Tanaka Y, *et al* (2014): Dose-dependent inhibition of gastric injury by hydrogen in alkaline electrolyzed drinking water. BMC Complement Altern Med, **14**: 81

Xia C, Liu W, Zeng D, *et al* (2013): Effect of hydrogen-rich water on oxidative stress, liver function, and viral load in patients with chronic hepatitis B. Clin Trans Sci, **6**: 372-375.

Xiao L and Miwa N (2016): Hydrogen-rich water achieves cytoprotection from oxidative stress injury in human gingival fibroblasts in culture or 3D-tissue equivalents, and wound-healing promotion, together with ROS-scavenging and relief from glutathione diminishment. Hum Cell, 2016 Nov 1. [Epub ahead of print].

Xiao M, Zhu T, Wang T, *et al* (2013): Hydrogen-rich saline reduces airway remodeling via inactivation of NF-κB in a murine model of asthma. Eur Rev Med Pharmacol Sci, **17**: 1033-1043.

Xiao X, Cai J, Xu J, *et al* (2012): Protective effects of hydrogen saline on diabetic retinopathy in a streptozotocin-induced diabetic rat model. J Ocul Pharmacol Ther. **28**:76-82.

Xie K, Yu Y, Pei Y, *et al* (2010a): Protective effects of hydrogen gas on murine polymicrobial sepsis via reducing oxidative stress and HMGB1 release. Shock, **34**: 90-97.

Xie K, Yu Y, Zhang Z, *et al* (2010b): Hydrogen gas improves survival rate and organ damage in zymosan-induced generalized inflammation model. Shock, **34**: 495-501.

Xie K, Yu Y, Huang Y, *et al* (2012a): Molecular hydrogen ameliorates lipopolysaccharide-induced acute lung injury in mice through reducing inflammation and apoptosis. Shock. **37**: 548-55.

Xie K, Fu W, Xing W, *et al* (2012b): Combination therapy with molecular hydrogen and hyperoxia in a murine model of polymicrobial sepsis. Shock, **38**: 655-663.

Xie K[1], Wang W, Chen H, *et al* (2015): Hydrogen-rich medium attenuated lipopolysaccharide-induced monocyte-endothelial cell adhesion and vascular endothelial permeability via Rho-associated coiled-coil protein kinase. Shock. **44**: 58-64.

Xie Q, Li XX, Zhang P, *et al* (2014): Hydrogen gas protects against serum and glucose deprivation-induced myocardial injury in H9c2 cells through activation of the NF-E2-related factor 2/heme oxygenase 1 signaling pathway. Mol Med Rep. **10**:1143-1149.

Xin HG, Zhang BB, Wu ZQ, *et al* (2014): Consumption of hydrogen-rich water alleviates renal injury in spontaneous hypertensive rats. Mol Cell Biochem, 2014 Mar 21. [Epub ahead of print].

Xu FF, Yu SQ, Zhao CL, *et al* (2017): [Effect of hydrogen-rich saline on the CD4(+) CD25(+) Foxp3(+) Treg cells of allergic rhinitis guinea pigs model]. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi., **52**(7):506-511.

Yamada T, Uchida K, Onuma K, *et al* (2014): Hydrogen supplementation of preservation solution improves viability of osteochondral grafts. The Sci World J, **2014**: Article ID 109876.

Yamamoto R, Homma K, Suzuki S, *et al* (2019): Hydrogen gas distribution in organs after inhalation: Real-time monitoring of tissue hydrogen concentration in rat. Sci Rep, **9**: 1255.

Yamasaki M, Miyazono M, Yoshihara M, *et al* (2019): Effects of hydrogen-rich water in a rat model of polycystic kidney disease. PLoS ONE, **14**: e0215766.

Yamazaki M, Kusano K, Ishibashi T, et al (2015): Intravenous infusion of H2-saline suppresses oxidative stress and elevates antioxidant potential in thoroughbred horses after racing exercise. Sci Rep, 5: 15514; DOI 10.1038/srep15514.

Yan H, Tian H, Kinjo T, *et al* (2010): Extension of the lifespan of *Caenorhabditis elegans* by the use of electrolyzed reduced water. Biosci Biotechnol Biochem, **74**: 2011-2015.

Yan W, Chen T, Long P, *et al* (2018): Effects of post-treatment hydrogen gas inhalation on uveitis induced by endotoxin in rats. Med

Sci Monit, 24: 3840-3847.

Yan WM, Chen T, Wang XC, *et al* (2017): The reason for the amelioration of N-methyl-N-nitrosourea-induced retinitis pigmentosa in rats by hydrogen-rich saline. Int J Ophthalmol., **10**(10):1495-1503.

Yan WM, Zhang L, Chen T, *et al* (2017): Effects of hydrogen-rich saline on endotoxin-induced uveitis. Med Gas Res, **7**: 9-18.

Yanagihara T, Arai K, Miyamae K, *et al* (2005): Electrolyzed hydrogen-saturated water for drinking use elicits an antioxidative effect: A feeding test with rats. Biosci Biotechnol Biochem, **69**: 1985-1987.

Yang CX, Yan H, Ding TB, *et al* (2013): Hydrogen saline prevents selenite-induced cataract in rats. Molecular Vision, **19**: 1684-1693.

Yang L, Li D, and Chen D (2016): Hydrogen water reduces NSE, IL-6, and TNF-α levels in hypoxic-ischemic encephalopathy. Open Med, **11**: 399-406.

Yang Q, Ji G, Pan R, *et al* (2017): Protective effect of hydrogen-rich water on liver function of colorectal cancer patients treated with mFOLFOX6 chemotherapy. Mol Clin Oncol. **7**(5):891-896.¥¥

Yao W, Lin X, Han X, *et al* (2019): MicroRNA files in the prevention of intestinal ischemia/reperfusion injury by hydrogen rich saline. Biosci Rep. 2019 Dec 2. pii; BSR20191043. doi: 10. 1042/BSR20191043. [Epub ahead of print].

Yonamine R, Satoh Y, Kodama M, *et al* (2013): Co-administration of hydrogen gas as part of the carrier gas mixture suppresses neuronal apoptosis and subsequent behavioral deficits caused by neonatal exposure to sevoflurane in mice. Anesthesiology, **118**: 105-113.

Yoneda T, Tomofuji T, Kunitomo M, *et al* (2017): Preventive effects of drinking hydrogen-rich water on gingival oxidative stress and alveolar bone resorption in rats fed a high-fat diet. Nutrients 2017, 9, 64; 10. 3390/nu9010064.

Yoshii Y, Inoue T, Uemura Y, *et al* (2017): Complexity of stomach-brain interaction induced by molecular hydrogen in Parkinson's disease model mice. Neurochem Res, **42**: 2658-2665.

Yan M, Yu Y, Mao X, *et al* (2019): Hydrogen gas inhalation attenuates sepsis-induced liver injury in a FUNDC-dependent manner. Int Immunopharmacol, **71**: 61-67.

Yang F, Chen Z, Chen SA, *et al* (2019): Skin ulcers infected with conditional pathogenic strains treated with local hydrogen water packing in two pemphigus vulgaris patients: Case reports with follow-up for 2 months. Dermatol Ther, **32**: e13027.

Yang S, He J, Li X, *et al* (2018): Hydrogen attenuated oxidized low-density lipoprotein-induced inflammation through the stimulation of autophagy via sirtuin 1. Exp Ther Med, **16**: 4042-4048.

Yang X, Guo L, Sun X, *et al* (2011): Protective effects of hydrogen-rich saline in preeclampsia rat model. Placenta. **32**: 681-686.

Yang Y, Li B, Liu C, *et al* (2012): Hydrogen-rich saline protects immunocytes from radiation-induced apoptosis. Med Sci Monit. **18**: BR144-148.

Yang Y, Gao F, Zhang H, *et al* (2013): Molecular hydrogen protects human lymphocyte AHH-1 cells against 12C6+ heavy ion radiation. Int J Radiat Biol, **89**:1003-1008.

Yang Y, Liu PY, Bao W, *et al* (2020): Hydrogen inhibits endometrial cancer growth via a ROS/NLRP3/Caspase-1/GSDMD-mediated pyroptotic pathway. BMC Cancer, **20**: 28.

Yao HT, Yang YH, Li ML (2019): Intake of molecular hydrogen in drinking water increase membrane transporters, p-glycoprotein, and multidrug resistance-associated protein 2 without affecting xenobiotic-metabolizing enzymes in rat liver. Molecules, **24** (14): 2627.

Yao L, Chen H, Wu Q, *et al* (2019): Hydrogen-rich saline alleviates inflammation and apoptosis in myocardial I/R injury via PINK-mediated autophagy. Int J Mol Med, **44**: 1048-1062.

Yao W, Guo A, Han X, *et al* (2019): Aerosol inhalation of a hydrogen-rich solution restored septic renal function. Aging, **11**: 12097-12113.

Ye J, Li Y, Hamasaki T, *et al* (2008): Inhibitory effect of electrolyzed reduced water on tumor angiogenesis. Biol Pharm Bull, **31**: 19-26.

Yokota T, Kamimura N, Igarashi T, *et al* (2015): Protective effect of molecular hydrogen against oxidative stress caused by peroxynitrite derived from nitric oxide in rat retina. Clin Experiment Ophthalmol, 2015 Mar 20. doi: 10.1111/ceo. 12525. [Epub ahead of print].

Yoon KS, Huang XZ, Yoon YS, *et al* (2011a): Histological study on the effect of electrolyzed reduced water-bathing on UVB radiation-induced skin injury in hairless mice. Biol Pharm Bull, **34**: 1671-1677.

Yoon YS, Kim DH, Kim SK, *et al* (2011b): The melamine excretion effect of the electrolyzed reduced water in melamine-fed mice. Food Chem Toxicol, **49**: 1814-1819.

Yoon YS, Sajo ME, Ignacio RM, *et al* (2014): Positive effects of hydrogen water on 2,4-dinitrochlorobenzene-induced atopic dermatitis in NC/Nga mice. Bio Pharm Bull, 2014; 37 (9): 1480-1485.

Yoritaka A, Takanashi M, Hirayama M, *et al* (2013): Pilot study of H2 therapy in Parkinson's disease. A randomized double-blind placebo-controlled trial. Mov Disord, **28**: 836-839.

Yoshida A, Asanuma H, Sasaki H, *et al* (2012): H_2 mediates cardioprotection via involvements of K_{ATP} channels and permeability transition pores of mitochondria in dogs. Cardiovasc Drugs Ther, **26**: 217-226.

Yu J, Zhang W, Zhang R, *et al* (2015): Molecular hydrogen attenuates hypoxia/reoxygenation injury of intrahepatic cholangiocytes by activating Nrf2 expression. Toxicol Lett, **238**: 11-19.

Yu J, Yu Q, Liu Y, *et al* (2017): Hydrogen gas alleviates oxygen toxicity by reducing hydroxyl radical levels in PC12 cells. PLoS ONE, 12: e0173645.

Yu P, Wang Z, Sun X, *et al* (2011): Hydrogen-rich medium protects human skin fibroblasts from high glucose or mannitol induced oxidative damage. Biochem Biophys Res Commun, **409**: 350-355.

Yu S, Zhao C, Che N, *et al* (2017): Hydrogen-rich saline attenuates eosinophil activation in a guinea pig model of allergic rhinitis via reducing oxidative stress. J Inflamm (Lond). **14**: 1. doi 10.1186/s12950-016-0148-x. eCollection 2017.

Yu Y, Wang WN, Han HZ, *et al* (2015): Protective effects of hydrogen-rich medium on lipopolysaccharide-induced monocytic adhesion and vascular endothelial permeability through regulation of vascular endothelial cadherin. Genet Mol Res, **14**: 6202-6212.

Yu Y, Yang Y, Bian Y, *et al* (2017): Hydrogen gas protects against intestinal injury in wild type but not NRF2 knockout mice with severe sepsis by regulating HO-1 and HMGB1 release. Shock, 2017 Feb 23. doi: 10. 1097/SHK. 0000000000000856. [Epub ahead of print].

Yu Y, Yang Y, Yang M, *et al* (2019): Hydrogen gas reduces HMGB1 release in lung tissues of septic mice in an Nrf/HO-1-dependent pathway. Int Immunopharmacol, 2019 Apr; 69; 11-18. doi: 10. 1016/j. intimp 2019.01.022. Eub 2019. Jan 18.

Yu YS, and Zheng H. (2012): Chronic hydrogen-rich saline treatment reduces oxidative stress and attenuates left ventricular hypertrophy in spontaneous hypertensive rats. Mol Cell Biochem. **365**: 233-242.

Yu J, Zhang W, Zhang R, *et al* (2015): Lactulose accelerates liver regeneration in rats by inducing hydrogen. J Surg Res. **195**:128-135.

Yuan L, Chen X, Qian L, *et al* (2015): Administration of hydrogen-rich saline in mice with allogeneic hematopoietic stem-cell transplantation. Med Sci Monit. **21**:749-754.

Yuan J, Wang D, Liu Y, *et al* (2016): Effects of hydrogen rich water on the expression of Nrf 2 and the oxidative stress in rats with traumatic brain injury. Chin Crit Care Med, **27**: 911-915. (in Chinese).

Yuan J, Wang D, Liu Y, *et al* (2018): Hydrogen-rich water attenuates oxidative stress in rats with traumatic brain injury via Nrf2 pathway. J Surg Res, 228: 238-246.

Zalesak M, Kura B, Graban J, et al (2017): Molecular hydrogen potentiates beneficial anti-infarct effect of hypoxic postconditioning in isolated rat hearts: a novel cardioprotective intervention. Can J Physiol Pharmacol 2017 Mar 28: 1-6. doi: 10. 1139/cipp-2016-0693. [Epub ahead of print].

Zeng K, Huang H, Jiang XQ, *et al* (2014): Protective effects of hydrogen on renal ischemia/reperfusion injury in rats. Sichuan Da Xue Xue Bao Yi Xue Ban, **45**: 39-41. (in Chinese).

Zhai X, Chen X, Lu J, *et al* (2017): Hydrogen-rich saline improves non-alcoholic fatty liver disease by alleviating oxidative stress and activating hepatic PPARα and PPARγ. Mol Med Rep. 15: 1305-1312.

Zhai Y, Zhou X, Dai Q, *et al* (2015): Hydrogen-rich saline ameliorates lung injury associated with cecal ligation and puncture-induced sepsis in rats. Exp Mol Pathol. **98**:268-276.

Zhai Y, Zhou XH, Liu H, *et al* (2019): The interventional effects of saturated hydrogen saline on lung injury in rats with cecal ligation and puncture operation. Zhongguo Ying Yong Sheng Li Xue Za Zhi, **35**: 107-112. (in Chinese).

Zhan Y, Chen C, Suzuki H, *et al* (2012): Hydrogen gas ameliorates oxidative stress in early brain injury after subarachnoid hemorrhage in rats. Crit Care Med. **40**: 1291-1296.

Zhang B, Zhao Z, Meng X, *et al* (2018): Hydrogen ameliorates oxidative stress via PI3K-Akt signaling pathway in UVB-induced HaCaT cells. Int J Mol Med. 2018 Mar 7. doi: 10. 3892/ijmm. 2018. 3550. [Epub ahead of print].

Zhang CB, Tang YC, Xu XJ, *et al* (2015): Hydrogen gas inhalation protects against liver ischemia/reperfusion injury by activating the NF-κB signaling pathway. Exp Ther Med. **9**:2114-2120.

Zhang DQ and Zhu JH (2012): Experimental studies of effects of hydrogen-rich saline in rats with severe acute pancreatitis. Zhonghua Yi Xue Za Zhi, **92**: 2436-2440. (in Chinese).

Zhang DQ, Feng H, and Chen WC (2013): Effects of hydrogen-rich saline on taurocholate-induced acute pancreatitis in rat. Evid Based Complement Alternat Med, **2013**: 731932. doi: 10.1155/2013/731932. [Epub ahead of print].

Zhang G, Gao S, Li X, et al (2015): Pharmacological postconditioning with lactic Acid and hydrogen rich saline alleviates myocardial reperfusion injury in rats. Sci Rep. 2015 Apr 30;5:9858. doi: 10.1038/srep09858

Zhang J, Wu Q, Song S, *et al* (2014): Effect of hydrogen-rich water on acute peritonitis of rat models. Int Immmunopharmacol, 2014 Apr 29. pii: S1567-5769(14)00147-7. doi: 10. 1016/j. intimp. 2014. 04. 011. [Epub ahead of print].

Zhang J, Xue X, Han X, *et al* (2017): Hydrogen-rich water ameliorates total body irradiation-induced hematopoietic stem cell injury by reducing hydroxyl radical. Oxid Med Cell Longev. 2017: 2017: 8241678. doi: 10. 1155/2017/8241678. [Epub ahead of print].

Zhang J, Zhou H, Liu J, *et al* (2019): Protective effects of hydrogen inhalation during the warm ischemia phase against lung ischemia-reperfusion injury in rat donors after cardiac death. Microvasc Res, **125**: 103885.

Zhang JY, Wu QF, Wan Y, *et al* (2013): Protective role of hydrogen-rich water on aspirin-induced gastric mucosal damage in rats. World J Gastroenterol, **20**: 1614-1622.

Zhang JY, Song SD, Pang Q, *et al* (2015): Hydrogen-rich water protects against acetaminophen-induced hepatotoxicity in mice.World J Gastroenterol, **21**:4195-209.

Zhang L, Shu R, Wang H, *et al* (2014a): Hydrogen-rich saline prevents remifentanil-induced hyperalgesia and inhibits MnSOD nitration via regulation of NR2B-containing NMDA receptor in rats. Neuroscience, 2014 Sep 18; 280C: 171-180. doi: 10. 1016/j. neuroscience. 2014. 09. 024. [Epub ahead of print].

Zhang L, Shu R, Wang C, *et al* (2014b): Hydrogen-rich saline controls remifentanil-induced hypernociception and NMDA receptor NR1 subunit membrane trafficking through GSK-3β in the DRG in rats. Brain Res Bull, **106**: 47-55.

Zhang L, Zhao P, Yue C, *et al* (2019): Sustained release of bioactive hydrogen by Pd hydride nanoparticles overcomes Alzheimer's disease. Biomaterials 2019 Mar; 197: 393-404.

Zhang N, Deng C, Zhang X, *et al* (2018): Inhalation of hydrogen gas attenuates airway inflammation and oxidative stress in allergic asthmatic mice. Asthma Res Pract. **4**: 3.

Zhang Q, Tao Y, Zhang ZM (2016): Hydrogen-rich saline is ineffective in oxygen-induced retinopathy. Life Sci, 2016 Apr 14, pii: S0024-3205(16)30236-3. doi: 10. 1016/j. lfs. 2016. 04. 015. [Epub ahead of print].

Zhang Q, Ge Y, Li H, *et al* (2018): Effect of hydrogen-rich saline on apoptosis induced by hepatic ischemia reperfusion upon laparoscopic hepatectomy in miniature pigs. Res Vet Sci, **119**: 285-291.

Zhang Q, Piao C, Xu J, *et al* (2019): Comparative study on protective effect of hydrogen rich saline and adipose-derived stem cells on hepatic ischemia-reperfusion and hepatectomy injury. Biomed Pharmacother, 2019 Sep 24; **120**: 109453.

Zhang W, Huang C, Sun A, *et al* (2018): Hydrogen alleviates cellular senescence via regulation of ROS/p53/p21 pathway in bone marrow-derived mesenchymal stem cells in vivo. Biomed Pharmacother, **106**: 1126-1134.

Zhang Y, Liu Y, Zhang J (2015): Saturated saline attenuates endotoxin-induced lung dysfunction. J Surg Res, **198**: 41-49.

Zhang Y, Li H, Yang C, *et al* (2015): Treatment with hydrogen-rich saline delays disease progression in a mouse model of amyotrophic lateral sclerosis. Neurochem Res, 2015 Nov 4. [Epub ahead of print].

Zhang Y, Su WJ, Chen Y, *et al* (2016): Effects of hydrogen-rich water on depressive-like behavior in mice. Sci Rep, **6**: 23742.

Zhang Y, Sun Q, He B, *et al* (2011): Anti-inflammatory effect of hydrogen-rich saline in a rat model of regional myocardium ischemia and reperfusion. Int J Cariol, **148**: 91-95.

Zhang YG, Sheng QS, Wang ZJ, *et al* (2015): Hydrogen-rich saline promotes motor functional recovery following peripheral nerve autografting in rats. Exp Ther Med, **10**: 727-732.

Zhang YX, Xu JT, You XC, *et al* (2016): Inhibitory effects of hydrogen on proliferation and migration of vascular smooth muscle cells via down-regulation of mitogen/activated protein kinase and ezrin-radixin-signaling pathways. Chin J Physiol, **59**: 46-55.

Zhang X, Liu J, Jin K, *et al* (2018): Subcutaneous injection of hydrogen gas is a novel effective treatment for type 2 diabetes. J Diabetes Investig, **9**: 83-90.

Zhao C, Yu S, Li J, *et al* (2017): Changes in IL-4 and IL-13 expression in allergic-rhinitis treated with hydrogen-rich saline in guinea-pig model. Allergol Immunopathol (Madr), 2017 Feb 15, pii; S0301-0546(16)30160-4. doi: 10. 1016/j. aller. 2016. 10. 007. [Epub ahead of print].

Zhao L, Zhou C, Zhang J, *et al* (2011): Hydrogen protects mice from radiation induced thymic lymphoma in BALB/c mice. Int J Bio Sci, **7**: 297-300.

Zhao L, Wang YB, Qin SR, *et al* (2013): Protective effect of hydrogen-rich saline on ischemia/reperfusion injury in rat skin flap. J Zhejiang Univ Sci B, **14**: 382-391.

Zhao L, Chen X, Dai Q, *et al* (2015): Role of FOXO3a in process of hydrogen-rich saline attenuating global cerebral ischemia-reperfusion injury in rats. Zhonghua Yi Xue Za Zhi, **95**: 457-461. (in Chinese).

Zhao M, Liu MD, Pu YY, *et al* (2016): Hydrogen-rich water improves neurological function recovery in experimental autoimmune encephalomyelitis mice. J Neuroimmunol, **294**: 6-13.

Zhao S, Mei K, Qian L, *et al* (2013): Therapeutic effects of hydrogen-rich solution on aplastic anemia *in vivo*. Cell Physiol Biochem, **32**: 549-560.

Zhao S, Yang Y, Liu W, *et al* (2014): Protective effect of hydrogen-rich saline against radiation-induced immune dysfunction. J Cell

Mol Med, J Cell Mol Med, 2014 Mar 12. doi: 10.1111/jcmm. 12245. [Epub ahead of print].

Zhao Y, Tang Y, Suo C, *et al* (2014): Effects of hydrogen-rich saline on endoplasmic reticulum stress during myocardial ischemia-reperfusion in rats. Zhonghua Yi Xue Za Zhi. 94:3024-3028. (in Chinese).

Zhao Y, Wei L, Zhang XW, *et al* (2020): Effects of low concentration hydrogen inhalation on asthma and sleep function in mice. Sichuan Da Xue Xue Bao, **51**: 219-224. (in Chinese).

Zhao YS, An JR, Yang S, *et al* (2019): Hydrogen and oxygen mixture to improve cardiac dysfunction and myocardial pathological changes induced by intermittent hypoxia in rats. Oxid Med Cell Longev, 2019: Article ID 7415212.

Zheng H, and Yu YS. (2012): Chronic hydrogen-rich saline treatment attenuates vascular dysfunction in spontaneous hypertensive rats. Biochem Pharmacol. **83**: 1269-1277.

Zheng W, Ji X, Zhang Q, et al (2018): Hydrogen-rich water and lactulose protect against growth suppression and oxidative stress in female piglets fed *Fusarium* toxins contaminated diets. Toxins (Basel). 2018 Jun 4; 10(6). pii: E228. doi: 10. 3390/toxins. 10060228.

Zheng X, Mao Y, Cai J, *et al* (2009): Hydrogen-rich saline protects against intestinal ischemia/reperfusion injury in rat. Free Rad Res, **43**: 478-484.

Zheng J, Liu K, Kang Z, *et al* (2010): Saturated hydrogen saline protects the lung against oxygen toxicity. Undersea Hyperb Med, **37**: 185-192.

Zhou J, Chen Y, Huang GQ, *et al* (2012a): Hydrogen-rich saline reverses oxidative stress, cognitive impairment, and mortality in rats submitted to sepsis by cercal ligation and puncture. J Surg Res. 2012 Apr 1. [Epub ahead of print].

Zhou L, Wang X, Xue W, *et al* (2013): Beneficial effects of hydrogen-rich saline against spinal cord ischemia-reperfusion injury in rabbits. Brain Res, 2013 Apr 17, doi; 10. 1016/j. brainres. 2013. 04. 007. [Epub ahead of print].

Zhou P, Lin B, Wang P, *et al* (2018): The healing effect of hydrogen-rich water on acute radiation-induced skin injury in rats. J Radia Res, 2018 Sep 27. doi: 10. 1093/jrr/rry074. [Epub ahead of print].

Zhou Y, Zheng H, Ruan F, *et al* (2012b): Hydrogen-rich saline alleviates experimental noise-induced hearing loss in guinea pigs. Neuroscience. **209**: 47-53.

Zhou H, Fu Z, Wei Y, *et al* (2013): Hydrogen inhalation decrease lung graft injury in brain-dead donor rats. J Heart Lung Transplant, **32**: 251-258.

Zhou HX, Han B, Hou LM, *et al* (2016): Protective effects of hydrogen gas on experimental acute pancreatitis. PLoS One, Doi: 10. 1371/journal. Pone. 0154483.

Zhou ZQ, Zhong CH, Su ZQ, *et al* (2018): Breathing hydrogen-oxygen decreases inspiratory effort in patients with tracheal stenosis. Respiration, 2018 Sep 18: 1-10. doi: 10. 1159/000492031. [Epub ahead of print].

Zhu Q, Wu Y, Li Y, *et al* (2018): Positive effects of hydrogen-water bathing in patients of psoriasis and parapsoriasis en plaques. Sci Rep. **8**: 8051. doi: 10. 1038/s41598-018-26388-3.

Zhu WJ, Nakayama M, Mori T, *et al* (2011): Intake of water with high levels of dissolved hydrogen (H_2) suppresses ischemia-induced cardio-renal injury in Dahl salt-sensitive rats. Nephrol Dial transplant, **26**: 2112-2118.

Zhu WJ, Nakayama M, Mori T, *et al* (2013): Amelioration of cardio-renal injury with aging in dahl salt-sensitive rats by H2-enriched electrolyzed water. Med Gas Res, **3**: 26.

Zhuang X, Yu Y, Jiang Y, et al (2020): Molecular hydrogen attenuates sepsis-induced neuroinflammation through regulation of microglia polarization through an mTOR-autophagy-dependent pathway. Int Immunopharmacol, 2020 Apr, 81: 106287. doi. 10. 1016/j. intimp 2020. 106287. Epub 2020 Feb 10.

Zhuang K, Zuo YC, Sherchan P, *et al* (2020): Hydrogen inhalation attenuates oxidative stress related endothelial cells injury after subarachnoid hemorrhage in rats. Front Neurosci, **13**: 1441.

Zhuang Z, Zhou ML, You WC, *et al* (2012): Hydrogen-rich saline alleviates early brain injury via reducing oxidative stress and brain edema following experimental subarachnoid hemorrhage in rabbits. BMC Neurosci. **13**: 47.

Zhuang Z, Sun XJ, Zhang X, *et al* (2013): Nuclear factor-κB/Bcl-XL pathyway is involved in the protective effect of hydrogen-rich saline on the brain following experimental subarachnoid hemorrhage in rabbits. J Neurosci Res, 2013 Sep 16. doi: 10. 1002/jnr. 23281. [Epub ahead of print].

Zong C, Song G, Yao S, *et al* (2012): Administration of hydrogen-saturated saline decreases plasma low-density lipoprotein cholesterol levels and improves high-density lipoprotein function in high-fat diet-fed hamsters. Metabolism, **61**: 79.

Zou R, Wang MH, Chen Y, *et al* (2018): Hydrogen-rich saline attenuates acute lung injury induced by limb ischemia/reperfusion via down-regulation chemerin and NLRP3 in rats. Shock, 2018 May 29. doi: 10. 1097/SHK. 0000000000001194. [Epub ahead of print].