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W81XWH-11-2-0019

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“Intraosseous Erythropoietin for Acute Tissue Protection in Battlefield Casualties Suffering Hypovolemic Shock”

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14. ABSTRACT The project compared in a swine model of hemorrhagic shock (HS) the effects of vasopressin (VP) infusion and low-volume fluid resuscitation using normal saline (NS) on 72 hour survival, with erythropoietin (EPO) administration and HS severity as confounders. Twenty-four male pigs (36-41 kg) were anesthetized with isoflurane and nitrous oxide in oxygen and instrumented to assess hemodynamic function and advance a 23-F cannula into the right atrium for blood withdrawal (BW) and blood reinfusion using a custom developed system that allowed modeling spontaneous bleeding as a mono-exponential decay function. Twenty-four pigs were randomized 2:1 to receive an intraosseous infusion of VP (0.04 U/kg·min ⁻¹) or vehicle control starting 7 minutes into BW until the start of blood reinfusion at minute 210. Pigs were also randomized 1:1 to receive NS (half the amount of BW) or no fluids. Pigs assigned to VP were also randomized 1:1 to EPO (1,200 U/kg) or vehicle control and to have 65% or 75% of their blood volume withdrawn. Randomization proceeded by blocks ensuring balanced distribution in all the subsets. Survival analysis to 72 hours showed that survival was influenced by VP and NS but not by EPO or HS severity with the highest survival rate in the group VP-NS (100%) followed by VP-noNS (37.5%), noVP-NS (25%), and noVP-noNS (0%) with a high overall statistical significance ($p=0.009$ by the log-rank test) with each subset different than VP-NS by the Holm-Sidak's test. Accordingly, these findings support an approach to the initial management of severe HS in the field that entails early initiation of VP infusion through the intraosseous route followed by low-volume fluid resuscitation (e.g., small boluses of normal saline).					
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Table of Contents

	Page
Introduction.....	4
Body.....	4
Key Research Accomplishments.....	11
Reportable Outcomes.....	11
Conclusion.....	11
References.....	12
Appendices.....	12
Supporting Data (included in body)	

INTRODUCTION

Hemorrhagic shock after penetrating trauma in the battlefield accounts for a high percentage of potentially survivable injuries. A report on 4,596 battlefield fatalities between October 2001 and June 2011 in Operation Iraqi Freedom and Operation Enduring Freedom showed that 87% of such fatalities occurred before arrival to a medical treatment facility with 24% deemed potentially survivable.¹ Of these potentially survivable injuries, 91% were associated with hemorrhage. Control of bleeding in compressible areas is highly effective and can save lives. However, severe hemorrhage can compromise vital organ perfusion and survivability. Fluid resuscitation is hemodynamically effective but is logistically constrained in the battlefield and not free of complications. In large quantities, fluids can precipitate coagulopathy by dilution and hypothermia and dislodge freshly formed clots. Similar considerations apply to hemorrhage associated with trauma in civilian populations. We have previously shown in a swine model of hemorrhagic shock – while investigating the effects of erythropoietin (EPO) – that vasopressin (VP) infusion promotes hemodynamic stability.² During the reported period, we investigated whether VP infusion with or without low-volume fluid resuscitation using normal saline (NS) could improve survival from severe and protracted hemorrhagic shock produced by removing 65% or 75% of the animal's blood volume.³ Consistent with the initial hypothesis of this project, i.e., that EPO could ameliorate tissue injury; we also included administration of EPO in this series.

Abbreviations:

BR = Blood reinfusion
EPO = Erythropoietin
VP = Vasopressin
NS = Normal saline
BW = Blood withdrawal

BODY

The experiments were designed based on findings reported last year (after having completed three series of experiments) refocusing the work on the potential role of VP and low-volume fluid resuscitation for hemodynamic stabilization under conditions of severe hemorrhagic shock maintaining the emphasis on battlefield relevance and constraints for management in far-forward scenarios. Accordingly, we modified our hemorrhagic shock protocol as described below using the swine preparation depicted in Figure 1:

1. ***Simulated bleeding pattern:*** The pattern of acute blood loss was changed from a linear function to a mono-exponential decay function to more closely model bleeding after traumatic injury (i.e., high initial bleeding with progressively slower rates as blood pressure drops and hemostatic mechanisms are endogenously activated and/or externally applied). The approach involved additional software development by us that enabled entering any mathematical function of our choosing into our closed-loop system to drive the flow removal pattern with a precision of < 1 ml/min.
2. ***Blood volume removed:*** Two target levels of blood withdrawal (BW) were studied; 65% and 75% of the estimated blood volume. It is pertinent to highlight that in our previous hemorrhagic shock series the highest amount of BW was 65% of the blood volume. Thus, for the first time experiments were conducted withdrawing 75% of the estimated blood volume. The same mono-exponential decay function was used for both BW targets, stopping after 60 minutes for the BW 65% and after 80 minutes for BW 75%.
3. ***Duration of hemorrhagic shock:*** A long interval of hemorrhagic shock was studied to model a situation in which evacuation and arrival to a medical treatment facility from the initial injury is delayed for up to 3 and a half hour. Accordingly, the time for starting blood reinfusion (BR) was at 210 minutes from the start of BW.

Pursue of findings originated from the previous series prompted the change in the protocol as described below:

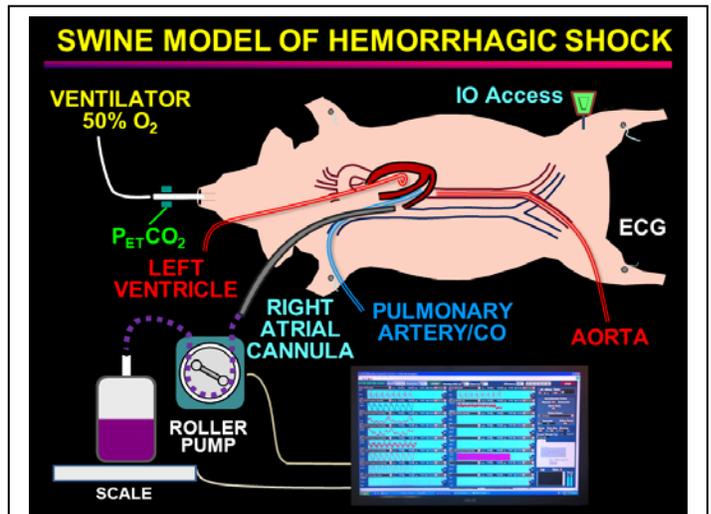


Figure 1: Rendition of our swine model of hemorrhagic shock depicting the intraosseous access for drug delivery into the left tibia; vascular catheterization to monitor left ventricular pressure, aortic pressure, pulmonary artery pressure, right atrial pressure, and cardiac output; right atrial cannulation for blood withdrawal and blood reinfusion programmatically controlled by custom developed software guided by gravimetric measurement of blood volume; and mechanical ventilation with measurement of the expired end-tidal PCO₂.

Vasopressin effect: As reported previously, the addition of vasopressin infusion in a previous series dramatically improved initial resuscitation and subsequent 72-hour survival relative to a previous series in which only fluid resuscitation with normal saline (NS) was used for stabilization before BR. The effect of vasopressin on these outcomes was associated with higher cardiac index, prompting us to speculate that VP could act in part by enhancing venous return. Because these observations were made in separate series, the question regarding the efficacy and hemodynamic effects of VP could not be directly addressed. Accordingly, for this series animals were randomized 2:1 to VP or noVP. VP was infused intraosseously at a constant rate of 0.04 U/kg·min⁻¹ from minute 7 of BW to minute 210; i.e., the start of BR.

Fluid resuscitation: The preceding series also showed that in the presence of vasopressin, initial resuscitability and 72-hour survival could be achieved successfully administering a reduced amount of NS corresponding to half the amount of BW or no fluids at all. Thus, for the present series we examined whether NS could be required under the more severe hemorrhagic shock conditions modeled. The approach involved starting the series without fluid resuscitation and performing an interim analysis halfway through the series (i.e., after completion of 12 experiments) to assess the needs for fluid resuscitation. The interim analysis showed a 72-hour survival of only 3 of 12 animals (25%) prompting the inclusion in the second half of the series the administration of NS from minute 90 to minute 120 in amount corresponding to half the volume of BW. The relatively small amount given was effective resulting in 9 out 12 animals (75%) surviving the 72 hour post-resuscitation interval.

Erythropoietin (EPO): In keeping with the original objective of our grant but incorporating knowledge gained from the

previous series, in which EPO had no effect on resuscitation and 72-hour survival but attenuated aortic lactate increases and organ dysfunction under conditions of severe but survivable hemorrhagic shock, we randomized in the subset of animals receiving VP to also receive EPO or vehicle control given – like in the preceding series – as a single intraosseous bolus dose of 1,200 U/kg after 10% of the blood volume had been removed (6 minutes from the start of BW).

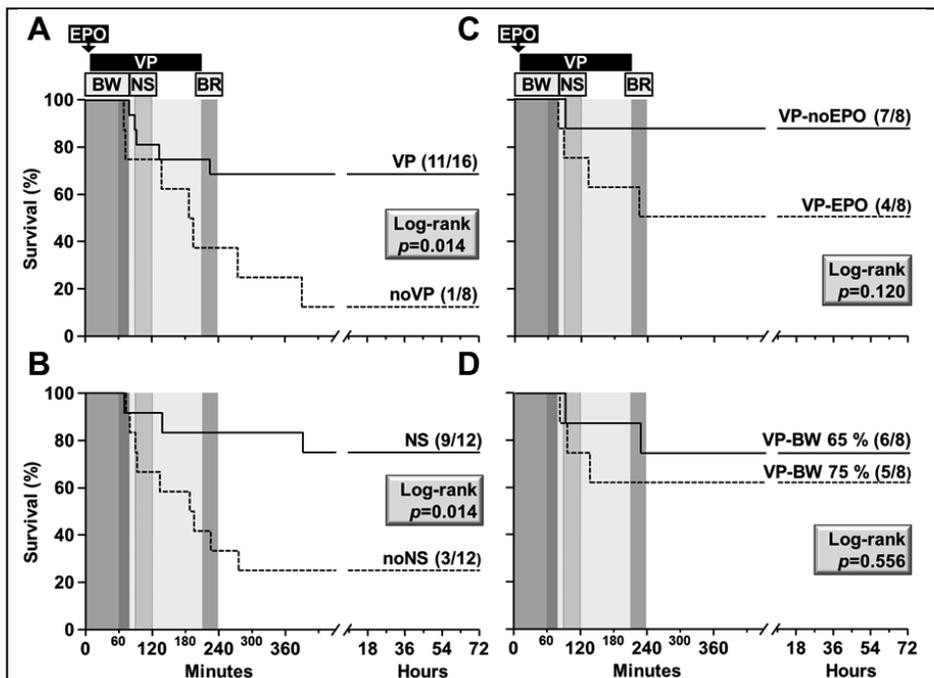
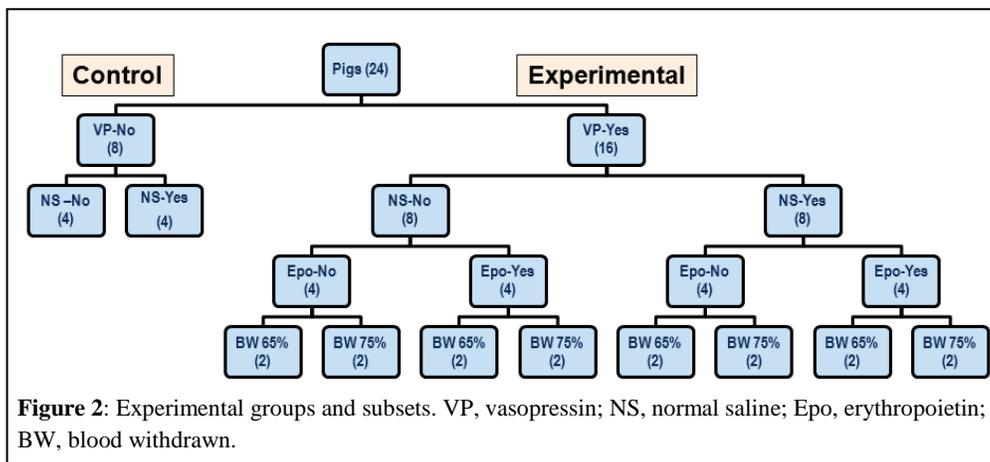


Figure 3: Kaplan- Maier survival curves analyzed using the log-rank test to assess the independent effects of normal saline (NS), vasopressin (VP), erythropoietin (EPO), and HS severity. BW, blood withdrawn (BW); BR, blood resuscitation.

Hemorrhagic shock severity: The effect of increasing the hemorrhagic shock severity was investigated only in the subset of animals receiving vasopressin by randomizing the animals to a severity of BW 65% or BW 75%.

Figure 2 summarizes the various groups and subsets investigated.

Survival Effect

Separate Kaplan-Maier survival analyses using the log-rank test were performed for each of the main factors while maintaining a balanced distribution of the remaining factors. As shown in Figure 3A, vasopressin was associated with statistically significant higher survival (68.8% vs 12.5%, $p=0.014$). The favorable effect occurred even though half of the animals in the vasopressin group, but none in controls, were subjected to more severe hemorrhagic shock BW (75% of blood volume). Administration of NS was also associated

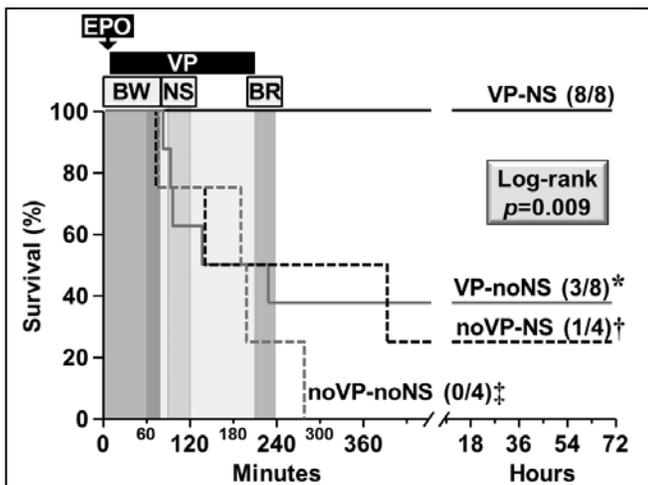


Figure 4: Kaplan- Maier survival curves comparing effects of vasopressin with normal saline (VP-NS), VP without NS (VP-noNS), no VP with NS (noVP-NS), and neither VP nor NS (noVP-noNS). The overall statistical significance was assessed by the log-rank test with all pairwise comparisons assessed by the Holm-Sidak's test demonstrating significantly lower survival for VP-noNS (* $p = 0.035$), noVP-NS ($\dagger p = 0.0198$), and noVP-noNS ($\ddagger p = 0.001$) compared with VP-NS. EPO, erythropoietin; BW, blood withdrawn; BR, blood reinfusion.

with higher 72-hour survival (25% vs 75%, $p=0.014$) as shown in Figure 3B. The use of EPO (Figure 3C) was associated with lower survival; however, the difference was not statistically significant. The increase in hemorrhagic shock severity had only a minimal and statistically insignificant effect on survival (Figure 3D).

Analysis of the combined effects of VP and NS on 72 hour survival is shown in Figure 4 demonstrating the highest survival rate associated with the combination of VP and NS and the worse with the absence of VP and NS.

A multiple linear regression analysis assessing the combined effects of vasopressin (yes[1]/No[0]), NS (Yes[1]/No[0]), erythropoietin (Yes[1]/No[0]), and hemorrhagic shock severity (65%[0]/75%[0]) on duration of survival (hours) demonstrated a statistically significant ($p<0.001$) predictive effect of these independent variables with an $R^2 = 0.632$:

$$\text{SURVIVAL (HOURS)} = -5.7 + (55.9 \times \text{VASOPRESSIN}) + (35.0 \times \text{NS}) - (26.1 \times \text{ERYTHROPOIETIN}) - (9.0 \times \text{SEVERITY})$$

However, only vasopressin ($p<0.001$), NS ($p=0.002$), and erythropoietin ($p=0.040$), but not severity ($p=0.455$) contributed statistically to the model.

Hemodynamic and Metabolic Effects

The factorial design of the study allowed separate analyses of the effects of NS and the effects of NS on hemodynamic and metabolic variables as shown in Figures 5 through Figure 8. VP as expected increased systemic vascular resistance through the interval of blood withdrawal and that this effect was associated with a reduction in cardiac index and also a reduction in heart rate (Figure 5). These hemodynamic effects were associated with a lower end-tidal PCO_2 (P_{ETCO_2}) and more intense lactic acidosis attributed to supply-dependent reduction in oxygen consumption (Figure 6). The effect, however, did not compromise survival. We interpreted these effects as indicative of a survival benefit prompted by redistribution of blood flow toward the heart by VP with likely reduction in oxygen requirements associated with a lower heart rate known to be an effect of VP modulating the baroreflex response. Low-volume fluid resuscitation was associated with an increase in left ventricular stroke work index and cardiac index – likely an effect on preload – that helped increase the aortic pressure and reduce the systemic vascular resistance (Figure 7). Metabolically, low-volume fluid resuscitation helped reduce lactic acidosis (Figure 8).

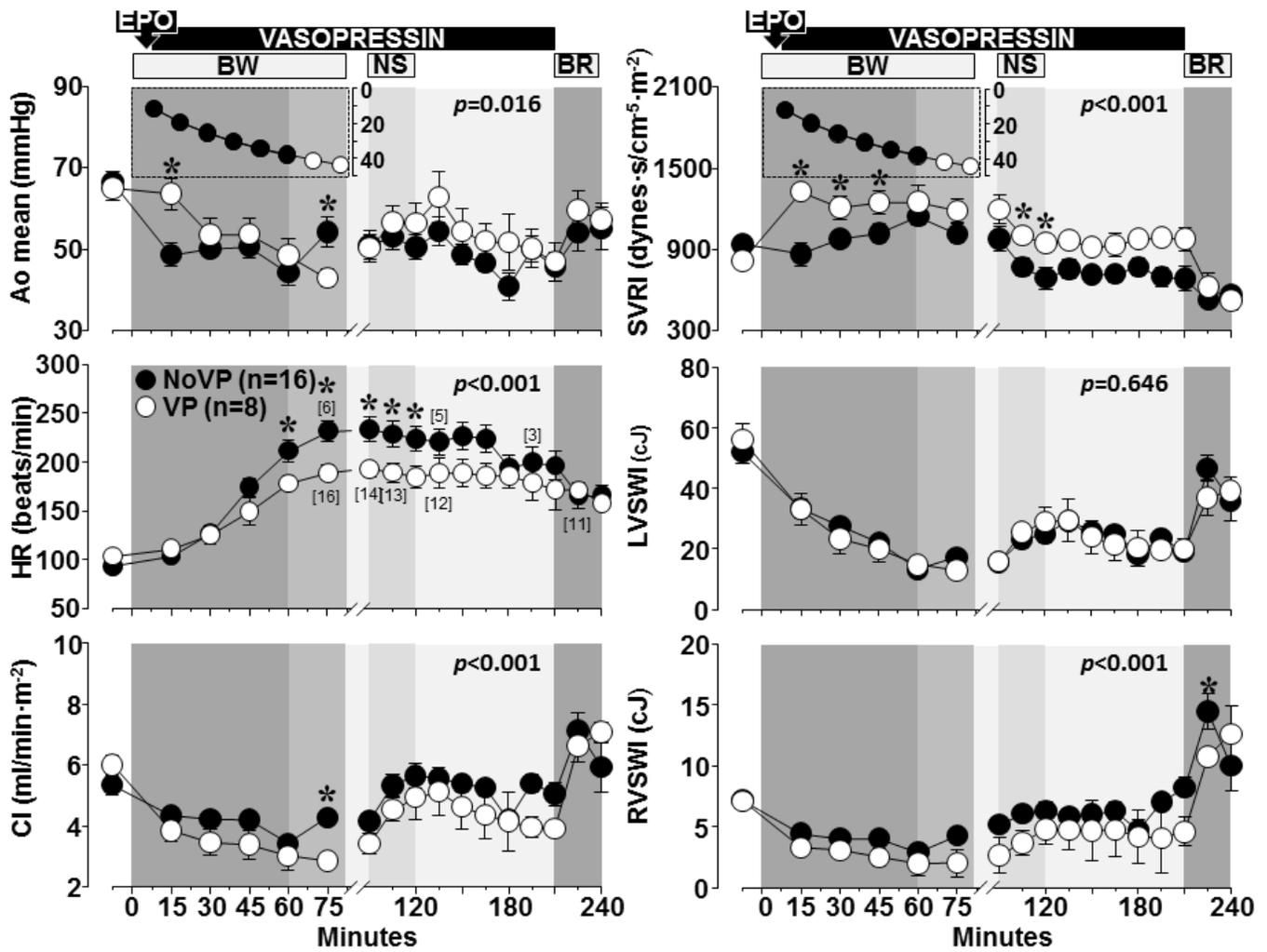


Figure 5: Effects of VP (open circles, $n = 16$) compared with vehicle control (closed circles, $n = 8$) on hemodynamic and myocardial function. Numbers in brackets indicate when the number of animals decreased from the preceding time point consequent to death. EPO, erythropoietin; VP, vasopressin; BW, blood withdrawal; HS, hemorrhagic shock; NS, normal saline; BR, blood reinfusion. The inset depicts the time course of the blood withdrawal (ml/kg) ending at 60 minutes in the 65% BW subset and at 80 minutes in the 75% BW group. Ao, aortic pressure; HR, heart rate; CI, cardiac index; SVRI, systemic vascular resistance index; LVSWI, left ventricular stroke work index; RVSWI, right ventricular stroke work index. Values are shown as mean \pm SEM. Differences between groups were analyzed by two-way repeated measures ANOVA. There was an overall statistically significant treatment effect for Ao mean, ($p = 0.016$); heart rate, ($p < 0.001$); CI, ($p < 0.001$); SVRI ($p < 0.001$) and RVSWI ($p < 0.001$). There was not statistically significant interaction between treatment and time. $*p \leq 0.05$, denote statistically significant differences between groups at the specified time points using the Holm-Sidak test for multiple comparisons.

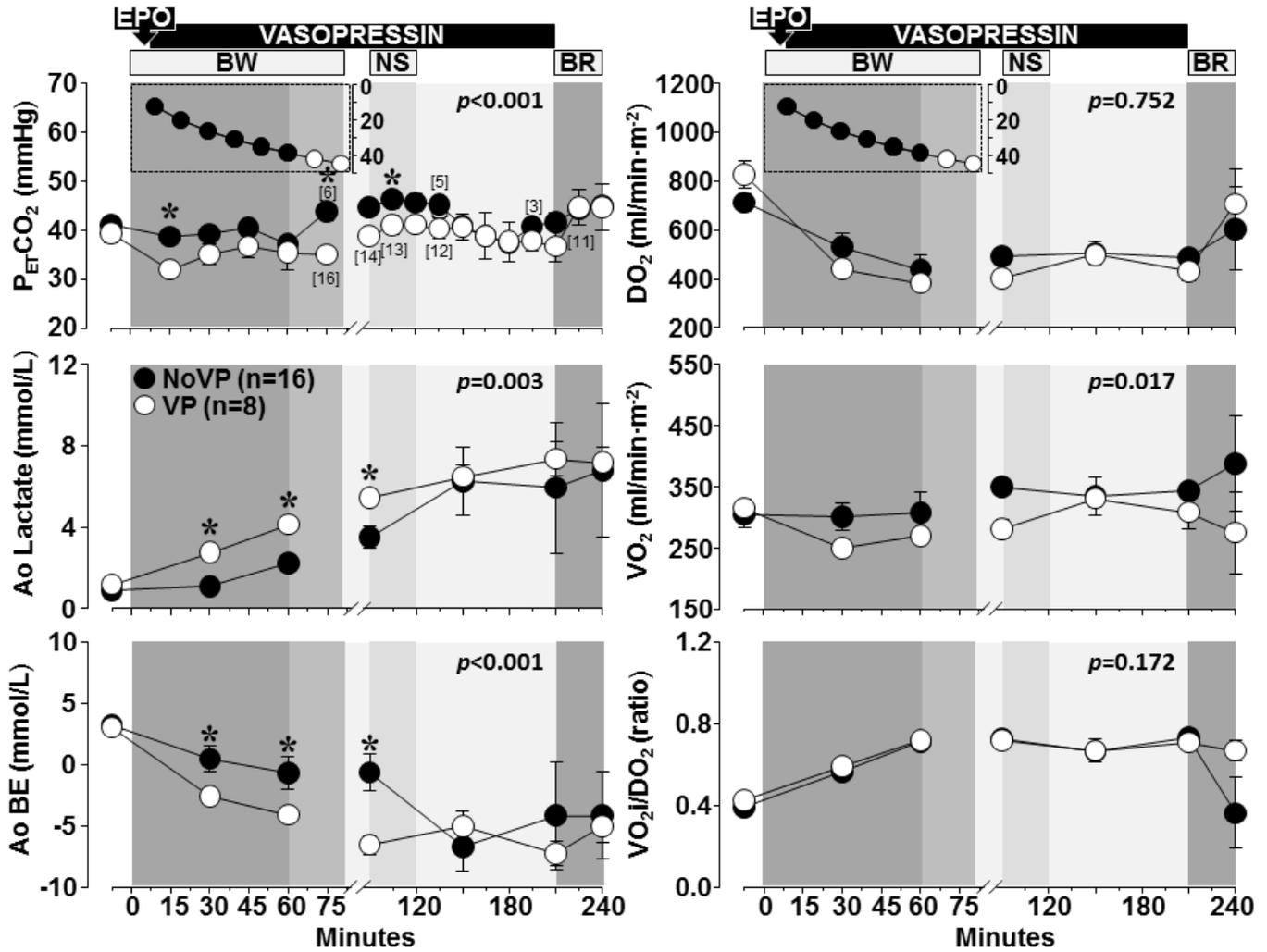


Figure 6: Effects of VP (open circles, $n = 16$) compared with vehicle control (closed circles, $n = 8$) on $P_{ET}CO_2$, lactic acidosis, and systemic oxygen metabolism. Numbers in brackets indicate when the number of animals decreased from the preceding time point consequent to death. EPO, erythropoietin; VP, vasopressin; BW, blood withdrawal; HS, hemorrhagic shock; NS, normal saline; BR, blood reinfusion. The inset depicts the time course of the blood withdrawal (ml/kg) ending at 60 minutes in the 65% BW subset and at 80 minutes in the 75% BW group. $P_{ET}CO_2$, end-tidal carbon dioxide; Ao, aortic; BE, base excess; DO_2 , oxygen delivery index; VO_2 , oxygen consumption index; VO_2/DO_2 , oxygen consumption and delivery ratio. Values are shown as mean \pm SEM. Differences between groups were analyzed by two-way repeated measures ANOVA. There was an overall statistically significant treatment effect for $P_{ET}CO_2$, ($p < 0.001$); Ao lactate, ($p = 0.003$); Ao BE, ($p < 0.001$) and VO_2 ($p = 0.017$). There was an overall statistically significant interaction between treatment and time for Ao BE ($p = 0.040$). $*p \leq 0.05$, denote statistically significant differences between groups at the specified time points using the Holm-Sidak test for multiple comparisons.

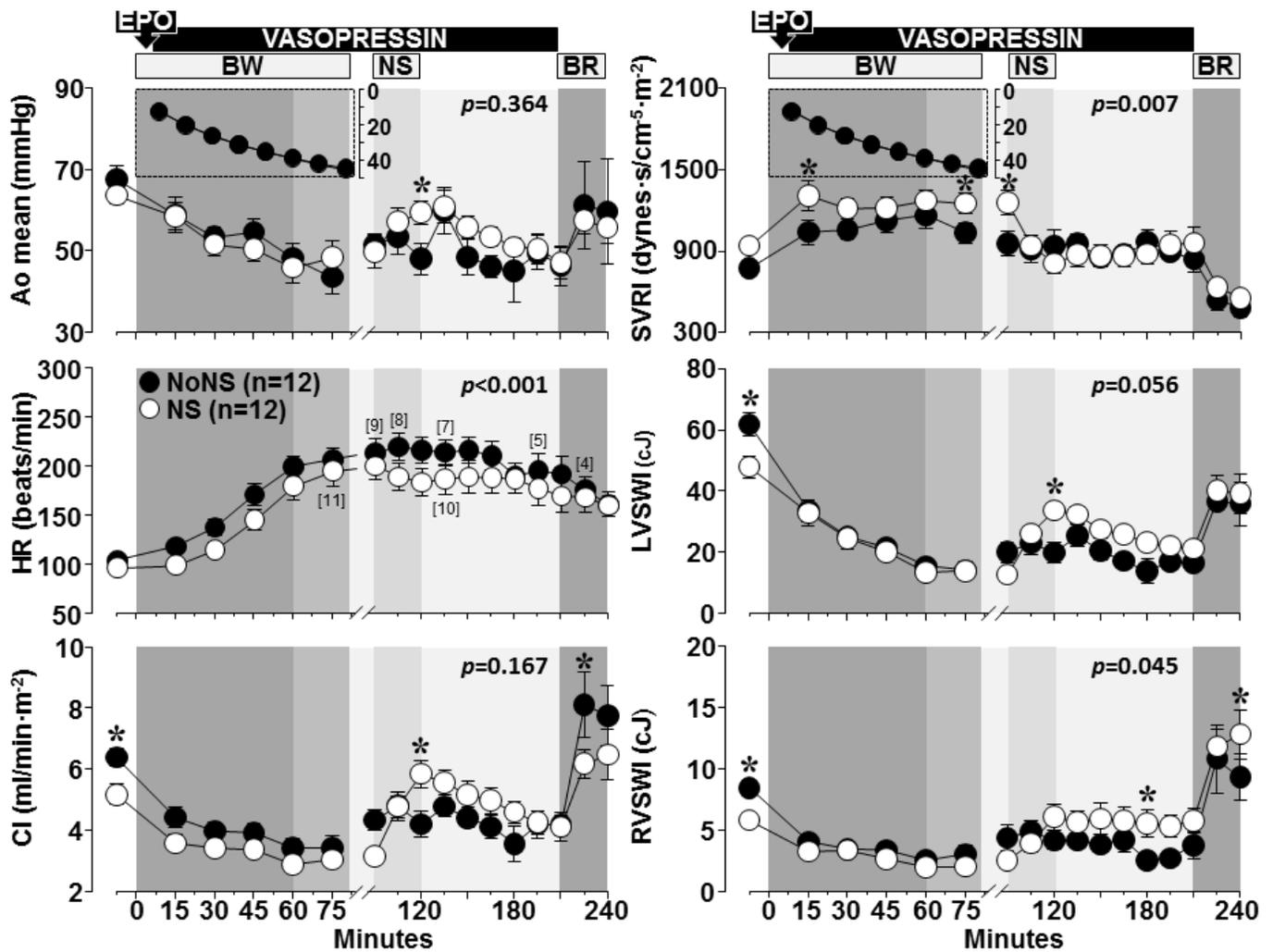


Figure 7: Effects of NS (open circles, $n = 12$) compared with vehicle control (closed circles, $n = 12$) on hemodynamic and myocardial function. Numbers in brackets indicate when the number of animals decreased from the preceding time point consequent to death. EPO, erythropoietin; BW, blood withdrawal; HS, hemorrhagic shock; NS, normal saline; BR, blood reinfusion. The inset depicts the time course of the blood withdrawal (ml/kg) ending at 60 minutes in the 65% BW subset and at 80 minutes in the 75% BW group. Ao, aortic pressure; HR, heart rate; CI, cardiac index; SVRI, systemic vascular resistance index; LVSWI, left ventricular stroke work index; RVSWI, right ventricular stroke work index. Values are shown as mean \pm SEM. Differences between groups were analyzed by two-way repeated measures ANOVA. There was an overall statistically significant treatment effect for heart rate, ($p < 0.001$); SVRI ($p = 0.007$) and RVWI ($p = 0.045$). There was an overall statistically significant interaction between treatment and time for CI ($p < 0.001$), LVSWI ($p = 0.007$) and RVWI ($p = 0.009$). $*p \leq 0.05$, denote statistically significant differences between groups at the specified time points using the Holm-Sidak test for multiple comparisons.

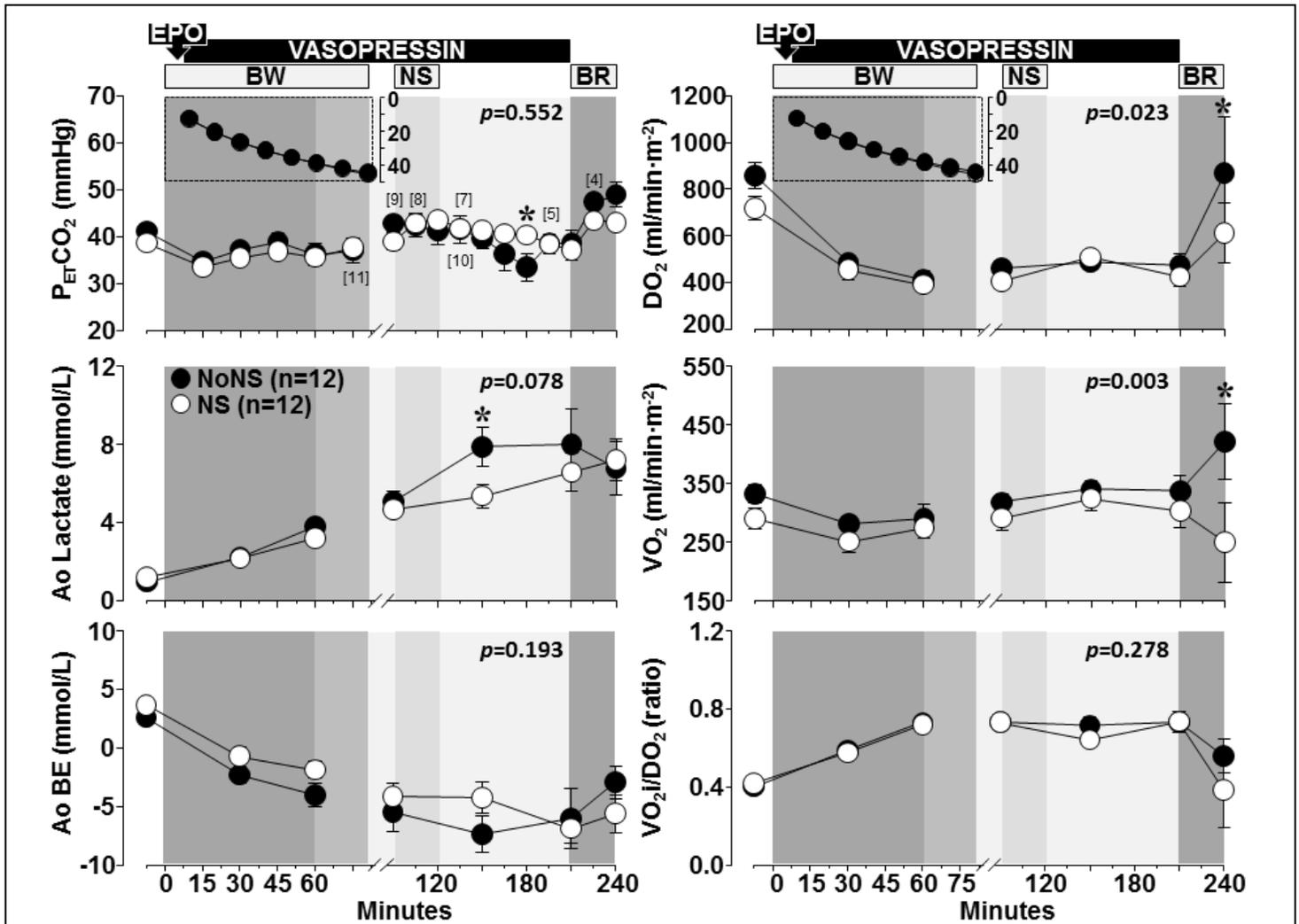


Figure 8: Effects of NS (open circles, n = 12) compared with vehicle control (closed circles, n = 12) on $P_{ET}CO_2$, lactic acidosis, and systemic oxygen metabolism. Numbers in brackets indicate when the number of animals decreased from the preceding time point consequent to death. EPO, erythropoietin; BW, blood withdrawal; HS, hemorrhagic shock; NS, normal saline; BR, blood reinfusion. The inset depicts the time course of the blood withdrawal (ml/kg) ending at 60 minutes in the 65% BW subset and at 80 minutes in the 75% BW group. $P_{ET}CO_2$, end-tidal carbon dioxide; Ao, aortic; BE, base excess; DO_2 , oxygen delivery index; VO_2 , oxygen consumption index; VO_2/DO_2 , oxygen consumption and delivery ratio. Values are shown as mean \pm SEM. Differences between groups were analyzed by two-way repeated measures ANOVA. There was an overall statistically significant treatment effect for DO_2 ($p = 0.023$) and VO_2 ($p = 0.003$). There was not statistically significant interaction between treatment and time. * $p \leq 0.05$, denote statistically significant differences between groups at the specified time points using the Holm-Sidak test for multiple comparisons.

Accordingly, the present series of experiments supports continuous intraosseous infusion of VP along with low-volume fluid resuscitation using NS for early and sustained hemodynamic stabilization during severe hemorrhagic shock in the battlefield pending evacuation to a medical treatment facility. VP infusion was associated with increases in systemic vascular resistance, reductions in cardiac index, and accentuation of lactic acidosis but reduced the risk of cardiac arrest suggesting a redistribution of blood flow from non-immediately vital territories towards vital organs. NS was associated with preload augmentation resulting in increases in cardiac index and reductions in lactic acid with the combination of VP and NS yielding 100% survival at 72 hours without organ dysfunction. The addition of EPO had no beneficial effect on initial resuscitation and survival contrary to the initial hypothesis. In fact, the data suggested a possible negative effect of EPO on initial resuscitability. The levels of severity; increasing the blood volume removed from 65% to 75%, had minimal detrimental effect on survival that was statistically insignificant suggesting that survival with the combination of VP and NS is feasible despite acute loss of 75% of the blood volume.

We are currently examining the effects of VP and NS as described above in a model of uncontrolled bleeding caused by liver laceration to more closely mimic clinical scenarios in which bleeding in the battlefield is initially uncontrolled and accompanied by tissue injury.

KEY RESEARCH ACCOMPLISHMENTS

- The swine model developed by us with funding under award # W81XWH-11-2-0019 was highly effective in reproducing key features of severe hemorrhagic shock allowing assessment of the proposed interventions on initial resuscitation and subsequent survival while exploring the underlying mechanisms.
- Additional software development allowed modeling the blood volume removal pattern to more closely reflect spontaneous bleeding. Such capability can be used in future protocols to model any pattern of blood loss the investigators might want to examine.
- The findings strongly support the use of VP infusion started early after recognition of severe bleeding following by administration of NS in small bolus amounts for hemodynamic stabilization until definitive care is available.

REPORTABLE OUTCOMES

PRESENTATIONS

Targeting Venous Capacitance during Resuscitation from Hemorrhagic Shock. Grand Rounds, Captain James A. Lovell Federal Health Care Center North Chicago, IL, August 2, 2012.

Novel Experimental Approaches to Resuscitation from Hemorrhagic Shock: A Report from the Resuscitation Institute. Department of Medicine Grand Rounds. Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL, January 9, 2013.

Venous Tone Augmentation with Vasopressin for Hemodynamic Stabilization during Hemorrhagic Shock (lecture, May 31); The Wolf Creek XII Conference. Westin Mission Hills Resort & Spa, Rancho Mirage, CA, May 31, 2013.

ABSTRACTS

1. Borovnik-Lesjak V, Whitehouse K, Baetiong V, Currie B, Radhakrishnan J, Gazmuri RJ. Identification of critical level of blood volume reduction in a swine model of hemorrhagic shock. *Circulation* 2012;126:A12073.
2. Gazmuri RJ, Whitehouse K, Borovnik-Lesjak V, Baetiong A, Radhakrishnan J. Vasopressin infusion during severe hemorrhagic shock increases systemic blood flow and markedly improves survival in a swine model. *Circulation* 2012;126:A15905.
3. Gazmuri RJ, Whitehouse K, Whittinghill KL, Baetiong A, Radhakrishnan J. Vasopressin with low-volume resuscitation is highly effective for resuscitation and survival from severe hemorrhagic shock. *Circulation* 2013;128:A341.

MANUSCRIPTS

Effects of intraosseous erythropoietin during hemorrhagic shock in swine. Borovnik-Lesjak V; Whitehouse K; Baetiong A; Miao Y; Currie B; Velmurugan S; Radhakrishnan J; Gazmuri RJ (ready for submission).

APPLICATIONS

Pre-Proposal submitted in response to USAMRMC BAA 13-1 entitled "Hemorrhagic Shock Control by Blood Flow Redistribution and Hemostatic Enhancement."

CONCLUSION

Intraosseous infusion of vasopressin from the onset of hemorrhagic shock until the start of blood reinfusion in combination with normal saline (half the amount of blood withdrawn) given at the end of hemorrhage over 30 minutes was highly effective in securing initial resuscitation and 72-hour survival under conditions of severe hemorrhagic shock, when compared with each intervention alone. Erythropoietin did not contribute to resuscitation and 72-hour survival and it might have had an adverse effect. Intraosseous infusion of vasopressin (delivered using a preloaded syringe and a small pump) and low-volume fluid resuscitation are low-skill techniques that could be deployed in far-forward battlefield operations providing extended hemodynamic stability in wounded soldiers pending evacuation to a medical treatment facility.

REFERENCES

1. Eastridge BJ, Mabry RL, Seguin P et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. *J Trauma Acute Care Surg* 2012;73:S431-S437.
2. Gazmuri RJ, Whitehouse K, Borovnik-Lesja V, Baetiong A, Radhakrishnan J. Vasopressin infusion during severe hemorrhagic shock increases systemic blood flow and markedly improves survival in a swine model. *Circulation* 2012;126:A15905.
3. Gazmuri RJ, Whitehouse K, Whittinghill KL, Baetiong A, Radhakrishnan J. Vasopressin with low-volume resuscitation is highly effective for resuscitation and survival from severe hemorrhagic shock. *Circulation* 2013;128:A341.

APPENDICES

Curriculum vitae

SUPPORTING DATA

Included in the Body.

CURRICULUM VITAE

Raúl J. Gazmuri, MD, PhD, FCCM

November 20, 2013

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Professor (tenure track), Department of Medicine

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EDUCATION

- 1991-1994 PhD degree. Department of Physiology and Biophysics. Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL (June 2, 1994).
- 1989-1991 Critical Care Medicine training. Department of Medicine, University of Health Sciences/The Chicago Medical School, North Chicago, IL.
- 1986-1989 Research Fellowship. Department of Medicine, University of Health Sciences/The Chicago Medical School, North Chicago, IL. Laboratory of Max Harry Weil, MD, PhD, Professor and Chairman, Department of Medicine.
- 1981-1984 Internship and Residency in Internal Medicine. University of Chile, Hospital del Salvador, Santiago.
- 1974-1980 MD degree. University of Chile School of Medicine.
- 1962-1973 Primary and High School, Saint Gaspar College, Santiago, Chile.

APPOINTMENTS

Present

- 2009-present Director, Resuscitation Institute at Rosalind Franklin University.
- 2002-present Professor (tenure-track). Department of Medicine and Chief, Division of Critical Care Medicine with cross-appointment in the Division of Pulmonary Medicine, Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL.
- 2009-present Professor. Department of Physiology and Biophysics, Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL.
- 2000-present Chief, Section of Critical Care Medicine
North Chicago VA Medical Center, North Chicago, IL.
- 1998-present ICU Director
North Chicago VA Medical Center, North Chicago, IL.

Past

- 2002-2009 Associate Professor. Department of Physiology and Biophysics, Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL.
- 2002-2006 Site Director (North Chicago VA Medical Center), Critical Care Fellowship Program, Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL.
- 1998-2002 Associate Professor. Department of Medicine, Finch University of Health Sciences/The Chicago Medical School, North Chicago, IL.
- 1998-2002 Assistant Professor. Department of Physiology and Biophysics, Finch University of Health Sciences/The Chicago Medical School, North Chicago, IL.
- 1995-1998 Assistant Professor. Department of Medicine, Finch University of Health Sciences/The Chicago Medical School, North Chicago, IL.

- 1994-1997 Critical Care Attending. North Chicago VA Medical Center, North Chicago, IL.
- 1992-1993 Associate Program Director of Critical Care Medicine. University of Health Sciences/The Chicago Medical School. North Chicago, IL.*
- 1992-1993 Chief, Critical Care Section. Medical Service, North Chicago VA Medical Center, North Chicago, IL.*
- 1991-1993 Vice-President for Research. Institute of Critical Care Medicine, a Public Educational and Research Foundation. North Chicago, IL, and Palm Springs, CA.*
- 1991-1992 Attending Physician in Critical Care Medicine, North Chicago VA Medical Center, North Chicago, IL.
- 1989-1994 Instructor. Department of Medicine. Finch University of Health Sciences/The Chicago Medical School. North Chicago, IL.
- 1988-1989 Senior Research Fellow and Laboratory Supervisor. Dr. Max Harry Weil's Research Laboratory. University of Health Sciences/The Chicago Medical School.
- 1986-1989 Research Fellow. Dr. Max Harry Weil's Research Laboratory. University of Health Sciences/The Chicago Medical School.
- 1984-1986 Staff physician. Center for the Critically Ill, Clínica Las Condes, Santiago, Chile.
- 1984-1986 Staff physician. Intensive Care Unit, DIPRECA Hospital, Santiago, Chile.

COMMITTEE ACTIVITIES (INTRAMURAL)

- 2004 Member, Search Committee, Chair Department of Physiology. Rosalind Franklin University of Medicine and Science.
- 2003-2008 Member, Internal Research Review Panel. Rosalind Franklin University of Medicine and Science.
- 2001-2006 Member, MD/PhD Combined Degree Admissions Committee. Rosalind Franklin University of Medicine and Science/The Chicago Medical School.
- 2000-present Member, Department of Medicine Medical Executive Committee. Rosalind Franklin University of Medicine and Science/The Chicago Medical School.
- 2001-2003 Member, IACUC. Combined Hines and North Chicago VA committee.
- 2000-2001 Chair, Research Audit Committee. North Chicago VA Medical Center.
- 2000-2003 Chair, Department of Medicine Research Committee. Finch University of Health Sciences/The Chicago Medical School.
- 1998-present Chair, Critical Care Committee at Captain James A. Lovell Federal Health Care Center.
- 1998-2011 Chair, CPR Committee at Captain James A. Lovell Federal Health Care Center.
- 1998-2000 Member of Infectious Control, Transfusion and Blood and Blood Products, and Surgical Case Review Committees. North Chicago VA Medical Center.
- 1997-1999 Co-Chair, Department of Medicine Research Committee. Finch University of Health Sciences/The Chicago Medical School.

* Appointments relinquished in 1993 to complete PhD program.

- 1997-1998 Chair, Animal Care Committee. Member of Critical Care and CPR, Infectious Control, Transfusion and Blood and Blood Products, Surgical Case Review, and Research and Development Committees. North Chicago VA Medical Center.
- 1988-1991 Member, Department of Medicine Research Committee. Finch University of Health Sciences/The Chicago Medical School.
- 1992-1993 Chairman, Critical Care and CPR Committee.
Member, Infectious Disease, Blood Products and Transfusion, Surgical Case Review, and Ethical Advisory Committees. North Chicago VA Medical Center, North Chicago, IL.*

COMMITTEE ACTIVITIES (EXTRAMURAL)

- 2009-2013 Member, Clinical and Integrative Cardiovascular Science (CICS) Study Section, Center for Scientific Review.
- 2011-2013 Member, American Heart Association's Advanced Cardiac Life Support (ACLS) Subcommittee.
- 2006-2011 Member, American Heart Association's Basic Life Support (BLS) Subcommittee (appointed from July 1, 2006 to June 30, 2008; reappointed until June 30, 2011).
- 2008 Member (temporary), Clinical and Integrative Cardiovascular Science (CICS) NIH Study Section. February 7-8, Washington, DC.
- 2007 Member (temporary), Myocardial Ischemia and Metabolism (MIM) NIH Study Section. February 22-23, Washington, DC.
- 2006 Member (temporary), Clinical and Integrative Cardiovascular Science (CICS) NIH Study Section. November 2-3, Washington, DC.
- 2000-2003 Member, Research Committee, Society of Critical Care Medicine.

MISCELLANEOUS ACTIVITIES

- 2011-present Member, International Scientific Committee, A.P.I.C.E. (Anesthesia, Pharmacology, Intensive Care, Emergency).
- 2009-present Director, Resuscitation Institute at Rosalind Franklin University.
- 2004-2008 Medical Director and Founder of the Rosalind Franklin University Life Saving Coalition for improving outcomes after out-of-hospital sudden cardiac arrest. It involves community participation. Donated AEDs to Lake County Sheriff Office [2006] Puerto Rican Society [June 2008].
- 1998-Present Software development (for research applications) using LabVIEW, National Instruments.

SPECIALTY AND SUBSPECIALTY CERTIFICATION

- 1993 Critical Care Medicine Board (recertified in 2013).
- 1992 American Board of Internal Medicine (recertified in 2002 and 2012).
- 1984 Chilean National Examination in Internal Medicine.

LICENSURE

- 1989 Illinois License, No. 036-078444

1980 Doctor of Medicine and Surgery, Chile

PROFESSIONAL SOCIETY MEMBERSHIP

2005-present Honorary Member “Sociedad Decano Lorenzo Sazié.” Santiago, Chile
1997-present American Heart Association
1997-present Fellow of the American College of Critical Care Medicine
1990-present Society of Critical Care Medicine, U.S.A.
1990-present American Federation for Medical Research.
1988-1996 American Association for the Advancement of Science.
1986-present Chilean Society of Intensive Care Medicine.
1986-present Medical Society of Santiago, Chile.
1983-present Chilean Medical College.

EDITORIAL AND PEER-REVIEW ACTIVITIES

Periodicals

1993-present Reviewer for *Critical Care Medicine; Circulation; American Journal of Physiology; and Journal of Applied Physiology*
1996-present Ad-hoc reviewer for *Annals of Emergency Medicine; The Lancet; Critical Care; The Journal of the American College of Cardiology; Expert Opinion on Therapeutic Patents; Resuscitation; and Journal of the American Association for Laboratory Animal Science; BMC Veterinary Research.*

Other

2009-present Associated Editor, Acta Medico-Biotechnica, University of Maribor, Slovenia.
2007-present Member, Scientific Committee, International Seminar on Acute Conditions, University of Maribor, Maribor, Slovenia.
2006-2009 Member, Faculty of 1000 Medicine, Acute Cardiovascular Problems, Critical Care & Emergency Medicine.
2003-2012 Abstract reviewer for the AHA Scientific Sessions.
1993-present Occasional reviewer of grant proposals for: FONDECYT (Chilean National Foundation for Science and Technology); Ministry of Education, Science and Sport, Republic of Slovenia, and the Austrian Science Fund (FWF).
1991-present Abstract reviewer for the Society of Critical Care Medicine Educational and Scientific Annual Symposia.

PROFESSIONAL INVITATIONS

Invited Lectures

1984 [Problems and Complications of Hemodynamic Monitoring] (workshop leader). First Course on Hemodynamic Monitoring. Center for the Critically Ill, Clinica Las Condes, Santiago, Chile.

- 1985 [Nutrition in the Patient with Acute Renal Failure]. First Course of Renal Failure in the Critically Ill. Center for the Critically Ill, Clinica Las Condes, Santiago, Chile.
- 1985 (a) [Hemodynamic Monitoring], (b) [Nutrition in the Critically Ill], (c) [Airway Management, and Venous Catheterization]. Hospital del Salvador, Santiago, Chile.
- 1986 [Renal Failure in the Critically Ill] (panel). Center for the Critically Ill, Clinica Las Condes, Santiago, Chile.
- 1986 [Septic Shock] (panel). Postgraduate Course. Medical Society of Valparaiso. Valparaiso, Chile.
- 1986 [Nutritional Aspects in Septicemia]. Postgraduate Course in Septic Shock. Medical Society of Valparaiso, Valparaiso, Chile.
- 1986 (a) [Hemodynamic Monitoring in Acute Myocardial Infarction], (b) [Problems and Complications in Hemodynamic Monitoring (workshop leader)]. Second Course on Hemodynamic Monitoring. Center for the Critically Ill. Clinica Las Condes, Santiago, Chile.
- 1986 [Pathophysiology, Diagnosis and Treatment of Shock]. Mutual de Seguridad. Santiago, Chile.
- 1986 (a) [Clinical Clues in the Diagnosis and Treatment of Shock], (b) [Hemodynamic Monitoring: The Nurse's Role]. Hospital DIPRECA, Santiago, Chile.
- 1986 [Multiple Organ Failure] (panel). Chilean Society of Intensive Medicine. Santiago, Chile.
- 1986 [Clinical Application of Electrocardiography] (panel moderator). Chilean Society of Cardiology, Santiago, Chile.
- 1988 [Cardiac Resuscitation by Extracorporeal Pump Oxygenator (ECPO) after Failure of Precordial Compression]. Chicago Cardiology Group, Chicago, IL, U.S.A.
- 1989 Extracorporeal Pump Oxygenation (ECPO) During Cardiac Arrest. Fourth Post-Graduate Course "Recent Advances in Anesthesia, Pain, Intensive Care and Emergency. November 21-25. Trieste, Italy.
- 1989 [The Rational Management of Cardiac Arrest. Departments of Anesthesia and Cardiology]. Catholic University of Chile. December 27 and 29. Santiago, Chile.
- 1990 (a) Anaphylaxis, (b) Buffers in the Treatment of Acidosis. Twenty-eighth University of Southern California Annual Symposium. Critical Care Medicine. March 12-15. Las Vegas, Nevada, U.S.A.
- 1990 Cardiac Resuscitation by Extracorporeal Circulation. Second International Post-graduate Course in Anesthesia and Intensive Care. June 23. 1990. Alimini Valtur Village, Otranto, (Lecce) Italy.
- 1990 (a) [Acute Respiratory Distress Syndrome (panel)], (b) [The Rational Management of Cardiac Arrest], (c) [Cardiac Resuscitation by Extracorporeal Circulation]. Eighth Annual Symposium, Chilean Society of Intensive Care Medicine, November 17-20. Santiago, Chile.
- 1990 [The Rational Management of Cardiac Arrest]. (a) Higuera Hospital, Talcahuano and (b) Sanatorio Alemán, Concepción, November 25; and (c) National Institute of Respiratory Diseases, November 26. Santiago, Chile.
- 1991 New Directions for Basic and Advanced Life Support. (a) Medical Grand Rounds, University of Health Sciences/The Chicago Medical School, July 31, North Chicago, IL;

- (b) The Tenth Annual Chicago Critical Care Symposium and Review Course, October 10-13. Chicago, IL; and (c) Cook County Hospital, Critical Care Conference, October 21. Chicago, IL, U.S.A.
- 1992 (a) Buffer Agents for the Treatment of Acidosis [panel], (b) Options for Cardiac Resuscitation When Conventional Methods Fail. 30th Annual University of Southern California Annual Symposium on Critical Care Medicine. February 3-7. Las Vegas Nevada, U.S.A.
- 1992 Options for Enhancement of Myocardial Perfusion During Cardiac Resuscitation. Seventh Post-Graduate Course. Recent Advances in Anesthesia, Pain, Intensive Care and Emergency. November 25-28. Trieste, Italy.
- 1992 Advances in Cardiopulmonary Resuscitation. Slovenian Society of Intensive Medicine. November 30. Ljubljana, Slovenia.
- 1993 Shock - What Does it Mean Today? Third Intensive Medicine Symposium. February 26-27. Bremen, Delmenhorst, Germany.
- 1993 (a) New Concepts in Cardiac Resuscitation, (b) Use of Capnography in the Critically Ill. Nineteenth Annual Midwest Conference. American Association of Critical Care Nurses. March 24. Arlington Heights, IL, U.S.A.
- 1994 (a) Capnography for CPR monitoring, (b) Prehospital CPR by ECPO and Intermittent Aortic Balloon Occlusion. 2nd International Congress on Emergency Medical Assistance. January 25-27. Lyon, France.
- 1994 [Myocardial Dysfunction after Resuscitation from Cardiac Arrest]. DIPRECA hospital. July 8. Santiago, Chile.
- 1994 (a) Current Approach to the Treatment of Cardiac Arrest - Chain of Survival, (b) Options to Restore Myocardial Perfusion. Third International Symposium on Intensive Care medicine. September 22-23. Bled, Slovenia.
- 1994 (a) [Is Positive Pressure Ventilation Essential During Early CPR?], (b) [Monitoring the Resuscitation Effort], (c) [Advances in Cardiopulmonary Resuscitation]. LXVII Chilean and International Congress of Surgery. November 28 - December 1. Santiago, Chile.
- 1996 Cardiopulmonary Resuscitation: The Search for More Effective Options. Medical Grand Rounds. Finch University of Health Sciences/The Chicago Medical School. April 3. North Chicago, IL.
- 1996 Clinical Use of Capnography. Third Joint Meeting of the Slovenian and Croatian Societies of Intensive Care Medicine. May 31 - June 1. Otocec, Slovenia.
- 1996 Myocardial Effects of Ventricular Fibrillation and Reperfusion in the Isolated Rat Heart. Department of Medicine Quarterly Research Seminar. Finch University of Health Sciences/The Chicago Medical School. September 18. North Chicago, IL.
- 1996 Mechanisms of Myocardial Pump Failure After the Global Ischemic Injury of Cardiac Arrest. Department of Microbiology and Immunology. Finch University of Health Sciences/The Chicago Medical School. November 12. North Chicago, IL.
- 1997 (a) [The Pathophysiological Bases of Cardiopulmonary Resuscitation]; (b) [Clinical Effectiveness of New Resuscitation Techniques]; (c) [Hemodynamic Guidance During Cardiac Resuscitation]; (d) [Myocardial Protection During Cardiac Arrest]; (e) [Chain of Survival: Community Involvement and Access to Emergency Services]; (f) [Ethical and Legal Aspects of Cardiopulmonary Resuscitation] (panel). First Symposium on

- Cardiopulmonary Resuscitation. Universidad Católica de la Santísima Concepción, Facultad de Ciencias de la Salud. May 7-8. Concepción, Chile.
- 1997 Advances in CPR: Medical Grand Rounds. Finch University of Health Sciences/The Chicago Medical School. December 17. North Chicago, IL.
- 1998 Resuscitation of the Arrested Heart: Research Activities at North Chicago. Department of Medicine Annual Retreat. Finch University of Health Sciences/Chicago Medical School.
- 1999 Options for Myocardial Protection during the Global Ischemic Injury of Cardiac Arrest. Department of Physiology and Biophysics Seminar. Finch University of Health Sciences/The Chicago Medical School. March 25. North Chicago, IL.
- 1999 The Effects of Repetitive Electrical Shocks on Post-Resuscitation Myocardial Function. Wolf Creek V Conference. The Institute of Critical Care Medicine. September 8-9. Rancho Mirage, CA.
- 1999 Myocardial Protection by Inhibition of Sarcolemmal Sodium Influx. Bioengineering New Resuscitation Therapies for the Treatment of Cardiac Arrest. Emergency Resuscitation Center. November 17-18. Argonne National Laboratory, Argonne, IL.
- 2000 Myocardial Protection by Inhibition of Sarcolemmal Sodium Influx. Naval Dental Research Institute/United States Army Dental Research Detachment/North Chicago VA Medical Center Scientific Colloquium. May 5. Great Lakes Navy Hospital, Great Lakes, IL.
- 2000 Successful Ventricular Defibrillation by Inhibition of the Sodium-Hydrogen Exchanger Isoform-1. Fifth Annual Meeting of Midwest Physiological Society. June 5-6. Finch University of Health Sciences/The Chicago Medical School, North Chicago, IL.
- 2000 NHE-1 Inhibition: A New Treatment Approach for Cardiac Resuscitation. Medical Grand Rounds, June 7, Finch University of Health Sciences/The Chicago Medical School, North Chicago, IL.
- 2001 Scientific presentation: Sodium Hydrogen Exchange Inhibitor for Minimizing Post-Resuscitation Myocardial Dysfunction. Panels: Mechanisms and Management of Post-Resuscitation Myocardial Dysfunction; Anti-Arrhythmic Drugs for Facilitating CPR; and Criteria for Discontinuing CPR Efforts. Sixth Wolf Creek Conference on Cardiopulmonary Resuscitation, June 4th – 7th, The Institute of Critical Care Medicine, Rancho Mirage, CA.
- 2001 Beneficial Effects of NHE-1 Inhibition in a Rat Model of Cardiac Arrest. The XVII World Congress of the International Society for Heart Research, July 10th, Winnipeg, Manitoba, Canada.
- 2001 Improving Resuscitation from Cardiac Arrest by Inhibition of the Sodium Hydrogen Exchanger Isoform 1. Aventis Pharma, August 16th, Frankfurt, Germany.
- 2001 Myocardial Protection during Ventricular Fibrillation by Inhibition of the Sodium-Hydrogen Exchanger Isoform-1. Pulmonary and Critical Care Medicine Grand Rounds, August 24th, University Hospitals of Cleveland and Case Western Reserve University, Cleveland, OH.
- 2002 Acute Complications of Pericardial Disease or Injury. February 19th. Acute Complications of Diabetes Mellitus. February 20th. An Update on the Clinical Presentation and Management of Diabetes Insipidus. February 20th. 40th Anniversary Symposium on Critical Care, Trauma, and Emergency Medicine. Keck School of

- Medicine, University of Southern California and The Institute of Critical Care Medicine, February 18 – 22, Ceasars Palace Hotel, Las Vegas, Nevada.
- 2002 NHE-1 Inhibition: A Potential New Treatment for Resuscitation from Cardiac Arrest. Medical Grand Rounds, April 4, Finch University of Health Sciences/The Chicago Medical School, North Chicago, IL.
- 2002 Optimal Timing for Electrical Defibrillation. Resuscitation and Bioengineering Science. Emergency Resuscitation Center. The University of Chicago and Argonne National Laboratory, April 18-19, Argonne National Laboratory, Argonne, IL
- 2002 NHE-1 Inhibition: A New form of Treatment for Resuscitation from Ventricular Fibrillation. Center for Magnetic Resonance Research, May 8, Evanston, IL
- 2002 NHE Inhibition in Cardiac Arrest. Advances in Na-H Exchange Research: From Molecular Regulation to Therapeutic Development. A Satellite Symposium of IUPHAR 2002. The University of Western Ontario, July 12-15, London, Ontario, Canada.
- 2003 Abnormalities in Water Metabolism (March 19th), CPR tutorial, and New Oprions in CPR (March 20th). Twenty Third International Symposium on Intensive Care and Emergency Medicine. Organized by the Free University of Brussels and the Belgian Society of Intensive Care and Emergency Medicine. Brussels Congress Center, March 18-21, Brussels, Belgium.
- 2003 Reanimación Cardiopulmonar Avanzada (November 6th), Algunas Sugerencias para hacer Investigación en Medicina Intensiva, Sodium-Hydrogen Exchanger Inhibition: A Potencial New Treatment for Cardiac Resuscitation, Augmenting Venous Return during Closed-Chest Resuscitation (November 7th), Mesa Redonda: Aspectos Clave en Paro (November 8th). XXI Congreso Chileno de Medicina Intensiva, November 5-8, Pucón, Chile.
- 2003 Myocardial Dysfunction Following Restoration of Spontaneous Circulation (November 16th). 18th International Symposium on Critical Care Medicine. APICE 2003, November 14-18, Trieste, Italy.
- 2004 Experimental and Clinical Advances in Cardiopulmonary Resuscitation. Department of Medicine Grand Rounds, May 20, Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL
- 2004 Minimizing Myocardial Ischemia and Maximizing Myocardial Protection during Resuscitation from Cardiac Arrest (lecture, June 25); Focus on Myocardial Preservation, Reperfusion Injury, Post-Resuscitation Myocardial Dysfunction, and the Role of Buffer Agents during Cardiac Arrest (panelist, June 25); From Basic to Advanced Life Support (panelist, June 26); Revisiting the Guidelines (panel co-chairman, June 26); Promising Pharmacological Agents for CPR (lecture, June 26); and Technological Innovations to Coordinate and Prioritize Electrical and Mechanical Interventions (panelist, June 26). First Safar-Weil Conference on Cardiopulmonary and Cerebral Resuscitation. June 25-27, Venezia, Italy.
- 2004 NHE-1 Inhibition for Resuscitation from Sudden Cardiac Death. Aventis Pharma. June 28, Frankfurt, Germany.
- 2004 NHE-1 Inhibition for Resuscitation from Sudden Cardiac Death. Department of Anesthesia, Leopold Franzens University of Innsbruck. June 29, Innsbruck, Austria.
- 2004 NHE-1 Inhibition and Coronary Blood Flow during VF are both Determinants of Post-Resuscitation Myocardial Function. Resuscitation Science Symposium (ReSS), grantees

- meeting, co-sponsored by the National Heart, Lung, and Blood Institute and the American Heart Association. November 5-6, New Orleans, LA.
- 2004 Myocardial Preservation, Reperfusion Injury, and Post-Resuscitation Myocardial Dysfunction (lecture, November 13th); Cardiac Arrest (session chair and panelist, November 13th). International Symposium on Critical Care Medicine, 19th Annual Meeting (APICE). November 12-15, Trieste, Italy.
- 2005 Sodium-Hydrogen Exchange (NHE-1) Inhibition: A Promising New Approach to Cardiac Resuscitation. Distinguished Lectures Series, Heart and Stroke Foundation of Ontario Program in Heart Failure and Department of Physiology & Pharmacology, University of Western Ontario, March 7, London, Ontario, Canada.
- 2005 Myocardial Protection during Cardiac Resuscitation by Limiting Sarcolemmal Sodium Entry. National Heart, Lung, and Blood Institute, March 18, Bethesda, MD.
- 2005 Sudden Cardiac Arrest and Mitochondrial Injury: A New Therapeutic Target? Research Symposium, North Chicago VA Medical Center, March 25, North Chicago, IL.
- 2005 Cariporide Enables Hemodynamically more Effective Chest Compression by Leftward Shift of the Flow-Depth Relationship. The 8th Wolf Creek Conference on Cardiopulmonary Resuscitation. June 10-13, The Lodge Hotel at Rancho Mirage, CA.
- 2005 Pathophysiology and Management of Myocardial Injury during Cardiopulmonary Resuscitation. 2nd Seminar with International Attendance. Emergency Conditions: Signs, Symptoms, Syndromes, Differential Diagnosis and Management, October 7, Congress Center Habakuk, Maribor, Slovenia.
- 2005 Myocardial Protection by NHE-1 Inhibition. Resuscitation Science RFAs Grantees' Meeting, October 21, Two Rockledge Centre, Bethesda, Maryland.
- 2005 Cardiac Resuscitation (Presentation at Plenary Session). Chest 2005, American College of Chest Physicians, October 21, Montréal, Québec, Canada.
- 2005 Basic Science and Pharmacology of Resuscitation (abstract oral session co-moderator). American Heart Association, Scientific Sessions 2005, November 14, Dallas, TX.
- 2005 Minimizing Reperfusion Injury in Settings of Myocardial Ischemia (lecture, November 20); Cardiovascular Advances (session co-chair, November 20); CPR Guidelines 2005: What Is New Under The Sun? (panel discussion co-chair, November 20). International Symposium on Critical Care Medicine, 20th Annual Meeting (APICE). November 18-21, Trieste, Italy.
- 2006 Resuscitation from Cardiac Arrest: Are Mitochondria at the Crossroads of Life and Death? Department of Physiology and Biophysics Seminar. Rosalind Franklin University of Medicine and Science. April 20. North Chicago, IL.
- 2006 Importance of Mitochondria during Resuscitation from Cardiac Arrest (April 27); Preclinical Resuscitation Network: A Progress Report (April 28) (self-chosen topics as Program Director). Symposium on Sudden Cardiac Arrest: From Research to Resuscitation, held at the Rosalind Franklin University of Medicine and Science, April 27-29. North Chicago, IL.
- 2006 2005 Guidelines for CPR and Emergency Cardiac Care: Renewed Emphasis on Blood Flow (lecture, May 11); Technological Advances in Resuscitation: A way to Implement Guidelines and Beyond (lecture, May 11); A Practical Approach to Fluid and Electrolyte Management (lecture, May 13). [International Course on Medical Emergencies and

- Critical Ill Patient, organized by a 16-hospital Chilean ICU network]. Hotel Crowne Plaza, May 11-13, Santiago, Chile.
- 2006 Resuscitation 2006. Clínica Las Condes, May 18, Santiago, Chile.
- 2006 Resuscitation 2006. Clínica Dávila, May 19, Santiago, Chile.
- 2006 Moderator for Panel Discussion. Advances in Post-Resuscitation Care. Organized by the Emergency Resuscitation Center, the University of Chicago and Argonne National Laboratory. The Gleacher Center, June 10, Chicago, IL.
- 2006 Advances in Cardiopulmonary Resuscitation: From Bench to Bedside. Department of Medicine Grand Rounds, July 5, Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL.
- 2006 Novel Targets for Ameliorating Injury Caused by Ischemia and Reperfusion. Department of Medicine Research Symposium. August 23, Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL.
- 2006 Basic CPR Physiology and New Research Directions. October 6, UT Southwestern Medical Center. Children's Medical Center, Dallas, TX.
- 2006 Cardiopulmonary resuscitation: Bridging the Gap between Knowledge and Practice. October 17, Lake County Medical Society, Lincolnshire, IL.
- 2007 Targets for Myocardial Protection during Resuscitation from Cardiac Arrest. Medical Service, Denver VA. February 9, Denver, CO.
- 2007 Management of Life Threatening Electrolyte Disorders. March 7th. Recognition and Management of Intrathoracic Crises with Special Reference to Cardiac Tamponade. March 9th. 45th Annual Symposium on Critical Care, Trauma and Emergency Medicine. Keck School of Medicine, University of Southern California, and The Weil Institute of Critical Care Medicine, March 5 – 9, Ceasars Palace Hotel, Las Vegas, Nevada.
- 2007 Activation of the Mitochondrial Apoptotic Pathway without Evidence of Apoptotic Cell Death after Resuscitation from Ventricular Fibrillation (lecture, June 23). Optimizing Post Resuscitation Management II – Priorities of Post Resuscitation Care, Do we as yet have enough Evidence to Justify a Unified Algorithm? (panel, June 23). Optimizing Transitions from Laboratory to Clinic (panel, June 23). The Wolf Creek IX Conference. June 21-24, The Renaissance Esmeralda Resort & Spa, Indian Wells, CA.
- 2007 In-Hospital Resuscitation (forum). Clínica Dávila, August 6, Santiago, Chile.
- 2007 Practical Concepts in Fluid Management. North Chicago VA Grand Rounds, September 4, North Chicago, IL.
- 2007 Myocardial Effects of Cardiac Arrest and Resuscitation with Especial Reference to Mitochondrial Injury (lecture). University of Maribor, Faculty of Medicine, October 3, Maribor, Slovenia.
- 2007 Myocardial Effects of Cardiac Arrest and Resuscitation with Especial Reference to Mitochondrial Injury (lecture, October 5); Critical Care Knowledge in Emergency Medicine. Emergency Conditions: Signs, Symptoms, Syndromes, Differential Diagnosis and Management, October 4-6, Congress Center Habakuk, Maribor, Slovenia.
- 2008 Sodium-Hydrogen Exchange Inhibition during Resuscitation: Saving Myocardium by Protecting Mitochondria? (lecture, hospital, April 23). Perspectives on How to Improve

- Resuscitation Outcomes (lecture, outpatient center, April 23; medical school and school of nursing, April 24). Rounds in various ICUs (April 23). Maribor, Slovenia.
- 2008 Carbon Dioxide during Resuscitation: A Gas to Monitor and a Molecule to Understand; Sodium Hydrogen Exchange Inhibition and other Pharmacological Interventions during Resuscitation: Saving Myocardium by Protecting Mitochondria? (lectures, April 28). Physio-Control. Perspectives on Improving Resuscitation Outcomes. Seattle Resuscitation Rounds. (lecture, April 29). Harborview Medical Center. Seattle, Washington.
- 2008 Conference: Myocardial protection after CPR; Practical Lessons Learned on How to Setup a Research Laboratory (May 8); A Practical Approach to Fluid Management (May 9); Cardiopulmonary Resuscitation: Bridging the GAP Between Knowledge and Practice (May 10). Physio-Control. XIII Brazilian Congress of Intensive Care Medicine and 1st International Symposium of the World Federation of Intensive and Critical Care Medicine. Salvador City, Bahia, Brazil, May 6 – 10.
- 2008 [Clinical Research Priorities in Cardiopulmonary Resuscitation, June 9]. [XLIII National Congress of the SEMICYUC and XXXIV National Congress of the SEEIUC]. Valencia, Spain, June 9-11.
- 2008 Advances in Cardiopulmonary Resuscitation (August 28). Clínica Dávila, Santiago, Chile.
- 2008 Erythropoietin for Cardiac Resuscitation. Department of Medicine Grand Rounds, Rosalind Franklin University of Medicine and Science/The Chicago Medical School. North Chicago, IL, July 30.
- 2008 Targeting Mitochondria for Resuscitation from Cardiac Arrest. Department of Medicine Grand Rounds, Rosalind Franklin University of Medicine and Science/The Chicago Medical School. North Chicago, IL, September 17.
- 2008 [Scientific Knowledge Gap on Resuscitation and Priorities in Clinical Resuscitation for ILCOR 2010, October 3]. [First Canary Conference on Resuscitation], Santa Cruz de Tenerife, Canary Islands, Spain, October 2-3.
- 2009 Enhancing the Hemodynamic Efficacy of Chest Compression by Preserving Mitochondrial Bioenergetic Function. Cardiovascular Research Center's Visiting Faculty Seminar Series, Mount Sinai School of Medicine, New York, NY, January 16.
- 2009 [Latest Advances in the Chain of Survival] and [Improving the Hemodynamic Efficacy of Chest Compression by Maintaining Mitochondrial Function] (lectures). [II Conference on Resuscitation. Cerebral Survival, SESCAM Office of Urgencies and Emergencies], Toledo, Spain, April 29.
- 2009 Erythropoietin Facilitates the Return of Spontaneous Circulation and Survival in Victims of Out-of-Hospital Cardiac Arrest. Hines/North Chicago Research Day, Hines, IL, May 6.
- 2009 Improving CPR Hemodynamics and Outcomes by Preserving Left Ventricular Distensibility. Department of Medicine Grand Rounds. Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL, August 19.
- 2009 Key Points for Improving the Outcome of Out-of-Hospital Cardiac Arrest (lecture, August 31), Inotropic Options for Post-Resuscitation Myocardial Dysfunction (lecture, August 31), CPR: From Flying Blind to Flying Right (lecture, September 1), Cardiopulmonary Resuscitation (moderator, August 31). 10th Congress of the World

- Federation of Societies of Intensive and Critical Care Medicine (WFICCM), Fortezza de Baso, Florence, Italy, August 28 – September 1.
- 2009 NHE-1 Inhibitors and Erythropoietin for Maintaining Myocardial Function during Cardiopulmonary Resuscitation (lecture October 16), Cardiopulmonary Resuscitation: From Flying Blind to Flying Right (lecture October 16). Acute Conditions: Signs, Symptoms, Syndromes, Differential Diagnosis and Management. Congressional Center Habakuk, Maribor, Slovenia, October 15-17.
- 2009 Medical Emergency Response System (MERS) at the North Chicago VAMC (Grand Rounds). Advances in Medicine, Surgery, and Psychiatry, Department of Veterans Affairs North Chicago and Rosalind Franklin University of Medicine and Science. North Chicago, IL, November 3.
- 2010 Advances in Resuscitation. Department of Medicine Grand Rounds. Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL, February 10.
- 2010 Resuscitative Medicine: Improving CPR Hemodynamics and Outcomes by Preserving Left Ventricular Distensibility. The Heart Institute for Children Research Club. Hope Children's Hospital, Oak Lawn, IL, March 5.
- 2010 Key Factors for Improving Outcome after Sudden Cardiac Arrest (lecture, March 19); Improving CPR Hemodynamics by Maintaining Left Ventricular Distensibility (lecture, March 19); An Elective in Critical Care Medicine for Second-Year Students (panel New Directions in Health Professions Education, March 19). 65th Annual Midwest Clinical Conference & Technology Summit. Westing Lombard Yorktown Center, Lombard, IL, March 18-19.
- 2010 Protecting Mitochondrial Bioenergetic Function during Resuscitation from Cardiac Arrest. Kick-Off Speaker Session, Hines/North Chicago VA Research Poster Day. Hines VA, Hines, IL, April 29.
- 2010 Protecting Mitochondrial Bioenergetic Function. First Maribor Resuscitation Summit: On The Future of CPR." Maribor, Slovenia, September 9-11.
- 2010 Pathophysiology and Severity of Post-Resuscitation Myocardial Dysfunction (lecture); ACLS Recall on Skills and Pharmacological Agents (panel); chairman for three sessions on CPR topics. APICE 23rd International Symposium on Critical Care Medicine, Catania, Italy, November 5-7.
- 2010 [Latest Recommendations in Resuscitation] and [Science of Resuscitation] (lectures). [III Conference on Advances in Resuscitation. New Recommendations and New Futures, SESCAM Office of Urgencies and Emergencies], Toledo, Spain, December 16.
- 2011 Recognition and Treatment of Physiological Deterioration and Other Life-Threatening Emergencies through Implementation of a Rapid Response System at the Captain James A. Lovell Federal Health Care Center. Grand Rounds, Captain James A. Lovell Federal Health Care. Center North Chicago, IL, May 5.
- 2011 Minimal Hemodynamic effects of Increasing Respiratory Rate and Volume during CPR but large Impact on $P_{ET}CO_2$ (lecture, June 11). Optimizing the Efficacy of Circulatory Support during CPR (panel, June 11). Optimizing Transitions from Laboratory to Clinic (panel, June 11). The Wolf Creek XI Conference. Westin Mission Hills Resort & Spa, Rancho Mirage, CA, June 9-12.
- 2011 Prevention of in Hospital Cardiac Arrest by Early Recognition and Treatment of Physiological Deterioration. Department of Medicine Grand Rounds. Rosalind Franklin

- University of Medicine and Science/The Chicago Medical School, North Chicago, IL, September 14.
- 2011 Cardiac arrest – From the Lab to Clinical Trials (lecture, December 11); A Giant of Critical Care – Prof. Max Harry Weil (panel, December 11). APICE Masterclass. Annual International Meeting Mediterranean School of Intensive and Critical Care Medicine. Catania University, Catania, Italy, December 9 – 11.
- 2012 Targeting Venous Capacitance during Resuscitation from Hemorrhagic Shock. Grand Rounds, Captain James A. Lovell Federal Health Care Center North Chicago, IL, August 2.
- 2012 Targeting Mitochondria during CPR (lecture, September 9); State-of-the-Art in Critical Care (panel, September 8); Quality of CPR (panel, September 8); Post-Resuscitation Care (panel, September 9). Weil Conference on Cardiac Arrest, Shock and Trauma. Istituto Mario Negri, Milan, Italy, September 8–9.
- 2012 [2010 Guidelines for Cardiopulmonary Resuscitation. Highlights] (lecture, November 12); [Physiological Principles of Cardiopulmonary Resuscitation] (lecture, November 12); Mitochondrial Protection during Cardiac Resuscitation (lecture, November 14); [Key Factors for Successful Resuscitation (lecture, November 14). XXXI World Congress of Internal Medicine. Santiago, Chile, November 11-15.
- 2013 Novel Experimental Approaches to Resuscitation from Hemorrhagic Shock: A Report from the Resuscitation Institute. Department of Medicine Grand Rounds. Rosalind Franklin University of Medicine and Science/The Chicago Medical School, North Chicago, IL, January 9.
- 2013 New Developments in Cardiopulmonary Resuscitation (lecture). University of Maribor, Faculty of Medicine. University of Maribor, Slovenia, March 22.
- 2013 Current Determinant of Successful Resuscitation and Suggestions for Future Research (lecture, March 22). Acute Conditions (5th): Signs, Symptoms, Syndromes, Differential Diagnosis and Management. Congressional Center Habakuk, Maribor, Slovenia, March 21-23.
- 2013 Venous Tone Augmentation with Vasopressin for Hemodynamic Stabilization during Hemorrhagic Shock (lecture, May 31); Estrogen Fails to Facilitate Resuscitation from VF in Male Rats (June 1). Optimizing Monitoring and Management of Circulatory Shock: Goal Directed Therapy (panel, May 31); After More than 50 Years of Modern CPR, do we Really Save More Lives? What are the Major Limiting Factors that Prevent Us to Do So? (panel, May 31); Optimizing the Efficacy of Circulatory Support during CPR: The role of Mechanical Devices (panel, June 1); Optimizing Transitions from Laboratory to Clinical Practice (panel, June 1); Optimizing Post-Resuscitation Management: Priorities of Post-Resuscitation Care. The Wolf Creek XII Conference. Westin Mission Hills Resort & Spa, Rancho Mirage, CA, May 30–June 2.
- 2013 Myocardial Effects of Protecting Mitochondrial Function during Resuscitation from Cardiac Arrest (lecture, September 20). American Heart Association 2013 Chicago Research Network Symposium: Transgenic Approaches to Cardiovascular Disease: Past, Present, and Future. Loyola University Chicago, Maywood, IL, September 20.

Other Invitations

- 2001 To attend the International Guidelines 2000 Conference on CPR and ECC. American Heart Association. February 6-8. Dallas, TX.

- 2003 To serve as expert reviewer for the International Liaison Committee of Resuscitation's (ILCOR) 2005 International Consensus on Emergence Cardiovascular Care (ECC) and Cardiopulmonary Resuscitation (CPR) Science with Treatment Recommendations Conference (C2005), reviewing the topic "Is CPR before defibrillation safe, effective, and feasible?"
- 2003 To serve as section editor for the June 2003 and June 2004 issues of *Current Opinion in Critical Care* dedicated to Cardiopulmonary Resuscitation.
- 2005 To serve as invited editor for the November 2005 issues of *Clinic@s de Medicina Critica* dedicated to Cardiopulmonary Resuscitation.
- 2005 To co-moderate a session on oral presentations on resuscitation topics at the 2005 annual Scientific Sessions of the AHA.
- 2006 To join the APICE 2006 International Scientific Committee.
- 2007 To co-moderate a session on oral presentations on resuscitation topics at the 2007 annual Scientific Sessions of the AHA and to co-moderate a poster discussion at the 2007 Resuscitation Science Symposium.
- 2008 Worksheet presenter at ILCOR meeting (November 5); Co-moderator of a poster session at the Resuscitation Science Symposium (November 9); Co-moderator of an abstract presentation session at AHA Scientific Sessions (November 10).
- 2009 To serve as expert reviewer for the International Liaison Committee of Resuscitation's (ILCOR) 2010 International Consensus on Emergence Cardiovascular Care (ECC) and Cardiopulmonary Resuscitation (CPR) Science with Treatment Recommendations Conference (C2010).

COURSES ORGANIZED

- 1985 [Second Course of Hemodynamic Monitoring (Coordinator)]. Center for the Critically Ill, Clinica Las Condes, Santiago, Chile.
- 1986 [Diagnosis of Emergencies in Intensive Medicine (Director)]. DIPRECA Hospital, Santiago, Chile.
- 2004 Sudden Cardiac Death: From Cell Physiology to Clinical Resuscitation. A symposium jointly sponsored by the Department of Medicine and the Department of Physiology and Biophysics and by the Medical Service at the North Chicago VA Medical Center. October 23. North Chicago, IL. Role: Program Director and Speaker. Invited speakers included several nationally recognized investigators.
- 2006 Symposium on Sudden Cardiac Arrest: From Research to Resuscitation, held at the Rosalind Franklin University of Medicine and Science, April 27-29. Program Director, Speaker, and Moderator. Invited speaker included 14 internationally recognized leaders in CPR.
- 2006 ICU Elective for 2nd year medical students (MMED 699 Critical Care Medicine). Fall quarter – 12 sessions, 2 hours each.
- 2010 First Maribor Resuscitation Summit: On The Future of CPR." Maribor, Slovenia, September 9-11. Co-Organizer with Dr. Štefek Grmec. Invited speaker included 16 internationally recognized leaders in CPR.

HOST OF RECOGNIZED SCIENTISTS AT DEPARTMENTAL LEVEL

- 2005 Morris Karmazyn, PhD, Canada Research Chair in Experimental Cardiology; Director, Heart and Stroke Foundation of Ontario; Professor of Physiology and Pharmacology, University of Western Ontario, Canada. *Mediation of Ischemic Myocardial Injury, Hypertrophy and Heart Failure by Sodium-Hydrogen Exchange*. Rosalind Franklin University of Medicine and Science, May 26.
- 2008 Roger J. Hajjar, MD, Professor of Medicine and Director of the Cardiovascular Research Center at Mount Sinai Medical Center, New York, NY. *Targeting Calcium Cycling in Heart Failure*. Department of Physiology & Biophysics seminar series. Rosalind Franklin University of Medicine and Science, March 27.

HOST OF THE RESUSCITATION INSTITUTE LECTURE SERIES

- 2012 Tom P. Aufderheide, MD, FACEP, FACC, FAHA; Professor of Emergency Medicine; Associate Chair of Research Affairs; Director, Adult Translational Research Unit; Department of Emergency Medicine; Medical College of Wisconsin. *Harnessing the Thoracic Pump to Treat Patients in Cardiac Arrest: From 1960 to the Present* (March 12).
- 2012 Terry L. Vanden Hoek, MD, FACEP; Professor and Chair Department of Emergency University of Illinois at Chicago. *Cardiopulmonary Resuscitation in 2012: New Opportunities for Translational Science* (June 8).
- 2012 Morris Karmazyn, PhD; Canada Research Chair in Experimental Cardiology; Professor, Department of Physiology and Pharmacology; University of Western Ontario, Canada. *The Myocardial Sodium-Hydrogen Exchanger and its Role in Heart Disease: From Basic Research to Clinical (Mis)Trials* (November 29).
- 2013 Wanchun Tang MD, MCCM, FCCP, FAHA Professor, President, and Chief Scientific Officer of the Weil Institute of Critical Care Medicine; Clinical Professor, Keck School of Medicine, University of Southern California; Professor of Emergency Medicine, UC San Diego School of Medicine. *Recent Advances in Cardiopulmonary Resuscitation* (August 21).

HONORS AND AWARDS (First or Senior Author)

- 1984 Acknowledgment to the best scientific project. Norgine Laboratory Prize. XXI Chilean Congress of Cardiology and Cardiovascular Surgery. December, Viña del Mar, Chile. [Arterial and venous prostaglandin E₂ levels in patients with valvular disease]. Guarda E, Zamorano B, **Gazmuri RJ**, Escobar E.
- 1988 Best Poster Prize. Annual meeting of Swiss Society of Intensive Care Medicine. September, Montreaux, Switzerland. [Non-invasive hemodynamic monitoring during cardiopulmonary resuscitation using capnography]. von Planta M, Weil MH, **Gazmuri RJ**.
- 1989 First Prize in Basic Sciences. 18th Annual Scientific Meeting of The Society of Critical Care Medicine. June, New Orleans, Louisiana, U.S.A. Myocardial depressant effect of carbon dioxide in the intact rat heart. Wanchun T, **Gazmuri RJ**, Weil MH, Kette F, Bisera J, Duggal C, Rackow EC.
- 1994 Honorary Member, Chilean Society of Surgeons. December 1. Santiago Chile.

- 1997 Poster award winner at the Annual Loyola/Hines Research Poster Session. April 4, Hines, IL. Left ventricular diastolic dysfunction after resuscitation from cardiac arrest. **Gazmuri RJ**, Berkowitz M, Cajigas H, Hawkins K.
- 2001 Emergency Medicine Specialty Award recipient for 2001. Society of Critical Care Medicine 30th Educational and Scientific Symposium, February 13, San Francisco, CA. Transtracheal Oxygenation during Cardiac Arrest Maintains its Effectiveness Despite Increased Duration of Chest Compression. Ayoub IM, **Gazmuri RJ**, Brown DJ, Obayashi DY.
- 2001 Research Citation (one of 30 semi-finalists). Society of Critical Care Medicine 30th Educational and Scientific Symposium, February 13, San Francisco, CA. Cariporide Facilitates Successful Defibrillation and Improves Post-Resuscitation Hemodynamic Function after Prolonged Untreated VF. **Gazmuri RJ**, Ayoub IM, Kolarova J, Damera M.
- 2002 Research Citation (one of 6 finalists). Society of Critical Care Medicine 31st Critical Care Congress, January 29, San Diego, CA. Successful Treatment of Prolonged Untreated Ventricular Fibrillation Requires Chest Compression before Electrical Shocks. Kolarova J, Yi Zhong, Ayoub IM, **Gazmuri RJ**.
- 2003 Emergency Medicine Specialty Award recipient for 2003. Society of Critical Care Medicine 32nd Critical Care Congress, February 1, San Antonio, TX. NHE-1 Inhibition Enhances the Pressor Responses to Epinephrine and Vasopressin during Chest Compression. Kolarova J, Yi Z, Ayoub IM, **Gazmuri RJ**.
- 2003 Research Citation (one of 5 finalists). Society of Critical Care Medicine 32nd Critical Care Congress, February 1, San Antonio, TX. Inhibition of the sodium-hydrogen exchanger isoform-1 (NHE-1) ameliorates reperfusion arrhythmias and prevents episodes of recurrent VF. Ayoub IM, Kolarova J, Yi Z, Maldonado MA, **Gazmuri RJ**.
- 2005 Research Citation. Society of Critical Care Medicine 34th Critical Care Congress, January 18, Phoenix, AZ. Zoniporide ameliorates post-resuscitation myocardial dysfunction by flow independent mechanisms. Ayoub IM, Kolarova JD, Radhakrishnan J, Wang S, **Gazmuri RJ**.
- 2005 Research Citation. Society of Critical Care Medicine 34th Critical Care Congress, January 18, Phoenix, AZ. Zoniporide ameliorates intramyocardial lactate increases during resuscitation from ventricular fibrillation. Radhakrishnan J, Wang S, Ayoub IM, Kolarova JD, **Gazmuri RJ**.
- 2006 Emergency Medicine Specialty Award. Society of Critical Care Medicine, 35th Critical Care Congress, January 10, San Francisco, CA. Cytochrome c: a novel biomarker for predicting survival after cardiac resuscitation. Ayoub IM, Wang S, Radhakrishnan J, Kolarova JD, Lyu T, Ryan C, **Gazmuri RJ**.
- 2008 Resuscitation/Critical Care Best Abstract Award presented by the American Heart Association's Council on Cardiopulmonary, Perioperative and Critical Care. American Heart Association Scientific Sessions 2008. November 11, New Orleans, Louisiana. Erythropoietin facilitates the return of spontaneous circulation and subsequent ICU admission in victims of out-of-hospital cardiac arrest. Grmec S, Strnad M, Kupnik D, Sinkovic A, Marc G, **Gazmuri RJ**.
- 2009 Cournand and Comroe Young Investigator Prize in Cardiopulmonary and Critical Care (one of 5 finalists), Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. American Heart Association Scientific Sessions 2009. November 17, Orlando, Florida. The mitochondrial permeability transition pore opens during

- ventricular fibrillation in a rat model of closed chest resuscitation. Ayoub IM, Radhakrishnan J, Upadhyaya MP, **Gazmuri RJ**.
- 2010 Second Prize Poster Winner at the Annual Hines/North Chicago VA Research Day. April 29, Edward Hines, Jr VA Hospital, Hines, IL. Preservation of left ventricular myocardial distensibility using a novel sodium-hydrogen exchanger isoform-1 inhibitor markedly enhances the hemodynamic efficacy of chest compression. Ayoub IM, Upadhyaya MP, Radhakrishnan J, **Gazmuri RJ**.
- 2011 Young Investigator Award. American Heart Association Resuscitation Science Symposium 2011. Erythropoietin enables mitochondria to preserve oxidative phosphorylation under conditions of calcium overload and oxidative stress. Radhakrishnan J, Ng M, Edelheit A, **Gazmuri RJ**.

BIBLIOGRAPHY

BOOK CHAPTERS

1. Weil MH, **Gazmuri RJ**, Rackow EC. Mechanisms of blood flow during precordial compression. In: Shoemaker W, Thompson WL, Holbrook PR (eds). *Textbook of Critical Care*, 2nd Edition. Philadelphia: WB Saunders 1987:40-45.
2. Shah D, Weil MH, **Gazmuri RJ**, Rackow EC. O₂ Transport in Low Flow States of Circulatory Shock and Cardiac Arrest. In: Reinhart K, Eyrick K (eds). *Clinical Aspects of O₂ Transport and Tissue Oxygenation*. Springer-Verlag, Heidelberg, Germany 1989:445-461.
3. Weil MH, **Gazmuri RJ**, Rackow EC. Issues in CPR. In: Fuhrman BP, Shoemaker W (eds). *Critical Care: State of the Art*. The Society of Critical Care Medicine, Fullerton, California, U.S.A. 1989;10: 427-63.
4. Weil MH, Kette F, **Gazmuri RJ**, Rackow EC. Alkalinizing agents for the treatment of cardiac arrest. In: Arieff AI (ed). *Hypoxia, Metabolic Acidosis and the Circulation*. Oxford Univ. Press 1992;175-195.
5. **Gazmuri RJ**, Weil MH, Rackow E. Options for Augmenting the Efficacy of Closed-Chest cardiopulmonary resuscitation. In: Ayres SM, Grenvik A, Holbrook PR, and Shoemaker WC (eds). *Textbook of Critical Care*, 3rd Edition. Philadelphia: WB Saunders, 1995, pp.29-38.
6. **Gazmuri RJ**, Maldonado F. Post-Resuscitation Management. In: Weil MH, Tang W (eds). *CPR: Resuscitation of the Arrested Heart*, 1st Edition. Philadelphia: WB Saunders, 1999, pp.179-191.
7. **Gazmuri RJ**, Ayoub IM. Myocardial Effects of Sodium-Hydrogen Exchange Inhibition during Resuscitation from Ventricular Fibrillation. In: Dhalla NS, Takeda N, Singh M, and Lukas A (eds). *Myocardial Ischemia and Preconditioning*. Boston: Kluwer Academic Publishers, 2003, pp.375-388.
8. **Gazmuri RJ**, Ayoub IM. NHE-1 Inhibition: A Potential New Form of Treatment for Resuscitation from Cardiac Arrest. In: Karmazyn M, Avkiran M, Fliegel L (Ed). *The Sodium-Hydrogen Exchanger. From Molecule to its Role in Disease*. Kluwer Academic Publishers, 2003, pp.291-308.
9. **Gazmuri RJ**, Ayoub IM, Kolarova J. Inhibition of the Sodium-Hydrogen Exchanger: A Potential Treatment for Resuscitation from Cardiac Arrest. In: Vincent JL (ed). *2003 Yearbook of Intensive Care and Emergency Medicine*. Springer-Verlag, 2003, pp.461-471.

10. **Gazmuri RJ**, Gopalakrishnan P. Ventricular Arrhythmias. In: Fink MP, Abraham E, Vincent JL, Kochanek P (eds). *Textbook of Critical Care*, 5th Edition. Philadelphia: Elsevier Inc., 2005, pp.783-794.
11. **Gazmuri RJ**, Vidyarthi V. Cardioversion and Defibrillation. In: Fink MP, Abraham E, Vincent JL, Kochanek P (eds). *Textbook of Critical Care*, 5th Edition. Philadelphia: Elsevier Inc., 2005, pp.1807-1815.
12. **Gazmuri RJ**, Ayoub IM. Transvenous and Transcutaneous Pacing. In: Fink MP, Abraham E, Vincent JL, Kochanek P (eds). *Textbook of Critical Care*, 5th Edition. Philadelphia: Elsevier Inc., 2005, pp.1817-1824.
13. **Gazmuri RJ**, Weil MH, Kern K, Tang W, Ayoub IM, Kolarova JD, Radhakrishnan J. Prevention and Therapy of Postresuscitation Myocardial Dysfunction. In: Paradis N, Halperin H, Kern K, Wenzel V, Chamberlain D (eds). *Cardiac Arrest - The Science and Practice of Resuscitation Medicine*, 2nd Edition. Cambridge University Press, 2007, pp.829-847
14. **Gazmuri RJ**. [Electrophysiology of Lethal Arrhythmias]. In: *Cardiopulmonary Cerebral Resuscitation and Emergency Cardiovascular Care: From Basic Science to Clinical Practice*. Chinese Textbook, 2008, pp.125-137.
15. **Gazmuri RJ**. [Prevention and Management of Post-Resuscitation Myocardial Dysfunction]. In: *Cardiopulmonary Cerebral Resuscitation and Emergency Cardiovascular Care: From Basic Science to Clinical Practice*. Chinese Textbook, 2008, pp.397-409.
16. **Gazmuri RJ**, Correa BM. Cardiovascular Function and Vascular Tone: Physiology for ECC. In: Field JM (Editor-In-Chief); Kudenchuk PJ, O'Connor RE, Vanden Hoek TL (AHA associate editors); Bresler MJ, Mattu A, Silvers SM (ACEP associate editors). *Textbook of Emergency Cardiovascular Care and CPR*. Lippincott Williams & Wilkins, 2009 pp.395-407.
17. **Gazmuri RJ**, Santonocito C. Ventricular Arrhythmias. In: Vincent JL, Abraham E, Moore FA, Kochanek P, Fink MP (eds). *Textbook of Critical Care*, 6th Edition. Philadelphia: Elsevier Inc., 2011 pp.575-586.

PEER REVIEWED ORIGINAL SCIENTIFIC ARTICLES

1. Escobar E, Zamorano B, **Gazmuri RJ**: Demonstration of prostaglandin E₂ and F_{2α} in atrial tissue of patients with heart disease. *Am J Cardiol* 1983;52:424-425.
2. von Planta I, Weil MH, von Planta M, Bisera J, Bruno S, **Gazmuri RJ**, Rackow EC: Cardiopulmonary resuscitation in the rat. *J Appl Physiol* 1988;65:2641-2647.
3. **Gazmuri RJ**, von Planta M, Weil MH, Rackow EC: Arterial PCO₂ as an indicator of systemic perfusion during cardiopulmonary resuscitation. *Crit Care Med* 1989;17:237-240.
4. von Planta M, Weil MH, **Gazmuri RJ**, Rackow EC: Myocardial potassium uptake during experimental cardiopulmonary resuscitation. *Crit Care Med* 1989;17:895-899.
5. von Planta M, Weil MH, **Gazmuri RJ**, Bisera J, Rackow EC: Myocardial acidosis associated with CO₂ production during cardiac arrest and resuscitation. *Circulation* 1989;80:684-692.
6. **Gazmuri RJ**, von Planta M, Weil MH, Rackow EC: Cardiac effects of carbon dioxide-consuming and carbon dioxide-generating buffers during cardiopulmonary resuscitation. *J Am Coll Cardiol* 1990;15:482-490.

7. von Planta M, Weil MH, **Gazmuri RJ**, Ritz MA, Rackow EC: Calcium-entry blockers during porcine cardiopulmonary resuscitation. *Clin Sci* 1990;78:207-213.
8. Kette F, Weil MH, von Planta M, **Gazmuri RJ**, Rackow EC: Buffer agents do not reverse intramyocardial acidosis during cardiac resuscitation. *Circulation* 1990;81:1660-1666.
9. Gudipati CV, Weil MH, **Gazmuri RJ**, Deshmukh HG, Bisera J, Rackow EC: Increases in coronary vein CO₂ during cardiac resuscitation. *J Appl Physiol* 1990;68:1405-1408.
10. Tang WC, Weil MH, **Gazmuri RJ**, Bisera J, Rackow EC: Reversible impairment of myocardial contractility due to hypercarbic acidosis in the isolated perfused rat heart. *Crit Care Med* 1991;19:218-224.
11. **Gazmuri RJ**, Weil MH, Bisera J, Rackow EC: End-tidal carbon dioxide tension as a monitor of native blood flow during resuscitation by extracorporeal circulation. *J Thorac Cardiovasc Surg* 1991;101:984-988.
12. von Planta I, Weil MH, von Planta M, **Gazmuri RJ**, Duggal C: Hypercarbic acidosis reduces cardiac resuscitability. *Crit Care Med* 1991;19:1177-1182.
13. **Gazmuri RJ**, Weil MH, von Planta M, Gazmuri RR, Shah DM, Rackow EC: Cardiac resuscitation by extracorporeal circulation after failure of conventional CPR. *J Lab Clin Med* 1991;118:65-73.
14. Tang W, Weil MH, **Gazmuri RJ**, Sun S, Duggal C, Bisera J: Pulmonary ventilation/perfusion defects induced by epinephrine during cardiopulmonary resuscitation. *Circulation* 1991;84:2101-2107.
15. Kette F, Weil MH, **Gazmuri RJ**: Buffer solutions may compromise cardiac resuscitation by reducing coronary perfusion pressure. *JAMA* 1991;266:2121-2126.
16. **Gazmuri RJ**, Weil MH, Terwilliger K, Shah DM, Duggal C, Tang W: Extracorporeal circulation as an alternative to open-chest cardiac compression for cardiac resuscitation. *Chest* 1992;102:1846-1852.
17. Sun S, Weil MH, Tang W, **Gazmuri RJ**, Bisera J, Greenberg SR, Kim YB: Cardiac anaphylaxis in the Sprague-Dawley rat. *J Lab Clin Med* 1992;120:589-596.
18. Duggal C, Weil MH, **Gazmuri RJ**, Tang W, Sun S, O'Connell F, Ali M: Regional blood flow during closed-chest cardiac resuscitation in rats. *J Appl Physiol* 1993;74:147-152.
19. Tang W, Weil MH, Sun S, **Gazmuri RJ**, Bisera J: Progressive myocardial dysfunction after cardiac resuscitation. *Crit Care Med* 1993;21:1046-1050.
20. Kette F, Weil MH, **Gazmuri RJ**, Bisera J, Rackow EC: Intramyocardial hypercarbic acidosis during cardiac arrest and resuscitation. *Crit Care Med* 1993;21:901-906.
21. Maldonado FA, Weil MH, Tang W, Bisera J, **Gazmuri RJ**, Johnson B, D'Alessio A: Myocardial hypercarbic acidosis reduces cardiac resuscitability. *Anesthesiology* 1993;78:343-352.
22. Noc M, Weil MH, Sun S, **Gazmuri RJ**, Tang W, Pakula JL: Comparison of gastric luminal and gastric wall PCO₂ during hemorrhagic shock. *Circ Shock* 1993;40:194-199.
23. Tang W, Weil MH, Noc M, Sun S, **Gazmuri RJ**, Bisera J: Augmented efficacy of external CPR by intermittent occlusion of the ascending aorta. *Circulation* 1993;88:1916-21.
24. Sun SJ, Weil MH, Tang W, **Gazmuri RJ**, Johnson B, Bisera J: Cardiac resuscitation by retro-aortic infusion of blood. *J Lab Clin Med* 1994;123:81-88.

25. Tang W, Weil MH, Sun S, Noc M, **Gazmuri RJ**, Bisera J. Gastric intramural PCO₂ as monitor of perfusion failure during hemorrhagic and anaphylactic shock. *J Appl Physiol* 1994;76:572-577.
26. Yang L, Weil MH, Noc M, Tang W, Turner T, **Gazmuri RJ**. Spontaneous gasping increases the ability to resuscitate during experimental cardiopulmonary resuscitation. *Crit Care Med* 1994;22:879-883.
27. Noc M, Weil MH, **Gazmuri RJ**, Sun S, Bisera J, Tang W. Ventricular fibrillation voltage as a monitor of the effectiveness of cardiopulmonary resuscitation. *J Lab Clin Med* 1994;124:421-426.
28. Tang W, Weil MH, Sun S, Kette D, Kette F, **Gazmuri RJ**, O'Connell F, Bisera J. Cardiopulmonary resuscitation by precordial compression but without mechanical ventilation. *Am J Respir Crit Care Med* 1994;150:1709-1713.
29. Desai VS, Weil MH, Tang W, **Gazmuri RJ**, Bisera J. Hepatic, renal, and cerebral tissue hypercarbia during sepsis and shock in rats. *J Lab Clin Med* 1995;125:465-461.
30. Duggal C, Weil MH, Tang W, **Gazmuri RJ**, Sun S. Effect of arrest time on the hemodynamic efficacy of precordial compression. *Crit Care Med* 1995;23:1233-1236.
31. Tang W, Weil MH, Sun S, Noc M, Yang L, **Gazmuri RJ**: Epinephrine increases the severity of postresuscitation myocardial dysfunction. *Circulation* 1995;92:3089-3093.
32. **Gazmuri RJ**, Weil MH, Bisera J, Tang W, Fukui M, Mackee D: Myocardial dysfunction after successful resuscitation from cardiac arrest. *Crit Care Med* 1996; 24:992-1000.
33. Zamorano B, Escobar E, **Gazmuri RJ**: Subcellular distribution of prostaglandin-E₂ and prostaglandin-F₂ alpha in atrial tissue from patients with mitral valve disease. *Biol Res* 1998;31:343-349.
34. **Gazmuri RJ**, Berkowitz M, Cajigas H: Myocardial effects of ventricular fibrillation in the isolated rat heart. *Crit Care Med* 1999;27:1542-1550.
35. **Gazmuri RJ**, Deshmukh S, Shah PR: Myocardial effects of repeated electrical defibrillations in the isolated fibrillating rat heart. *Crit Care Med* 2000;28:2690-2696.
36. **Gazmuri RJ**, Hoffner E, Kalcheim J, Ho H, Patel M, Ayoub IM, Epstein M, Kingston S, Han Y. Myocardial protection during ventricular fibrillation by reduction of proton-driven sarcolemmal sodium influx. *J Lab Clin Med* 2001;137:43-55.
37. **Gazmuri RJ**, Ayoub IM, Hoffner E, Kolarova JD. Successful ventricular defibrillation by the selective sodium-hydrogen exchanger isoform-1 inhibitor cariporide. *Circulation* 2001;104:234-239.
38. Ayoub IM, Brown DJ, **Gazmuri RJ**. Transtracheal oxygenation: An alternative to endotracheal intubation during cardiac arrest. *Chest* 2001;120:163-70.
39. **Gazmuri RJ**, Ayoub IM, Kolarova JD, Karmazyn M. Myocardial protection during ventricular fibrillation by inhibition of the sodium-hydrogen exchanger isoform-1. *Crit Care Med* 2002;30:S166-S171.
40. Ayoub IM, Kolarova J, Yi Z, Trevedi A, Deshmukh H, Lubell DL, Franz MR, Maldonado FA, **Gazmuri RJ**. Sodium-hydrogen exchange inhibition during ventricular fibrillation: Beneficial effects on ischemic contracture, action potential duration, reperfusion arrhythmias, myocardial function, and resuscitability. *Circulation* 2003;107:1804-9 (PMID: 12665493).

41. Kolarova J, Ayoub IM, Yi Z, **Gazmuri RJ**. Optimal timing for electrical defibrillation after prolonged untreated ventricular fibrillation. *Crit Care Med* 2003;31:2022-8.
42. Kolarova J, Yi Z, Ayoub IM, **Gazmuri RJ**. Cariporide potentiates the effects of epinephrine and vasopressin by non-vascular mechanisms during closed-chest resuscitation. *Chest* 2005;127:1327-34.
43. Kolarova JD, Ayoub IM, **Gazmuri RJ**. Cariporide enables hemodynamically more effective chest compression by leftward shift of the flow-depth relationship. *Am J Physiol Heart Circ Physiol* 2005;288:H2904-11.
44. Ayoub IM, Kolarova J, Kantola RL, Sanders R, **Gazmuri RJ**. Cariporide minimizes adverse myocardial effects of epinephrine during resuscitation from ventricular fibrillation. *Crit Care Med* 2005;33:2599-605.
45. Radhakrishnan J, Wang S, Ayoub IM, Kolarova J, Levine, RF, **Gazmuri RJ**. Circulating levels of cytochrome c after resuscitation from cardiac arrest: a marker of mitochondrial injury and predictor of survival. *Am J Physiol Heart Circ Physiol* 2007;292:H767-75 (PMCID: PMC1796625).
46. Wang S, Radhakrishnan J, Ayoub IM, Kolarova JD, Taglieri DM, **Gazmuri RJ**. Limiting sarcolemmal Na⁺ entry during resuscitation from ventricular fibrillation prevents excess mitochondrial Ca²⁺ accumulation and attenuates myocardial injury. *J Appl Physiol* 2007;103:55-65.
47. Singh D, Kolarova JD, Wang S, Ayoub IM, **Gazmuri RJ**. Myocardial protection by erythropoietin during resuscitation from ventricular fibrillation. *Am J Ther* 2007;14:361-8.
48. Ayoub IM, Kolarova J, Kantola R, Radhakrishnan J, Wang S, **Gazmuri RJ**. Zoniporide preserves left ventricular compliance during ventricular fibrillation and minimizes post-resuscitation myocardial dysfunction through benefits on energy metabolism. *Crit Care Med* 2007;35:2329-36 (PMID: 17944021).
49. Radhakrishnan J, Ayoub IM, **Gazmuri RJ**. Activation of caspase-3 may not contribute to post-resuscitation myocardial dysfunction. *Am J Physiol Heart Circ Physiol* 2009;296:H1164-74 (PMCID: PMC2670683).
50. Grmec S, Strnad M, Kupnik D, Sinkovič A, **Gazmuri RJ**. Erythropoietin facilitates the return of spontaneous circulation and survival in victims of out-of-hospital cardiac arrest. *Resuscitation* 2009;80:631-7 (PMID: 19371997).
51. Ayoub IM, Kolarova J, **Gazmuri RJ**. Cariporide given during resuscitation promotes return of electrically stable and mechanically competent cardiac activity. Resuscitation. 2010;81:106-10. doi: 10.1016/j.resuscitation.2009.09.013. Epub 2009 Oct 22. PMID: 19853351 (PMCID: PMC2814946).
52. Radhakrishnan J, Kolarova J, Ayoub IM, **Gazmuri RJ**. AVE4454B – a novel sodium-hydrogen exchanger isoform-1 inhibitor – compared less effective than cariporide for resuscitation from cardiac arrest. *Transl Res*. 2011;157:71-80 (PMCID: PMC3651912).
53. **Gazmuri RJ**, Ayoub IM, Radhakrishnan J, Motl J, Upadhyaya MP. Clinically plausible hyperventilation does not exert adverse hemodynamic effects during CPR but markedly reduces end-tidal PCO₂. *Resuscitation* 2012;83:259-264 (PMID: 21854734).
54. Motl J, Radhakrishnan J, Ayoub IM, Grmec S, **Gazmuri RJ**. Vitamin-C compromises cardiac resuscitability in a rat model of ventricular fibrillation. *Am J Ther* 2012;Jun 16 [ePub] (PMID: 22713530).

55. Radhakrishnan J, Upadhyaya MP, Ng M, Edelheit A, Moy HM, Ayoub IM, **Gazmuri RJ**. Erythropoietin facilitates resuscitation from ventricular fibrillation by signaling protection of mitochondrial bioenergetic function in rats. *Am J Transl Res* 2013;5:316-326 (PMID: 23634242 [PubMed] PMCID: PMC3633974).
56. Borovnik-Lesjak V, Whitehouse K, Baetiong A, Artin B, Radhakrishnan J, **Gazmuri RJ**. High-dose erythropoietin during cardiac resuscitation lessens post-resuscitation myocardial stunning in swine. *Transl Res* 2013;162:110-121 (DOI:10.1016/j.trsl.2013.06.002; PMID 23806450).

PEER REVIEWED PHARMA-SPONSORED MULTICENTER CLINICAL TRIALS

1. Granger CB, Alexander JH, McMurray JJ, Lopes RD, Hylek EM, Hanna M, Al-Khalidi HR, Ansell J, Atar D, Avezum A, Bahit MC, Diaz R, Easton JD, Ezekowitz JA, Flaker G, Garcia D, Geraldes M, Gersh BJ, Golitsyn S, Goto S, Hermosillo AG, Hohnloser SH, Horowitz J, Mohan P, Jansky P, Lewis BS, Lopez-Sendon JL, Pais P, Parkhomenko A, Verheugt FW, Zhu J, Wallentin L; ARISTOTLE Committees and Investigators (**Gazmuri RJ** collaborator among 1151). Apixaban versus warfarin in patients with atrial fibrillation. *N Engl J Med* 2011;365:981-92.
2. Tricoci P, Huang Z, Held C, Moliterno DJ, Armstrong PW, Van de WF, White HD, Aylward PE, Wallentin L, Chen E, Lokhnygina Y, Pei J, Leonardi S, Rorick TL, Kilian AM, Jennings LH, Ambrosio G, Bode C, Cequier A, Cornel JH, Diaz R, Erkan A, Huber K, Hudson MP, Jiang L, Jukema JW, Lewis BS, Lincoff AM, Montalescot G, Nicolau JC, Ogawa H, Pfisterer M, Prieto JC, Ruzyllo W, Sinnaeve PR, Storey RF, Valgimigli M, Whellan DJ, Widimsky P, Strony J, Harrington RA, Mahaffey KW (**Gazmuri RJ** collaborator). Thrombin-receptor antagonist vorapaxar in acute coronary syndromes. *N Engl J Med* 2012;366:20-33.
3. Easton JD, Lopes RD, Bahit MC, Wojdyla DM, Granger CB, Wallentin L, Alings M, Goto S, Lewis BS, Rosenqvist M, Hanna M, Mohan P, Alexander JH, Diener HC (**Gazmuri RJ** collaborator among 1129). Apixaban compared with warfarin in patients with atrial fibrillation and previous stroke or transient ischaemic attack: a subgroup analysis of the ARISTOTLE trial. *Lancet Neurol* 2012;11:503-11.

CONSENSUS STATEMENTS AND GUIDELINES

1. **Gazmuri RJ**, Nadkarni VM, Nolan JP, Arntz H-R, Billi JE, Bossaert L, Deakin CD, Finn J, Hammill WW, Handley AJ, Hazinski MF, Hickey RW, Jacobs I, Jauch EC, Kloeck WGJ, Mattes MH, Montgomery WH, Morley P, Morrison LJ, Nichol G, O'Connor RE, Perlman J, Richmond S, Sayre M, Shuster M, Timerman S, Weil MH, Weisfeldt ML, Zaritsky A, Zideman DA. Scientific Knowledge Gaps and Clinical Research Priorities for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Identified During the 2005 International Consensus Conference on ECC and CPR Science With Treatment Recommendations. A Consensus Statement From the International Liaison Committee on Resuscitation (American Heart Association, Australian Resuscitation Council, European Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, and the New Zealand Resuscitation Council); the American Heart Association Emergency Cardiovascular Care Committee; the Stroke Council; and the Cardiovascular Nursing Council. Simultaneously published in *Circulation* 2007;116:2501-12 (PMID: 17993477) and *Resuscitation* 2007;75:400-11 (PMID: 17993368).
2. Sayre MR, Koster RW, Botha M, Cave DM, Cudnik MT, Handley AJ, Hatanaka T, Hazinski MF, Jacobs I, Monsieurs K, Morley PT, Nolan JP, Travers AH; (**Gazmuri RJ** collaborator among 36) Part 5: Adult basic life support: 2010 International Consensus on

Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation* 2010;122:S298-S324.

3. Cave DM, **Gazmuri RJ**, Otto CW, Nadkarni VM, Cheng A, Brooks SC, Daya M, Sutton RM, Branson R, Hazinski MF. Part 7: CPR techniques and devices: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2010;122:S720-28 (PMID: 20956223).

CASE REPORTS

1. Trivedi K, Borovnik-Lesjak V, **Gazmuri RJ**: LUCAS 2™ device, compression depth, and 2010 CPR guidelines. *Am J Emerg Med* 2013;May 17 [Epub].
<http://dx.doi.org/10.1016/j.ajem.2013.03.007>

REVIEW ARTICLES

2. Weil MH, von Planta M, **Gazmuri RJ**, Rackow EC: Incomplete global myocardial ischemia during cardiac arrest and resuscitation. *Crit Care Med* 1988;16:997-1001. (peer reviewed)
3. **Gazmuri RJ**, Weil MH, von Planta M: [Cardiopulmonary resuscitation: Acid-base alterations and alkalizing therapy]. *Rev Med Chile* 1989;117:322-329. (peer reviewed)
4. von Planta M, Weil MH, **Gazmuri RJ**: [Non-invasive hemodynamic monitoring during cardiopulmonary resuscitation using capnography]. *Schweiz Med Wochenschr* 1989;119:371-375. (peer reviewed)
5. Weil MH, **Gazmuri RJ**, Rackow EC. Drug intervention during cardiac arrest. *CARDIO* 1989;May:128-140.
6. Weil MH, **Gazmuri RJ**, Rackow EC. The clinical rationale of cardiac resuscitation. *Disease-a-Month* 1990;36:423-468.
7. **Gazmuri RJ**, Weil MH, Tang W: [The rationale of cardiopulmonary resuscitation]. *Rev Med Chile* 1991;119:1301-1310. (peer reviewed)
8. Weil MH, **Gazmuri RJ**. Recent advances in cardiopulmonary resuscitation. *Appl Cardiopulm Pathophys* 1991;4:97-102.
9. Weil MH, **Gazmuri RJ**. Shock: New developments in the management of shock. *Appl Cardiopulm Pathophys* 1991;4:103-107.
10. **Gazmuri RJ**, Becker J: Cardiac resuscitation: The search for hemodynamically more effective methods. *Chest* 1997;111:712-723. (peer reviewed)
11. **Gazmuri RJ**. Effects of repetitive electrical shocks on post-resuscitation myocardial function. *Crit Care Med* 2000;28:N228-32.
12. **Gazmuri RJ**, Ayoub IM, Kolarova J. Myocardial protection during resuscitation from cardiac arrest. *Curr Opin Critic Care* 2003;9:199-204.
13. **Gazmuri RJ**. [Advances in cardiopulmonary resuscitation]. *Clinic@s de Medicina Crítica* 2004;2:1-23.
14. **Gazmuri RJ**, Kube E. Defibrillator/monitors for ICU and hospital use. *ICU Management* 2005;3:40-41.
15. Ayoub IM, Kolarova JD, Radhakrishnan J, Wang S, **Gazmuri RJ**. [Pathophysiology and management of myocardial injury during cardiopulmonary resuscitation]. *Clinic@s de Medicina Crítica* 2005;3:1-22.

16. **Gazmuri RJ**. Chest-compression—only CPR for lay rescuers? *Currents in Emergency Cardiovascular Care* (Fall) 2007;18:1-2.
17. Alvarez-Fernandez J-A, **Gazmuri RJ**. Mortalidad evitable por parada cardíaca extrahospitalaria [Avoidable mortality after out-of-hospital cardiac arrest]. *Med Clin (Barc)* 2008;130:710-4. (peer reviewed)
18. Ayoub IM, Radhakrishnan J, **Gazmuri RJ**. Targeting mitochondria for resuscitation from cardiac arrest. *Crit Care Med* 2008;36:S440-6 (PMCID: PMC2865162).
19. **Gazmuri RJ**, Alvarez-Fernandez J-A. Tendencias en resucitación cardiopulmonar [Trends in cardiopulmonary resuscitation]. *Med Intensiva* 2009;33:31-9. (peer reviewed)
20. **Gazmuri RJ**, Ayoub IM, Radhakrishnan J. Protecting mitochondrial bioenergetic function. *Signa Vitae* 2010;5(Suppl 1):32-5.
21. **Gazmuri RJ**, Ayoub IM, Radhakrishnan J. NHE-1 inhibitors and erythropoietin for maintaining myocardial function during cardiopulmonary resuscitation. *Signa Vitae* 2010;5(2):6-13.
22. **Gazmuri RJ**, Radhakrishnan J. Protecting mitochondrial bioenergetic function during resuscitation from cardiac arrest. *Crit Care Clin* 2012;28:245-70. PMID:22433486; PMCID:PMC3310365 (Available on 2013/4/1).

CONFERENCE PROCEEDINGS

1. von Planta M, **Gazmuri RJ**, Deshmukh HG, Weil MH, Rackow EC. Acid-base management of cardiopulmonary arrest. In: Fantoni A, Ripamonti D, Favero A (eds). *Atti del XVII corsonazionale di aggiornamento in rianimazione e terapia intensiva*. Milano 1987:18-30.
2. Weil MH, von Planta M, **Gazmuri RJ**, Rackow EC. New advances in CPR. In: *Applied Cardiopulmonary Pathophysiology*. International Research Symposium on the Reversibility of Clinical Death. University of Pittsburgh Resuscitation Research Center. Kluwer Academic Publishers, Dordrecht, The Netherlands 1988;2:151-8.
3. **Gazmuri RJ**, Weil MH, Kette F. Cardiac resuscitation by extracorporeal pump oxygenation (ECPO). In: Mocavero G, Gullo A, Paladini VF, Romano E (eds). *Recent Advances in Anesthesia, Pain, Intensive Care and Emergency*, Trieste, Italy. 1989;4:369-374.
4. Kette F, Weil MH, **Gazmuri RJ**. Myocardial acidosis during cardiac arrest and its therapeutic implications. In: Mocavero G, Gullo A, Paladini VF, Romano E (eds). *Recent Advances in Anesthesia, Pain, Intensive Care and Emergency*, Trieste, Italy. 1989;4:369-374.
5. **Gazmuri RJ**. [End-tidal CO₂ for hemodynamic monitoring during cardiopulmonary resuscitation]. In: Santelices E (ed). *Manejo del Paciente Quirúrgico Crítico*. XXXIII Congreso Chileno, III Latinoamericano, American College of Surgeons, Santiago Chile 1989:42-44.
6. **Gazmuri RJ**, Weil MH, Kette F. Cardiac resuscitation by extracorporeal circulation. In: *Second International Post-graduate Course in Anesthesia and Intensive Care*. Alimini Valtur Village, Otranto, (Lecce) Italy. June 23-30, 1990.
7. Kette F, Cvietissa F, Weil MH, **Gazmuri RJ**. Il monitoraggio continuo della CO₂ di fine espirazione (ETCO₂) durante rianimazione cardiorespiratoria. *Giornale di Medicina Critica Terapia Antalgica e Cure Palliativa* 1990;2:163-169.

8. **Gazmuri RJ**, Tang W, Weil MH, Noc, M. Options for enhancement of myocardial perfusion during cardiac resuscitation. In: Gullo A (ed). *Recent Advances in Anaesthesia Pain Intensive Care and Emergency*. Club A.P.I.C.E. Trieste, Italy 1992, p255-62.
9. Tang W, Weil MH, Sun SJ, **Gazmuri RJ**. The effects of epinephrine and vasopressor agents on ET_{CO}₂ during CPR. In: Gullo A (ed). *Recent Advances in Anaesthesia, Pain, Intensive Care and Emergency*. A.P.I.C.E. Trieste, Italy, 1992, pp. 263-267.
10. **Gazmuri RJ**. [Extracorporeal circulation using peripheral vascular access]. In: Santelices (ed). *Cuidados Postoperatorios y Paciente Quirúrgico Crítico*. Sociedad de Cirujanos de Chile. Santiago, Chile, 1994, pp.282-283.
11. **Gazmuri RJ**. [Is positive pressure ventilation essential during basic life support?]. In: Santelices (ed). *Cuidados Postoperatorios y Paciente Quirúrgico Crítico*. Sociedad de Cirujanos de Chile. Santiago, Chile, 1994, pp.275-276.
12. **Gazmuri RJ**. [Mechanisms of blood flow during precordial compression]. In: Santelices (ed). *Cuidados Postoperatorios y Paciente Quirúrgico Crítico*. Sociedad de Cirujanos de Chile. Santiago, Chile, 1994, pp.277-279.
13. **Gazmuri RJ**. [Metabolic and functional abnormalities during myocardial ischemia]. In: Santelices (ed). *Cuidados Postoperatorios y Paciente Quirúrgico Crítico*. Sociedad de Cirujanos de Chile. Santiago, Chile, 1994, pp.287-288.
14. **Gazmuri RJ**. [Monitoring of the resuscitation effort]. In: Santelices (ed). *Cuidados Postoperatorios y Paciente Quirúrgico Crítico*. Sociedad de Cirujanos de Chile. Santiago, Chile, 1994, pp.269-270.
15. **Gazmuri RJ**. [Post-resuscitation myocardial dysfunction]. In: Santelices (ed). *Cuidados Postoperatorios y Paciente Quirúrgico Crítico*. Sociedad de Cirujanos de Chile. Santiago, Chile, 1994, pp.284-286.
16. **Gazmuri RJ**. [Reestablishment of coronary blood flow is a critical hemodynamic determinant of successful resuscitation]. In: Santelices (ed). *Cuidados Postoperatorios y Paciente Quirúrgico Crítico*. Sociedad de Cirujanos de Chile. Santiago, Chile, 1994, pp.280-281.
17. **Gazmuri RJ**. Current approach to the treatment of cardiac arrest: The chain of survival. In: Cerovic O and Stajer D (eds). *Third International Symposium on Intensive Care*. Bled, Slovenia, 1994, pp.18-21.
18. **Gazmuri RJ**. Options for restoring myocardial perfusion during CPR: The chain of survival. In: Cerovic O and Stajer D (eds). *Third International Symposium on Intensive Care*. Bled, Slovenia, 1994, pp.18-21.
19. **Gazmuri RJ**, Vidyarthi V. Myocardial dysfunction following restoration of spontaneous circulation. In: Gullo A (Ed.) *Anaesthesia, Pain, Intensive Care and Emergency – A.P.I.C.E. Proceedings of the 18th Postgraduate Course in Critical Care Medicine*. Trieste, Italy, 2003, pp.459-70.
20. **Gazmuri RJ**, Radhakrishnan J, Kolarova J. Myocardial preservation, reperfusion injury, and post-resuscitation myocardial dysfunction. In: Gullo A (Ed.) *Anaesthesia, Pain, Intensive Care and Emergency – A.P.I.C.E. Proceedings of the 19th Postgraduate Course in Critical Care Medicine*. Trieste, Italy, 2004, pp.517-526.
21. **Gazmuri RJ**. Minimising reperfusion injury in settings of myocardial ischemia. In: Gullo A (Ed.) *Anaesthesia, Pain, Intensive Care and Emergency – A.P.I.C.E. Proceedings of the 20th Postgraduate Course in Critical Care Medicine*. Trieste, Italy, 2005, pp.267-276.

22. **Gazmuri RJ**, Ayoub IM, Radhakrishnan J. Myocardial effects of cardiac arrest and resuscitation with especial reference to mitochondrial injury. In: Grmec Š and Kupnik D (Eds.) Acute Conditions: Signs, Symptoms, Syndromes, Differential Diagnosis and Management. *Proceedings and Algorithms of the 3rd International Seminar on Acute Medicine*. Maribor, Slovenia, 2007, pp.73-80.
23. Wang S, Zhang L, **Gazmuri RJ**, Yang, CF. *In-Vivo* external sensor for mitochondrial injury: circulating cytochrome c.” IEEE-SAS Proceedings 2008, pp.13-15.
24. Ayoub IM, Radhakrishnan J, **Gazmuri RJ**. Caspase-3 may not play a role during cardiac arrest and resuscitation. In: Grmec Š (Ed.) Acute Conditions: Signs, Symptoms, Syndromes, Differential Diagnosis and Management. *Proceedings and Algorithms of the 4th International Seminar on Acute Medicine*. Maribor, Slovenia, October 15-17, 2009, pp.146-56.
25. **Gazmuri RJ**, Ayoub IM, Radhakrishnan J. NHE-1 inhibitors and erythropoietin for maintaining myocardial function during cardiopulmonary resuscitation. In: Grmec Š (Ed.) Acute Conditions: Signs, Symptoms, Syndromes, Differential Diagnosis and Management. *Proceedings and Algorithms of the 4th International Seminar on Acute Medicine*. Maribor, Slovenia, October 15-17, 2009, pp.157-69.
26. **Gazmuri RJ**, Ayoub IM, Radhakrishnan J. Cardiopulmonary resuscitation: from flying blind to flying right. In: Grmec Š (Ed.) Acute Conditions: Signs, Symptoms, Syndromes, Differential Diagnosis and Management. *Proceedings and Algorithms of the 4th International Seminar on Acute Medicine*. Maribor, Slovenia, October 15-17, 2009, pp.170-5.
27. **Gazmuri RJ**, Ayoub IM, Radhakrishnan J. Physiopathology and severity of postresuscitation myocardial dysfunction: effects of sodium–hydrogen exchanger isoform-1 (NHE-1) inhibitors and erythropoietin. A.P.I.C.E. *Proceedings of the 23th Postgraduate Course in Critical Care Medicine*. Catania, Italy, 2011 (In Press).
28. **Gazmuri RJ**. Current determinant of successful resuscitation and suggestions for future research (lecture, March 22). Acute Conditions (5th): Signs, Symptoms, Syndromes, Differential Diagnosis and Management. *Proceedings and Algorithms of the 5th International Seminar on Acute Medicine*. Maribor, Slovenia, March 21-23, 2013, pp.16-18.

LETTERS TO THE EDITOR

1. Weil MH, **Gazmuri RJ**, von Planta M, Rackow EC. Bicarbonate in severe lactic acidosis. *Ann Intern Med* 1987;107:258.
2. **Gazmuri RJ**, Weil MH, Wanchun T, Bisera J, Rackow EC. Simultaneous aortic, jugular bulb, and right atrial pressures during cardiopulmonary resuscitation in humans. *Circulation* 1990;81:1158-1159.
3. **Gazmuri RJ**, Mecher C, Weil MH. The HA-1A monoclonal antibody for gram-negative sepsis. *N Engl J Med* 1991;325:279-280.
4. **Gazmuri RJ**, Hanif S, Wagner D. Persistent paralysis after vecuronium administration. *N Engl J Med* 1992;327:1881-1882.
5. **Gazmuri RJ**. Response to the letter to the editor entitled “Cardiac arrest in the elderly: CPR or no CPR, that is the question!” *Chest* 1997;112:1147-1148.
6. **Gazmuri RJ**, Ayoub IM. The case for sodium-hydrogen exchanger isoform-1 inhibition during cardiac resuscitation remains strong. *Crit Care Med* 2006;34:1580-1582.

7. **Gazmuri RJ**, Ayoub IM. Reply to Letter to the Editor by Faybik, Peter MD, Lahner, Daniel MD, and Schramm, Wolfgang MD entitled “An outlasting error of Ernest Henry Starling for at least 83 years in the medical literature”. *Resuscitation* 2010;81:1584-5 (doi:10.1016/j.resuscitation.2010.05.024).

EDITORIALS/COMMENTARIES

1. Weil MH, **Gazmuri RJ**, Rackow EC, Kette F, Bisera J. End-tidal CO₂ during cardiopulmonary resuscitation. *JAMA* 1990;263:814-815.
2. Weil MH, **Gazmuri RJ**, Rackow EC. Immediate Resuscitation. *Crit Care Med* 1990;18:455.
3. Weil MH, **Gazmuri RJ**. Hypothermia after cardiac arrest. *Crit Care Med* 1991;19:315.
4. **Gazmuri RJ**. Interposed abdominal compression for cardiac arrest. *ACP Journal Club* 1992;116(Suppl 3):65.
5. **Gazmuri RJ**. Pulse oximetry and capnometry in critical care: A review. *ACP Journal Club* 1992;117(Suppl 1):21.
6. **Gazmuri RJ**. Airway management during cardiopulmonary resuscitation: A shifting paradigm. *Crit Care Med* 1999;27:27-28.
7. **Gazmuri RJ**. Buffer treatment for cardiac resuscitation: Putting the cart before the horse? *Crit Care Med* 1999;27:875-876.
8. **Gazmuri RJ**. Outcome after cardiopulmonary resuscitation: Is age a factor? *Crit Care Med* 1999;27:2295-2296.
9. **Gazmuri RJ**, Ayoub I. How do you spell basic life support? *Crit Care Med* 1999;27:2048-2050.
10. **Gazmuri RJ**. Acidosis during cardiac arrest: A manifestation of inadequate perfusion. *Crit Care Med* 1999;27:2055-2056.
11. **Gazmuri RJ**, Ayoub I. Pressors for cardiopulmonary resuscitation: Is there a new kid on the block? *Crit Care Med* 2000;28:1236-1237.
12. **Gazmuri RJ**, Ayoub I. Myocardial effects of epinephrine during ventricular fibrillation: Does flow matter? *Crit Care Med* 2000;28:1678-1679.
13. **Gazmuri RJ**, Shakeri SA. Low-dose vasopressin for reversing vasodilation during septic shock. *Crit Care Med* 2001;29:673-675.
14. **Gazmuri RJ**. A clinical decision aid was accurate for predicting survival to hospital discharge after in-hospital cardiac resuscitation. Commentary. *ACP Journal Club* 2001;135:117.
15. **Gazmuri RJ**, Ayoub IM, Shakeri SA. Ventricular fibrillation waveform analysis for guiding the time of electrical defibrillation. *Crit Care Med* 2001;29:2395-2397.
16. **Gazmuri RJ**, Shakeri SA. Blood transfusion and the risk of nosocomial infection: An underreported complication? *Crit Care Med* 2002;30:2389-2391.
17. **Gazmuri RJ**. Editorial Overview. Cardiopulmonary resuscitation. *Curr Opin Crit Care* 2003;9:181-182.
18. **Gazmuri RJ**, Kube E. Capnography during cardiac resuscitation: A clue on mechanisms and a guide to interventions. *Critical Care* 2003;7:411-412 (PMCID: PMC374377).

19. **Gazmuri RJ**, Gopalakrishnan P. Hypothermia: Cooling down inflammation. *Crit Care Med* 2003;31:2811-2812.
20. **Gazmuri RJ**. Editorial: Optimizando la calidad en medicina intensiva [Optimizing the quality of intensive care medicine]. *Rev Chil Med Intensiva* 2004;19:53-54.
21. **Gazmuri RJ**, Ayoub IM. B-type natriuretic peptide for predicting outcomes after open heart surgery: Superior than traditional scoring systems? *Crit Care Med* 2005;33:459-460.
22. **Gazmuri RJ**, Kolarova JD, Ayoub IM. Inotropic options for post-resuscitation myocardial dysfunction. *Crit Care Med* 2005;33:668-670.
23. **Gazmuri RJ**. [Editorial to issue dedicated to cardiopulmonary resuscitation]. *Clinic@s de Medicina Crítica* 2005;3:(In Press)
24. **Gazmuri RJ**. Faculty of 1000 Medicine: evaluations for Supinski GS & Callahan LA *J Appl Physiol* 2006;100:1770-7, 15 Mar 2006
<http://www.f1000medicine.com/article/id/11408/evaluation>.
25. **Gazmuri RJ**. Faculty of 1000 Medicine: evaluations for Kellum MJ et al *Am J Med* 2006;119:335-40, 21 Apr 2006
<http://www.f1000medicine.com/article/id/12578/evaluation>.
26. **Gazmuri RJ**. Faculty of 1000 Medicine: evaluations for Müller D et al. *Circulation* 2006;114:1146-50, 4 Oct 2006
<http://www.f1000medicine.com/article/id/1043113/evaluation>.
27. **Gazmuri RJ**. Faculty of 1000 Medicine: evaluations for SOS-KANTO study group *Lancet* 2007 Mar 17 369:920-6, 9 Jul 2007
<http://www.f1000medicine.com/article/id/1088321/evaluation>.
28. **Gazmuri RJ**, Bhuriya R, Ayoub IM. CO₂: Friend or foe? *Crit Care Med* 2007;35:1788-1789.
29. **Gazmuri RJ**. Faculty of 1000 Medicine: evaluations for Ewy GA et al. *Circulation* 2007;116:2525-30, 28 Nov 2007
<http://www.f1000medicine.com/article/id/1098065/evaluation>.
30. **Gazmuri RJ**, Tandon M. Cardiopulmonary resuscitation: From flying blind to flying right. *Crit Care Med* 2008;36:357-358.
31. **Gazmuri RJ**, Puthenveetil VJ. Faculty of 1000 Medicine: evaluations for Chan PS et al *N Engl J Med* 2008;358:9-17
<http://www.f1000medicine.com/article/id/1099044/evaluation>.
32. **Gazmuri RJ**, Borovnik-Lesjak V. Mechanical devices for chest compression: An evolving process shedding light on mechanisms. *Crit Care Med* 2012;40:3095-3096 (doi: 10.1097/CCM.0b013e31826324fe).

ABSTRACTS

1. **Gazmuri RJ**, Zamorano B, Escobar E. [Arterial and venous prostaglandin E₂ levels in patients with valvular disease]. *XX Congreso Chileno de Cardiología y Cirugía Cardiovascular, XI Congreso Sud-Americano de Cardiología y II Iberoamericano de Cardiología*, Noviembre 1983.
2. **Gazmuri RJ**, Lobos T, Valdés S. [ARDS associated with elevated Mycoplasma Pneumoniae titers]: Caso clínico. *XVII Congreso Chileno de Enfermedades Respiratorias y V Congreso de la Sociedad Chilena de Alergia e Inmunología*, Octubre 1984.

3. **Gazmuri RJ**, Valdés S, Aracena AM, Silva A, Soto V. [Pulmonary artery catheterization in the critically ill patient: Complications]. *II Congreso Chileno de la Sociedad de Cuidados Intensivos*, 1984.
4. Mañalich J, **Gazmuri RJ**, Lobos T, Palma R, Valenzuela ME, Valdés S. [Diarrhea associated with Clostridium Difficile: Preliminary experience]. *XI Congreso Chileno de Gastroenterología*, Noviembre 1984.
5. Guarda E, Zamorano B, **Gazmuri RJ**, Escobar E. [Plasma levels of prostaglandin E₂ in patients with asymptomatic aortic regurgitation]. *XXI Congreso Chileno de Cardiología y Cirugía Cardiovascular*, Diciembre 1984.
6. Zamorano B, Escobar E, **Gazmuri RJ**. [Prostaglandin E₂ and F_{2α} concentration human myocardium]. *Sixth International Conference on Prostaglandins and related compounds* (Florence, Italy), June 1986.
7. **Gazmuri RJ**, Gil R, Soto V, Echagüe C, Valdés S. [Noninvasive measurement of cardiac output and thermodilution]. *XXII Congreso Chileno de Cardiología y Cirugía Cardiovascular*, Diciembre 1985.
8. **Gazmuri RJ**, Soto V, Morales S, Valdés S. [Computerized therapeutic intervention scoring system (TISS)]. *V Congreso Chileno de Medicina Intensiva*, Septiembre 1986.
9. **Gazmuri RJ**, Araya M, Urrejola P, Valdés S. [Outcome of elderly critically ill patients]. *V Congreso Chileno de Medicina Intensiva*, Septiembre 1986.
10. von Planta M, Weil MH, **Gazmuri RJ**, Rackow EC. pH determinants of electromechanical dissociation (EMD) after reversal of cardiac arrest. *Clin Res* 1987;35:386A.
11. von Planta M, Gudipati R, Weil MH, **Gazmuri RJ**, Mitchell D, Rackow EC. ET_{CO}₂ during experimental CPR: relationship with mixed venous CO₂ after tromethamine (THAM) and NaHCO₃. *Clin Res* 1987;35:386A.
12. **Gazmuri RJ**, Weil MH, von Planta M, Rackow EC. Alkalinizing agents in venous hypercarbia, end-tidal CO₂ (ET_{CO}₂) and resuscitability after experimental cardiac arrest. *The Physiologist* 1987;30:212.
13. von Planta I, von Planta M, Bisera J, **Gazmuri RJ**, Weil MH, Rackow EC. A new rodent model for investigation of cardiopulmonary resuscitation (CPR). *The Physiologist* 1987;30:215.
14. von Planta M, Weil MH, **Gazmuri RJ**, Rackow EC. Mechanism of myocardial respiratory acidosis during CPR. *Clin Res* 1987;35:879A.
15. **Gazmuri RJ**, Weil MH, von Planta M, Bisera J, Rackow EC. Arterial PCO₂ reflects cardiac output and prognosticates resuscitability during CPR. *Clin Res* 1987;35:875A.
16. von Planta M, von Planta I, Weil MH, **Gazmuri RJ**, Anderson J, Rackow EC. ET_{CO}₂ as noninvasive hemodynamic parameter during rodent resuscitation (CPR). *Clin Res* 1987;35:840A.
17. **Gazmuri RJ**, Weil MH, von Planta M, Rackow EC. Effects of buffer agents on myocardial resuscitability after cardiac arrest. *J Am Coll Cardiol* 1988;11:89A.
18. **Gazmuri RJ**, von Planta M, Weil MH, Rackow EC. Absence of acidemia in arterial blood after 12 minutes of cardiac arrest. *Crit Care Med* 1988;16:385.
19. von Planta M, von Planta I, Weil MH, **Gazmuri RJ**, Rackow EC. End-tidal carbon dioxide (P_{ET}CO₂) for monitoring blood flow during CPR. *Crit Care Med* 1988;16:388.

20. von Planta M, von Planta I, Weil MH, **Gazmuri RJ**, Ritz M, Rackow EC. CO₂ transport and elimination during rodent cardiopulmonary resuscitation. *Clin Res* 1988;36:373A.
21. von Planta M, Weil MH, **Gazmuri RJ**, Ritz M, Rackow EC. Myocardial uptake of potassium during CPR. *Circ Shock* 1988;24:286.
22. **Gazmuri RJ**, Weil MH, Gazmuri RR, von Planta M, Erickson S, Rackow EC. End-tidal PCO₂ for monitoring cardiac resuscitation during extracorporeal pump oxygenation. *Clin Res* 1988;36:863A.
23. Kette F, von Planta M, Weil MH, Bisera J, **Gazmuri RJ**, Rackow EC. Failure of buffer agents to reverse myocardial acidosis during CPR. *Clin Res* 1988;36:864A.
24. von Planta M, Weil MH, **Gazmuri RJ**, Bruno S, Rackow EC. Failure of calcium channel blockers (CCB) to increase resuscitability during CPR. *Chest* 1988;94:6S.
25. von Planta M, Weil MH, **Gazmuri RJ**. [Non-invasive hemodynamic monitoring during cardiopulmonary resuscitation using capnography]. Proceeding of the 1988 Annual Meeting. *Schweiz Med Wschr* 1989;119:9.
26. **Gazmuri RJ**, Weil MH, von Planta M, Bisera J, Erickson S, Rackow EC. Cardiac resuscitation by extracorporeal pump oxygenation (ECPO) after failure of precordial compression. *J Am Coll Cardiol* 1989;13:220A.
27. Tang W, **Gazmuri RJ**, Weil MH, Kette F, Bisera J, Duggal C, Rackow EC. Myocardial depressant effect of carbon dioxide in the intact rat heart. *Crit Care Med* 1989;17:S14.
28. Shah D, **Gazmuri RJ**, Weil MH, Rackow EC. Changes in ST segment during resuscitation with extracorporeal pump oxygenator (ECPO). *Crit Care Med* 1989;17:S72.
29. Kette F, **Gazmuri RJ**, Weil MH, von Planta M, Rackow EC. Hypertonic buffer solutions decrease coronary perfusion pressure during CPR. *Crit Care Med* 1989;17:S130.
30. **Gazmuri RJ**, Weil MH, Shah D, Duggal C, Rackow EC. ECPO vs direct cardiac massage for resuscitation after 15 min of cardiac arrest. *Crit Care Med* 1989;17:S130.
31. Kette F, Weil MH, **Gazmuri RJ**, Bisera J, Rackow EC. Increases in myocardial PCO₂ during CPR correlate inversely with coronary perfusion pressures (CPR) and resuscitability. *Circulation* 1989; 80:II-494.
32. Tang W, Weil MH, Sun S, **Gazmuri RJ**, Duggal C, Bisera J, Rackow EC. Epinephrine produces both hypoxemia and hypercarbia during CPR. *Crit Care Med* 1990;18:S276.
33. Duggal C, Weil MH, **Gazmuri RJ**, Bruno SJ, Tang W, Rackow EC. Effect of duration of cardiac arrest on coronary perfusion pressure and end-tidal CO₂ as predictors of resuscitability. *Crit Care Med* 1990;18:S222.
34. von Planta I, Bruno S, Weil MH, von Planta M, **Gazmuri RJ**. Hypercarbia after cardiac arrest precludes resuscitability. *Crit Care Med* 1990;18:S246.
35. Kette F, Weil MH, **Gazmuri RJ**, Rackow EC. PCO₂ as a predominant cause of myocardial acidosis during cardiac arrest. *Crit Care Med* 1990;18:S246.
36. Tang W, Weil MH, **Gazmuri RJ**, Sun J, Bisera J, Rackow EC. Buffer agents ameliorate the myocardial depressant effect of carbon dioxide. *Crit Care Med* 1990;18:S182.
37. Tang W, **Gazmuri RJ**, Weil MH, Bisera J, Rackow EC. Progressive ventricular dysfunction after cardiac resuscitation. *Crit Care Med* 1990;18:S277.
38. Tang W, **Gazmuri RJ**, Weil MH, Bisera J, Rackow EC. Progressive ventricular dysfunction after cardiac resuscitation. *Crit Care Med* 1990;18:S277.

39. Tang W, Weil MH, Sun S, **Gazmuri RJ**, Bisera J. Epinephrine produces pulmonary A-V shunt during CPR. *Circulation* 1990;82:III-485.
40. Sun S, Weil MH, Tang W, **Gazmuri RJ**, Bisera J, Rackow EC. The heart as a primary target organ in experimental anaphylaxis in the rat. *Circulation* 1990;82:III-484.
41. Duggal C, Weil MH, **Gazmuri RJ**, O'Connell F, Tang W, Ali M, Bisera J. End-tidal CO₂ as a predictor of cardiac output and coronary perfusion pressure during CPR. *Clin Res* 1990;38:888A.
42. Tang W, Weil MH, Sun S, **Gazmuri RJ**, Duggal LC, Bisera J. Epinephrine eliminates the predictive value of ETCO₂ during CPR. *Clin Res* 1990;38:823A.
43. Sun S, Weil MH, Tang W, Kette D, Kette F, O'Connell F, **Gazmuri RJ**. Precordial compression alone produces adequate ventilation for cardiac resuscitation. *FASEB J* 1991;5:A683.
44. Sun S, Weil MH, Tang W, **Gazmuri RJ**, Bisera J. End-tidal PCO₂ and arterial PCO₂ indicate severity of perfusion failure during anaphylactic shock. *Clin Res* 1991;39:422A.
45. Tang W, Weil MH, Sun S, O'Connell F, **Gazmuri RJ**, Winkler S, Bisera J. Myocardial function after CPR by precordial compression without mechanical ventilation. *Chest* 1991;100:132S.
46. Tang W, Weil MH, Sun S, Duggal C, Recientes YL, **Gazmuri RJ**. ETCO₂ as a hemodynamic determinant of hemorrhagic shock in the rat. *Chest* 1991;100:134S.
47. Sun S, Weil MH, Tang W, **Gazmuri RJ**, Desai V. Gastric intramural PCO₂ as an indicator of organ ischemia during anaphylactic shock. *Clin Res* 1991;39:708A.
48. Sun S, Weil MH, Tang W, **Gazmuri RJ**, Bisera J. Retro-aortic blood infusion with epinephrine for CPR. *Crit Care Med* 1992;20:S24.
49. Tang W, Weil MH, Maldonado FA, **Gazmuri RJ**, Bisera J. Hypercarbia decreases effectiveness of electrical defibrillation during CPR. *Crit Care Med* 1992;20:S24.
50. Sun S, Weil MH, Tang W, **Gazmuri RJ**, Noc M, Bisera J. Gastric intramural bicarbonate: Limitations of the tonometry method. *Crit Care Med* 1992;20:S66.
51. Noc M, Weil MH, Sun S, Tang W, **Gazmuri RJ**, Pakula J, Desai V. Relationship between measured and tonometrically determined gastric intramural pH during hemorrhagic shock. *Circ Shock* 1992;37:8.
52. Tang W, Weil MH, Sun S, Desai V, **Gazmuri RJ**, Mecher C. Ischemia during low-flow states constitutes a dual defect of oxygen deficit and CO₂ excess. *Circ Shock* 1992;37:13.
53. Tang W, Weil MH, **Gazmuri RJ**, Reese K, Bisera J. Coronary blood flow during hypercarbia. *J Am Coll Cardiol* 1992;19:133A.
54. Tang W, Weil MH, Sun S, **Gazmuri RJ**, Bisera J. Gastric intramural bicarbonate: A potential limitation of the tonometry method. *Chest* 1992;102:133S.
55. **Gazmuri RJ**, Weil MH, Sun S, Tang W, Yang G. Amplitude of ventricular fibrillation waveforms and resuscitability. *Chest* 1992;102:127S.
56. Weil MH, Sun S, Bisera J, Tang W, **Gazmuri RJ**. Challenge to the ABCs of cardiopulmonary resuscitation. *Chest* 1992;102:127S.
57. **Gazmuri RJ**, Todd A, Pollock BA, Sullivan M, Gazmuri RR, Weil MH. Is intravascular volume reduced during cardiac arrest and CPR? *Clin Res* 1992;40:696A.

58. Tang W, Weil MH, Sun S, **Gazmuri RJ**, Desai V, Noc M, Bisera J. A new method for cardiac resuscitation by proximal aortic balloon occlusion with aortic infusion. *Circulation* 1992;86:I-547.
59. Noc M, Weil MH, **Gazmuri RJ**, Tang W, Sun S, Turner T, Bisera J. Amplitude of ventricular fibrillation waveform as a monitor of efficacy of cardiopulmonary resuscitation. *Crit Care Med* 1993;21:S197.
60. Tang W, Weil MH, Noc M, Sun S, Turner T, **Gazmuri RJ**. Proximal aortic balloon occlusion with aortic infusion: A new option for cardiac resuscitation. *Crit Care Med* 1993;21:S249.
61. Sun S, Weil MH, Tang W, Noc M, **Gazmuri RJ**, Bisera J. Epinephrine increases the severity of post resuscitation myocardial dysfunction. *Crit Care Med* 1993;21:S272.
62. Noc M, Weil MH, Sun S, Tang W, **Gazmuri RJ**. The gradient between gastric wall and arterial bicarbonate during hemorrhagic shock is not abated by H₂ blockade. *Crit Care Med* 1993;21:S145.
63. Noc M, Weil MH, Johnson BA, Davidson RS, Tang W, **Gazmuri RJ**. Myocardial energy metabolism and post-resuscitation myocardial dysfunction. *Crit Care Med* 1993;21:S193.
64. **Gazmuri RJ**, Weil MH, Tang W, Sun S, Bisera J. Epinephrine reverses post-resuscitation myocardial dysfunction. *Crit Care Med* 1993;21:S193.
65. Tang W, Weil MH, Sun S, Maldonado F, **Gazmuri RJ**, Noc M, Bisera J. Increased venous admixture following epinephrine is not due to pulmonary anatomical A-V shunt. *Chest* 1993;104:74S.
66. Noc M, Weil MH, Tang W, Turner T, Sun S, **Gazmuri RJ**, Yang L. Cardiopulmonary resuscitation without mechanical ventilation. *Chest* 1993;104:74S.
67. Sun S, Weil MH, Tang W, **Gazmuri RJ**, Bisera J. The effect of spontaneous gasping on resuscitability during CPR. *Chest* 1993;104:79S.
68. Noc M, Weil MH, Turner T, Johnson BA, Tang W, **Gazmuri RJ**. Ventricular fibrillation voltage and myocardial high energy phosphates. *Chest* 1993;104:166S.
69. **Gazmuri RJ**, Weil MH, Bisera J, Tang W, Fukui M, Mackee D. Progressive loss of ventricular compliance during closed-chest cardiac resuscitation. *Circulation* 1994;90:I-287.
70. **Gazmuri RJ**, Weil MH, Tang W, Bisera J, Fukui M, McKee D. Prolonged contractile failure and ventricular dilation after successful resuscitation from cardiac arrest. *Chest* 1995;108:94S.
71. Fukui M, Weil MH, **Gazmuri RJ**, Tang W, Sun S. Spontaneous gasping generates cardiac output during cardiac arrest. *Chest* 1995;108:94S.
72. **Gazmuri RJ**, Cajigas H, Berkowitz M, Antypas A. Left ventricular diastolic dysfunction after resuscitation from ventricular fibrillation. *Crit Care Med* 1997;25:A58.
73. **Gazmuri RJ**, Berkowitz M, Cajigas H, Hawkins K. Ventricular fibrillation hastens the development of ischemic contracture during cardiac arrest. *Crit Care Med* 1997;25:A58.
74. **Gazmuri RJ**, Berkowitz M, Cajigas H, Hawkins K. Ventricular fibrillation predisposes to ischemic contracture during cardiac arrest and left ventricular diastolic dysfunction after resuscitation. Poster presented at the AHA task force "Public Access Defibrillation II: Strengthening the Chain of Survival." April 17-19, 1997, Washington DC.

75. Najeed SA, Khokher T, Molnar J, **Gazmuri RJ**, Somberg, JC. The differential effect of glyburide and metformin on QT dispersion: A potential K⁺ sensitive ATP channel effect. *Circulation* 1997;96:I-325.
76. **Gazmuri RJ**, Deshmukh SH, Shah PR, Ho HH. Post-ischemic diastolic dysfunction after repeated low-energy electrical defibrillations. *Circulation* 1998;17:I-174.
77. **Gazmuri RJ**, Deshmukh SH, Patel M, Ho H, Hoffner E, Ayoub I, Dey L. Selective NHE-1 inhibition ameliorates ischemic contracture in the isolated fibrillating rat heart. *Crit Care Med* 1999;27:A43.
78. Ayoub I, Kalcheim J, Brown D, **Gazmuri RJ**. Preservation of left ventricular function despite intense hypercarbic acidosis in the intact rat. *Crit Care Med* 1999;27:A107.
79. Maldonado FA, Sorresso DJ, Gluck EH, **Gazmuri RJ**. Improved care delivery utilizing an intensivist-led hospitalist system in a veterans affairs hospital. *Crit Care Med* 1999;27:A155.
80. Welsh TL, Asbell RC, **Gazmuri RJ**. Inverse relationship between duration of CPR and survival after in-hospital cardiac arrest. *Chest* 1999;116:245S.
81. Hoffner E, Kalcheim JL, Ayoub IM, **Gazmuri RJ**. Amelioration of ischemic contracture during ventricular fibrillation by interventions that limit sarcolemmal sodium entry. *Chest* 1999;116:245S.
82. **Gazmuri RJ**, Hoffner E, Katakam R, Thompson K, Ayoub I. Sarcolemmal Na⁺-Ca²⁺ exchanger inhibition ameliorates post-resuscitation diastolic dysfunction. *Crit Care Med* 1999;27:A35.
83. Ayoub IM, **Gazmuri RJ**, Chamkur A, Obayashi DY, Dey L. Transtracheal oxygenation during CPR: An effective alternative to endotracheal intubation. *Crit Care Med* 1999;27:A29.
84. Asbell RC, Welsh TL, **Gazmuri RJ**. Outcome after in-hospital cardiac arrest: Is age a factor? *Crit Care Med* 1999;27:A65.
85. **Gazmuri RJ**, Ayoub IM, Hoffner E. Successful ventricular defibrillation by inhibition of the sodium-hydrogen exchanger isoform-1. *Circulation* 2000;102:II-571.
86. **Gazmuri RJ**, Hoffner E, Ayoub IM, Epstein M, Kingston S. Ventricular fibrillation (VF) worsens ischemia-induced intramyocardial sodium accumulation: Effects of Na⁺-influx limiting interventions. *Crit Care Med* 2000;28:A66.
87. Ayoub IM, **Gazmuri RJ**, Kolarova J, Damera M. Cariporide facilitates successful defibrillation without effects on post-resuscitation hemodynamic function after short duration of untreated VF. *Crit Care Med* 2000;28:A65.
88. **Gazmuri RJ**, Ayoub IM, Kolarova J, Damera M. Cariporide facilitates successful defibrillation and improves post-resuscitation hemodynamic function after prolonged untreated VF. *Crit Care Med* 2000;28:A36.
89. Ayoub IM, **Gazmuri RJ**, Brown DJ, Obayashi DY. Transtracheal oxygenation during cardiac arrest maintains its effectiveness despite increased duration of chest compression. *Crit Care Med* 2000;28:A36.
90. Ayoub IM, **Gazmuri RJ**, Kolarova J, Yi Z. Improved post-resuscitation electrical and hemodynamic function by inhibition of the sodium - hydrogen exchanger isoform-1 (NHE-1) during ventricular fibrillation (VF). *Crit Care Med* 2001;29:A17.

91. Shakeri SA, Ayoub IM, Kolarova J, Yi Z, **Gazmuri RJ**. Inhibition of the sodium-hydrogen exchanger isoform-1 (NHE-1) improves ventricular fibrillation (VF) amplitude and frequency characteristics. *Crit Care Med* 2001;29:A53.
92. Kolarova J, Yi Z, Ayoub IM, **Gazmuri RJ**. Successful treatment of prolonged untreated ventricular fibrillation requires chest compression before electrical shocks. *Crit Care Med* 2001;29:A17.
93. Ayoub IM, Kolarova JD, Yi Z, Trivedi A, Lubell DL, Deshmukh HG, Maldonado FA, **Gazmuri RJ**. NHE-1 inhibition during VF prevents ischemic contracture. *Circulation* 2002;106;II-264.
94. Kolarova J, Yi Z, Ayoub IM, **Gazmuri RJ**. NHE-1 inhibition enhances the pressor responses to epinephrine and vasopressin during chest compression. *Crit Care Med* 2002;30:A3.
95. Ayoub IM, Kolarova J, Yi Z, Maldonado MA, **Gazmuri RJ**. Inhibition of the sodium-hydrogen exchanger isoform-1 (NHE-1) ameliorates reperfusion arrhythmias and prevents episodes of recurrent VF. *Crit Care Med* 2002;30:A121.
96. Ayoub IM, Kolarova J, Sehgal MA, Franz MR, **Gazmuri RJ**. Sodium-hydrogen exchanger isoform-1 (NHE-1) inhibition prevents action potential (AP) shortening during early post-resuscitation. *Crit Care Med* 2002;30:A120.
97. Shakeri SA, Kolarova J, Yi Z, Ayoub IM, **Gazmuri RJ**. Improved VF waveform characteristics during closed-chest resuscitation precedes successful defibrillation after prolonged untreated VF. *Crit Care Med* 2002;30:A120.
98. Kolarova JD, Ayoub IM, Sehgal MA, **Gazmuri RJ**. Delaying start of resuscitation to allow NHE-1 inhibition before reperfusion compromises outcome. *Circulation* 2003;108:IV-1035.
99. Ayoub IM, Kolarova JD, Sehgal MA, Sanders R, Sheth O, **Gazmuri RJ**. Sodium-hydrogen exchange inhibition minimizes adverse effects of epinephrine during cardiac resuscitation. *Circulation* 2003;108:IV-420.
100. Sehgal MA, Kolarova JD, Ayoub IM, Sheth O, **Gazmuri RJ**. Reverse mode inhibition of the Na⁺-Ca²⁺ exchanger protects the myocardium during resuscitation from ventricular fibrillation. *Circulation* 2003;108:IV-380.
101. Gopalakrishnan PP, Ayoub IM, Kolarova JD, Sehgal MA, **Gazmuri RJ**. Dynamic obstruction to forward blood flow may explain instances of ineffective closed-chest resuscitation. *Circulation* 2003;108:IV-1037.
102. Kolarova JD, Ayoub IM, Hoda ZA, Sehgal MA, **Gazmuri RJ**. NHE-1 inhibition improves the depth/flow relationship of chest compression. *Crit Care Med* 2003;31:A10.
103. Ayoub IM, Kolarova JD, **Gazmuri RJ**. NHE-1 inhibition during hemorrhagic shock preserves myocardial function. *Crit Care Med* 2003;31:A29.
104. Ayoub IM, Kolarova JD, **Gazmuri RJ**. Hyperlactatemia in swine after stable surgical preparation. *Crit Care Med* 2003;31:A31.
105. Ayoub IM, Kolarova JD, Kantola R, Sanders R, Sheth O, **Gazmuri RJ**. Cariporide minimizes adverse myocardial effects of epinephrine during resuscitation from ventricular fibrillation. *Circulation* 2004;110:III-531.
106. Kolarova JD, Ayoub IM, Hoda ZA, **Gazmuri RJ**. Cariporide decreases the depth of chest compression required to maximize forward blood flow. *Circulation* 2004;110:III-531.

107. Kolarova JD, Radhakrishnan J, Wang S, Gopalakrishnan P, Ayoub IM, **Gazmuri RJ**. Effects of cariporide on myocardial energy metabolism during resuscitation from VF. *Circulation* 2004;110:III-532.
108. Ayoub IM, Kolarova JD, Radhakrishnan J, Wang S, **Gazmuri RJ**. NHE-1 Inhibition and Coronary Blood Flow during VF are both Determinant of Post-Resuscitation Myocardial Dysfunction. (ReSS at the AHA 2004 meeting).
109. Radhakrishnan J, Wang S, Ayoub IM, Kolarova JD, **Gazmuri RJ**. Zoniporide ameliorates intramyocardial lactate increases during resuscitation from ventricular fibrillation. *Crit Care Med* 2004;32:A57.
110. Sanders RW, Ayoub IM, Kolarova JD, **Gazmuri RJ**. Possible neuroprotective effects of zoniporide during resuscitation from cardiac arrest. *Crit Care Med* 2004;32:A57.
111. Ayoub IM, Kolarova JD, Radhakrishnan J, Wang S, **Gazmuri RJ**. Zoniporide ameliorates post-resuscitation myocardial dysfunction by flow independent mechanisms. *Crit Care Med* 2004;32:A57.
112. Radhakrishnan J, Wang S, Ayoub IM, Kolarova JD, **Gazmuri RJ**. Progressive increases in plasma cytochrome c after resuscitation from ventricular fibrillation. *Circulation* 2005;112:II-324.
113. Radhakrishnan J, Wang S, Ayoub IM, Kolarova JD, **Gazmuri RJ**. Myocardial caspase-3 activation after resuscitation from ventricular fibrillation. *Circulation* 2005;112:II-324.
114. Ayoub IM, Kolarova JD, Kantola R, Radhakrishnan J, Wang S, **Gazmuri RJ**. NHE-1 inhibition prevents ischemic contracture and minimizes post-resuscitation myocardial dysfunction through flow-independent mechanisms. *Circulation* 2005;112:II-488.
115. Kolarova JD, Staicu I, Ayoub IM, **Gazmuri RJ**. NHE-1 inhibition delays onset of ischemic contracture during untreated ventricular fibrillation. *Circulation* 2005;112:II-1101.
116. Wang S, Kolarova JD, Radhakrishnan J, Ayoub IM, **Gazmuri RJ**. Cariporide attenuates intramyocardial Na⁺ increases during resuscitation from ventricular fibrillation. *Circulation* 2005;112:II-434.
117. Ayoub IM, Wang S, Kolarova JD, Radhakrishnan J, Singh D, Taglieri DM, **Gazmuri RJ**. Decreased ventilatory requirements during cardiac resuscitation. *Circulation* 2005;112:II-433.
118. Ayoub IM, Wang S, Radhakrishnan J, Kolarova JD, Lyu T, Ryan C, **Gazmuri RJ**. Cytochrome c: a novel biomarker for predicting survival after cardiac resuscitation. *Crit Care Med* 2005;33:A24.
119. Singh D, Ayoub IM, Kolarova JD, Wang S, Havalad S, **Gazmuri RJ**. Cardioprotection by erythropoietin during resuscitation from ventricular fibrillation. *Crit Care Med* 2005;33:A24.
120. Wang S, Radhakrishnan J, Ayoub IM, Kolarova JD, Taglieri DM, **Gazmuri RJ**. Post-resuscitation mitochondrial Ca²⁺ overload is prevented by limiting sarcolemmal Na⁺ entry during resuscitation from ventricular fibrillation. *Circulation* 2006;114:II-1202.
121. Radhakrishnan J, Ayoub IM, Wang S, Kolarova JD, Taglieri DM, **Gazmuri RJ**. Myocardial protection by glycogen synthase kinase-3 β inhibition during resuscitation from cardiac arrest. *Circulation* 2006;114:II-98.

122. Radhakrishnan J, Ayoub IM, Wang S, Kolarova JD, Taglieri DM, **Gazmuri RJ**. Activation of the mitochondrial apoptotic pathway without evidence of apoptotic cell death after resuscitation from ventricular fibrillation. *Circulation* 2006;114:II-1194.
123. Kolarova JD, Ayoub IM, Wang S, Radhakrishnan J, Taglieri DM, **Gazmuri RJ**. AVE4454 (a new NHE-1 inhibitor) administered during resuscitation from VF ameliorates post-resuscitation myocardial dysfunction. *Circulation* 2006;114:II-1197.
124. Taglieri DM, Ayoub IM, Kolarova JD, Wang S, Radhakrishnan J, **Gazmuri RJ**. Early administration of epinephrine during closed-chest resuscitation fails to improve return of spontaneous circulation or short-term survival. *Circulation* 2006;114:II-1207.
125. Taglieri DM, Ayoub IM, Kolarova JD, Radhakrishnan J, Wang S, **Gazmuri RJ**. Failure of propranolol and epinephrine combination to improve resuscitability and short-term survival in a rat model of ventricular fibrillation. *Circulation* 2006;114:II-1206.
126. Ayoub IM, Radhakrishnan J, **Gazmuri RJ**. Cyclosporin A does not prevent myocardial dysfunction after resuscitation from cardiac arrest in rats. *Circulation* 2007;116: II-941-II-942.
127. Grmec S, Strnad M, Kupnik D, Sinkovic A, Marc G, **Gazmuri RJ**. Erythropoietin facilitates the return of spontaneous circulation and subsequent ICU admission in victims of out-of-hospital cardiac arrest. *Circulation* 2008;118:S-766.
128. Prosen G, Grmec Š, Kupnik D, Križmarić M, Završnik J, **Gazmuri RJ**. Focused echocardiography (F-ECHO) and capnography during resuscitation from pulseless electrical activity (PEA) after out-of-hospital cardiac arrest (OHCA). *Critical Care* 2009;13:S25-6.
129. Ayoub IM, Upadhyaya MP, Radhakrishnan J, **Gazmuri RJ**. Preservation of left ventricular myocardial distensibility using a novel sodium-hydrogen exchanger isoform-1 inhibitor markedly enhances the hemodynamic efficacy of chest compression. *Circulation* 2009;120:S-670.
130. Ayoub IM, Upadhyaya MP, Radhakrishnan J, **Gazmuri RJ**. The mitochondrial permeability transition pore opens during ventricular fibrillation in a rat model of closed chest resuscitation. *Circulation* 2009;120:S-633.
131. Ayoub IM, Radhakrishnan J, Upadhyaya MP, **Gazmuri RJ**. Opening of the mitochondrial permeability transition pore is not precluded with cyclosporine A in vivo during cardiac arrest. *Circulation* 2009;120:S-786.
132. Ayoub IM, Azul J, Upadhyaya MP, Radhakrishnan J, **Gazmuri RJ**. Higher ventilatory rates during chest compression may not be detrimental at lower tidal volumes. *Crit Care Med* 2010;37:A244.
133. Motl JR, Radhakrishnan J, Ayoub IM, Grmec S, **Gazmuri RJ**. Vitamin-c compromises cardiac resuscitability in a rat model of ventricular fibrillation and closed chest resuscitation. *Circulation* 2010;122:A77.
134. **Gazmuri RJ**, Ayoub IM, Radhakrishnan J, Motl JR, Upadhyaya MP. Varying respiratory rate and tidal volume during cardiopulmonary resuscitation exerts minimal hemodynamic effect but markedly affects end tidal carbon dioxide. *Circulation* 2010;122:A79.
135. Radhakrishnan J, Kolarova JD, Ayoub IM, **Gazmuri RJ**. Plasma cytochrome c level: A marker of post-resuscitation left ventricular dysfunction? *Circulation* 2010;122:A76.
136. Upadhyaya MP, Radhakrishnan J, Ayoub IM, **Gazmuri RJ**. Erythropoietin given during CPR improves post-resuscitation myocardial function. *Circulation* 2010;122:A172.

137. Radhakrishnan J, Upadhyaya MP, Ayoub IM, **Gazmuri RJ**. Erythropoietin administered during resuscitation from cardiac arrest improves cytochrome c oxidase activity in left ventricular tissue. *Circulation* 2010;122:A169.
138. Radhakrishnan J, Ayoub IM, Upadhyaya MP, Azul J, Kohlbrenner E, Hajjar R, **Gazmuri RJ**. Age dependent differential expression of adeno associated virus serotype 9 encoded green fluorescent protein in rats. *Crit Care Med* 2010;38(Suppl.):7.
139. Radhakrishnan J, Upadhyaya MP, Ayoub IM, **Gazmuri RJ**. Erythropoietin ameliorates mitochondrial injury during resuscitation from VF evidenced by less post-resuscitation myocardial dysfunction and lower plasma cytochrome c levels. *Crit Care Med* 2010;38(Suppl.):38.
140. Radhakrishnan J, Ayoub IM, Upadhyaya MP, **Gazmuri RJ**. Preservation of left ventricular myocardial distensibility by a novel NHE-1 inhibitor BIX with no effect on caspase-3 activity. *Crit Care Med* 2010;38(Suppl.):446.
141. Radhakrishnan J, Ng M, Edelheit A, **Gazmuri RJ**. Erythropoietin enables mitochondria to preserve oxidative phosphorylation under conditions of calcium overload and oxidative stress. *Circulation* 2011;124:A287.
142. Radhakrishnan J, Moy HM, Gazmuri RJ. Erythropoietin selectively preserves electron transport complex IV activity during resuscitation from cardiac arrest. *Circulation* 2011;124:A57.
143. Edelheit A, Miao Y, Radhakrishnan J, **Gazmuri RJ**. Administration of β -estradiol during cardiac resuscitation fails to improve resuscitability and survival in male sprague-dawley rats. *Circulation* 2012;126:A13786.
144. Miao Y, Velmurugan S, Borovnik-Lesjak V, Radhakrishnan J, **Gazmuri RJ**. Escalating doses of β -estradiol fail to improve resuscitation outcomes in a rat model of ventricular fibrillation and closed chest resuscitation. *Circulation* 2012;126:A15679.
145. Miao Y, Velmurugan S, Borovnik-Lesjak V, Radhakrishnan V, **Gazmuri RJ**. β -Estradiol fails to reverse post-resuscitation myocardial dysfunction in male sprague-dawley rats. *Circulation* 2012;126:A15214.
146. Borovnik-Lesjak V, Whitehouse K, Baetiong A, Bassel A, Jawad E, Radhakrishnan J, **Gazmuri RJ**. Erythropoietin given during CPR increases post-resuscitation myocardial O₂ consumption and reduces myocardial stunning. *Circulation* 2012;126:A12586.
147. Borovnik-Lesjak V, Kaufman CL, Whitehouse K, Baetiong A, Radhakrishnan J, **Gazmuri RJ**. AMSA partly reflects changes in myocardial oxygen consumption during resuscitation from ventricular fibrillation. *Circulation* 2012;126:A13487.
148. Whitehouse K, Borovnik-Lesjak V, Miao Y, Baetiong A, Velmurugan S, Currie B, Radhakrishnan J, **Gazmuri RJ**. Effects of erythropoietin during hemorrhagic shock in a swine model. *Circulation* 2012;126:A18674.
149. Borovnik-Lesjak V, Whitehouse K, Baetiong V, Currie B, Radhakrishnan J, **Gazmuri RJ**. Identification of critical level of blood volume reduction in a swine model of hemorrhagic shock. *Circulation* 2012;126:A12073.
150. **Gazmuri RJ**, Whitehouse K, Borovnik-Lesjak V, Baetiong A, Radhakrishnan J. Vasopressin infusion during severe hemorrhagic shock increases systemic blood flow and markedly improves survival in a swine model. *Circulation* 2012;126:A15905.
151. Kaufman CL, Borovnik-Lesjak V, Whitehouse K, Baetiong A, Radhakrishnan J, **Gazmuri RJ**. AMSA predicts return of organized rhythm in a swine model of ventricular fibrillation

and controlled coronary perfusion by extracorporeal circulation. *Heart Rhythm* 2013;10:S261.

152. Borovnik-Lesjak V, Whitehouse K, Baetiong A, Radhakrishnan J, Kaufman CL, **Gazmuri RJ**. Changes in AMSA during controlled coronary perfusion by extracorporeal circulation in a swine model of ventricular fibrillation. *Circulation* 2013;128:A73
153. Velmurugan S, Radhakrishnan J, Baetiong A, **Gazmuri RJ**. Marked attenuation of cell injury by substrate availability during ischemia. *Circulation* 2013;128:A340.
154. Velmurugan S, Radhakrishnan J, Baetiong A, **Gazmuri RJ**. NHE-1 inhibition reduces rigor and hypercontracture in isolated cardiomyocytes during ischemia and reperfusion. *Circulation* 2013;128:A186.
155. Whittinghill KL, Miao Y, Radhakrishnan J, **Gazmuri RJ**. Vasodilatory effect of ginseng after resuscitation from cardiac arrest. *Circulation* 2013;128:A147.
156. **Gazmuri RJ**, Whitehouse K, Whittinghill KL, Baetiong A, Radhakrishnan J. Vasopressin with low-volume resuscitation is highly effective for resuscitation and survival from severe hemorrhagic shock. *Circulation* 2013;128:A341.

PHD THESIS

Gazmuri RJ. Myocardial Function after Resuscitation From Cardiac Arrest. Finch University of Health Sciences/The Chicago Medical School. Department of Physiology and Biophysics, North Chicago, IL 1994.

THESIS ADVISOR (PHYSICIAN ASSISTANT PROGRAM AT FINCH UNIVERSITY OF HEALTH SCIENCES)

Asbell C and Welsh T. In Hospital Resuscitation: Factors Influencing Outcome. North Chicago, IL 1999.

PHD THESIS MENTOR (DEPARTMENT OF PHYSIOLOGY & BIOPHYSICS AT ROSALIND FRANKLIN UNIVERSITY OF MEDICINE AND SCIENCE)

Iyad M. Ayoub, MS. Mitochondrial Injury during Resuscitation from Cardiac Arrest. North Chicago, IL 2009.

PATENTS

FACILITATION OF RESUSCITATION FROM CARDIAC ARREST BY ERYTHROPOIETIN

Patent No.: US 8,067,36 B2 Date of Patent: Nov 29, 2011 Inventor: Raúl J.Gazmuri
Assignee: Rosalind Franklin University of Medicine and Science.

CIRCULATING CYTOCHROME C AS BIOMARKER OF REPERFUSION INJURY AFTER WHOLE BODY ISCHEMIA AND PREDICTOR OF SURVIVAL

Provisional application No. 60/937728 filed on June 29, 2007 (112461.00057)
Status, pending.

RESEARCH GRANTS (PAST/ACTIVE)

PEER REVIEWED

Past

- 1981-1983 **“The Role of Prostaglandins in the Cardiac Adaptation to Overload.”**
Source: Libraries and Research Department, University of Chile. #1156-8114.
Role: Research Assistant.
Principal Investigator: Edgardo Escobar, MD
- 1984-1985 Project: **The Role of Prostaglandins in the Development of Cardiac Failure**
Source: Libraries and Research Department, University of Chile. #M18761-8413.
Role: Research Associate.
Principal Investigator: Edgardo Escobar, MD
- 1987-1994 Project: **Myocardial Acid-Base Changes During CPR**
Source: National Institutes of Health, NHLBI #1R01 HL39148-01 and Competing Continuation #1R01 HL39148-04A2.
Annual Direct Costs: \$82,000 to approximately \$200,000.
Role: Co-Investigator.
Principal Investigator: Max Harry Weil, MD, PhD
- 1989-1991 Project: **Extracorporeal Pump Resuscitation After Prolonged Arrest**
Source: American Heart Association, #890912.
Annual Direct Costs: \$29,900.
Role: Collaborating Investigator.
Principal Investigator: Max Harry Weil, MD, PhD
- 1989-1991 Project: **Resuscitation after Prolonged Cardiac Arrest**
Source: National Institutes of Health, NHLBI #1R01 HL42590-01.
Annual Direct Costs: \$148,986.
Role: Co-Investigator.
Principal Investigator: Max Harry Weil, MD, PhD
- 1998-2000 Project: **Myocardial Protection During Cardiac Arrest**
Source: VA Merit Review.
Annual Direct Cost: \$105,800 to \$109,100.
Role: Principal Investigator.
- 2001-2004 Project: **Myocardial Protection During Ventricular Fibrillation**
Source: VA Merit Review.
Annual Direct Cost: \$150,000 to \$225,500.
Role: Principal Investigator.
- 2002-2006 Project: **Myocardial Protection by NHE-1 Inhibition**
RFA: Basic Research to Improve Cardiopulmonary and Neurological Outcomes.
Source: NHLBI, 1 R01 HL71728-01.
Annual Direct Cost: \$175,000 to \$225,000.
Role: Principal Investigator.
- 2005-2006 Project: **Evaluation of a New Technique for Controlled Manual Ventilation**
RFA: SBIR/STTR - Technologies for monitoring and performing resuscitation.
Source: NIH.
Annual Direct Cost: \$100,000.
Role: Collaborator.

2006-2007 Project: **Myocardial Protection by GSK-3 β Inhibition during Resuscitation from Cardiac Arrest**
Internal Funding Program (pilot grant).
Source: Rosalind Franklin University of Medicine and Science.
Annual Direct Cost: \$25,000.
Role: Principal Investigator.

2006-2007 Project: **Bridge Funds**
Sponsor: Rosalind Franklin University of Medicine and Science
Total Cost: \$50,000
Role: Principal Investigator.

Active

2010-2014 Project: **Myocardial Effects of Erythropoietin during Resuscitation from Cardiac Arrest**
Source: VA Merit Review.
Annual Direct Cost: \$150,000
Role: Principal Investigator.

2010-2013 Project: **Intraosseous Erythropoietin for Acute Tissue Protection in Battlefield Casualties Suffering Hypovolemic Shock**
Source: Defense Medical Research and Development Program (DMRDP), Applied Research and Technology Development Award (ARADTA).
Annual Direct Cost: \$400,000
Role: Principal Investigator.

2012-2013 Project: **Plasma Cytochrome c as Biomarker of Traumatic Injury and Predictor of Outcome**
Source: Chicago Medical School and Advocate Lutheran General Hospital Translational Research Pilot Grant Program
Annual Direct Cost (RFUMS): \$70,250
Role: Co-Principal Investigator.

NON-PEER REVIEWED (INVESTIGATOR INITIATED)

1987-1988 Project: **Effects of an Extracorporeal Pump Oxygenator in Myocardial Resuscitability during Experimental Cardiac Arrest**
Source: Baxter (American Bentley).
Annual Direct Costs: \$82,000.
Principal Investigator: Max Harry Weil, MD, PhD
Role: Co-Investigator.

1995-1997 Project: **Start-up funds**
Source: Finch University of Health Sciences/The Chicago Medical School.
Total Cost: \$20,000.
Role: Principal Investigator.

2000-2001 Project: **Bridge funds**
Source: Finch University of Health Sciences/The Chicago Medical School.
Total Cost: \$20,000.
Role: Principal Investigator.

2004-2005 Project: **Myocardial Protection during Ventricular Fibrillation by NHE-1 Inhibition Using Cariporide: Studies in a Porcine Model**
Sponsor: Aventis Pharma, Frankfurt, Germany
Total Cost: \$40,000.
Role: Principal Investigator.

- 2008-2009 Project: **Investigation of an NHE-1 Inhibitor for Resuscitation from Cardiac Arrest**
Sponsor: Boehringer Ingelheim Pharmaceuticals, Inc.
Total Cost: \$50,000.
Role: Principal Investigator.
- 2009-2010 Project: **Volume-Controlled Manual Ventilation during Resuscitation from Cardiac Arrest**
Sponsor: Dessinier Corporation
Total Cost: \$120,000
Role: Principal Investigator.
- 2009-2010 Project: **Vitamin-C Preserves Myocardial Distensibility during Resuscitation from Cardiac Arrest**
Sponsor: Zdravstveni Dom. Dr. Adolfa Drolca, Maribor, Slovenia
Total Cost: \$20,000
Role: Principal Investigator.
- 2010-2010 Project: **Mechanisms of Cytochrome c Release during Resuscitation – Adeno-Associated Viral Gene Transfer (Pilot Grant)**
Sponsor: Gift for cardiovascular research administered by the Hines VA Research Service.
Total Cost: \$40,000
Role: Principal Investigator.

NON-PEER REVIEWED (SPONSORED CLINICAL TRIALS)

- 1999-2000 Project: **Antithrombin III in Patients with Severe Sepsis. A Multinational, Double-Blind, Randomized, Placebo-Controlled Phase-III Study**
Protocol No. BI51.071/7MN-303SE
Sponsor: Centeon Pharma GmbH.
Sponsor Representative: PPD Pharmaco International.
Role: Principal Investigator at North Chicago VA.
- 1999-2000 Project: **Linezolid (PNU-100766) in the Treatment of Patients with Nosocomial Pneumonia: A Double-Blind, Randomized, Comparator-Controlled Study**
Protocol No. M/1260/0048
Sponsor: Pharmacia & Upjohn.
Role: Sub-Investigator at North Chicago VA.
Principal Investigator: Frank A. Maldonado, MD.
- 2000-2001 Project: **A Randomized, Double-Blind, Double-Dummy, Multicenter Study to Compare the Efficacy and Safety of Intravenous Gemifloxacin (SB-265805) Followed by Oral Gemifloxacin Versus Intravenous Lovofloxacin Followed by Oral Levfloxacin in the Treatment of Hospitalized Adult Patients with Community-Acquired Pneumonia (CAP)**
Sponsor: SmithKline Beecham.
Role: Principal Investigator at North Chicago VA.

- 2000-2001 **Project: A Randomized, Double-Blind, Double-Dummy, Multicenter, Parallel Group Study to Assess the Efficacy and Safety and Tolerability of Intravenous Gemifloxacin Followed by Oral Gemifloxacin versus Intravenous Ceftriaxone Followed by Oral Levofloxacin in the Treatment of Nosocomial Pneumonia (NP) in Adults at Low Risk for Infection with Pseudomonas Aeruginosa**
Sponsor: SmithKine Beecham.
Role: Sub-Investigator.
Principal Investigator: Frank A. Maldonado, MD.
- 2000-2001 **Project: A Randomized, Double-Blind, Phase III, Comparative Study of Cidecin™ (Daptomycin) to Rocephin® (Ceftriaxone) in the Treatment of Moderate to Severe Community-Acquired Acute Bacterial Pneumonia Due to S. Pneumoniae**
Sponsor: Cubist Pharmaceuticals
Role: Sub-Investigator.
Principal Investigator: Ashok M. Fulambarker, MD.
- 2008-2010 **Project: CV185030: A Phase III, Active (Warfarin) Controlled, Randomized, Double-Blind, Parallel Arm Study to Evaluate Efficacy and Safety of Apixaban in Preventing Stroke and Systemic Embolism in Subjects with Nonvalvular Atrial Fibrillation (ARISTOTLE)**
Sponsor: Bristol Myers Squibb.
Total Cost: \$415,245 (target 19 patients).
Role: Principal Investigator at the North Chicago VA Medical Center.
- 2008-2010 **Project: A Multi-center, Randomized, Double-Blind, Placebo-Controlled Study to Evaluate the Safety and Efficacy of SCH 530348 in Addition to Standard of Care in Subjects With Acute Coronary Syndrome: Thrombin Receptor Antagonist for Clinical Event Reduction in Acute Coronary Syndrome (TRACER)**
Sponsor: Schering-Plough.
Total Cost: \$123,809 (target 13 patients).
Role: Principal Investigator at the North Chicago VA Medical Center.
- 2008-2010 **Project: A Multicenter, Double-Blind, Randomized Study to Establish the Clinical Benefit and Safety of Vytorin (Ezetimibe/Simvastatin Tablet) vs Simvastatin Monotherapy in High- Risk Subjects Presenting With Acute Coronary Syndrome (IMPROVED Reduction of Outcomes: Vytorin Efficacy International Trial – IMPROVE IT)**
Sponsor: Schering-Plough.
Total Cost: \$85,000 (target 17 patients).
Role: Principal Investigator at the North Chicago VA Medical Center.
- 2008-2010 **Project: A Phase 3 Randomized, Double-blind, Parallel-group, Multi-center Study of the Safety and Efficacy of Apixaban for Prophylaxis of Venous Thromboembolism in Acutely Ill Medical Subjects During and Following Hospitalization**
Sponsor: Bristol Myers Squibb.
Total Cost: \$40,766.90 (target 5 patients).
Role: Principal Investigator at the North Chicago VA Medical Center.

2008-2010 Project: **Stabilization Of pLaques usIng Darapladib” - A Clinical Outcomes Study of Darapladib versus Placebo in Subjects Following Acute Coronary Syndrome to Compare the Incidence of Major Adverse Cardiovascular Events (MACE) (SOLID TIMI 52)**
Sponsor: GlaxoSmithKline LLC.
Total Cost: \$91,125. (target 10 patients).
Role: Principal Investigator at the North Chicago VA Medical Center.

GIFTS

2004-2005 Project: **Unrestricted Gift in Support of Industrial Partnership**
Donor: Aventis Pharma Deutschland GmbH
Total Gift: \$50,000.
Role: Principal Investigator.

2004-2005 Project: **Gift for Research and Education of First Responders to Victims of a Heart Attack**
Donor: The Curtis I. Kossman Foundation
Total Cost: \$50,000.
Role: Principal Investigator.

2005-2006 Project: **Gift for Research Activities**
Donor: Pediatric Critical Care Specialists, P.C.
Total Cost: \$7,000.
Role: Principal Investigator.

2005-2007 Project: **Gift for Research and Education of First Responders to Victims of a Heart Attack**
Donor: The Curtis I. Kossman Foundation
Annual Gift: \$55,000.
Role: Principal Investigator.

2008-2009 Project: **Unrestricted Gift to Support Resuscitation Research**
Donor: Michael G. Klug and Marie Kube
Total Gift: \$5,000.
Role: Principal Investigator.

2011 Project: **Unrestricted Funds to Support Educational and Research Activities**
Donor: ZOLL Medical Corporation
Total Gift: \$ 12,000
Role: Principal Investigator.

2013 Project: **Unrestricted Funds for Cardiac Research**
Donor: Monica Ply
Total Gift: \$ 32,500
Role: Principal Investigator.