

Country Factors Associated With the Risk of Hospitalization and Aeromedical Evacuation Among Expatriate Workers

Myles Druckman, MD, Philip Harber, MD, MPH, Yihang Liu, MD, MS, MA, and Robert L. Quigley, MD, DPhil

Objective: To assess country factors associated with the risk of requiring aeromedical evacuation and hospitalization among expatriate workers and their dependents. **Methods:** The 2009–2010 data including 5725 aeromedical evacuations and 17,828 hospitalizations, and 2009 data of hospitalizations and aeromedical evacuations among 94,651 at-risk expatriates, were analyzed to assess 2 country risk rating tools. Each tool utilized four risk categories and reflected level of development and medical capabilities. **Results:** Country risk category was strongly associated with risk of evacuation and/or hospitalization for each risk rating tool (eg, 46-fold increase from lowest to highest country risk category). **Conclusion:** Country risk tools strongly associate hospitalization and aeromedical evacuation with country risk category, and thus can be important indicators of relative medical risk. Employers may use these results to implement targeted prevention programs to support expatriate workers and their families.

As business expands globally, organizations require an increasing number of international assignees to support their operations. The number of international assignments increased by 25% in the last decade and a further 50% growth is predicted by 2020.¹ Global organizations placed employees in an average of 13 international locations in 1998, increasing to 22 in 2009, and it is expected to reach 33 by 2020. With health costs rising both domestically and abroad, and with more aging employees working internationally, understanding the relative risks that both employees and employers face is increasingly important particularly in the context of business productivity and duty of care.² Corporate occupational health physicians are playing an increasingly important role in implementing programs to mitigate international health incidents, and organizations look to them for leadership and direction as operations expand internationally.

Aeromedical evacuation is defined as a medically directed patient movement to upgraded medical care. Aeromedical evacuations can be performed via air ambulance, though the vast majority of international patient movements are performed via commercial carrier, either with or without a medical escort. Organizations are responsible for assignee well-being and it is generally the employer's duty to ensure timely, appropriate, and adequate care in the event of injury or illness. Thus if local care is not available or appropriate, the patient may be medically transferred to another location for care. By this standard, aeromedical evacuation activity may be a useful indicator of a country's overall medical capabilities and endemic health risks. A recent meta-analysis indicates that less developed countries have significantly higher rates of hospital infections³ leading to poorer clinical outcomes. In another study, patient age, availability of local medical resources, and patient location were most closely associated

with the need for immediate aeromedical evacuation.⁴ Other factors that influence the decision to evacuate include adherence to universal precautions and hygiene standards, accessibility and safety of local blood products, quality and reliability of critical drugs, and medical expertise and equipment to manage the clinical case.⁵

The purpose of this article is threefold: (1) to quantify the magnitude of hospitalization and aeromedical evacuation risk for international assignees; (2) to quantify the relevance of geographical location as a risk factor for hospitalizations and aeromedical evacuations; and (3) to quantify the efficacy of two potential country medical risk rating tools.

METHODS

Analyses are based on records of international medical cases. Medical Cases are categorized into two service areas:

- Aeromedical evacuation: the medically driven patient movement to a location of upgraded care.
- Hospitalization: the diagnosis and/or treatment within a hospital, requiring at least 24 hours admission.
- All aeromedical evacuations were considered to have initially required hospitalization.

Two categories of personnel were evaluated: (1) International assignee: an employee working and living outside his or her home country, typically for at least 12 months. (2) A dependent: a family member accompanying the international assignee. Travelers and other personnel have been excluded from this study.

Information from two databases from a major provider of International Medical Emergency Services was analyzed. Personal identifiers were removed before sharing data. Following were the data sets:

(1) Database DB09: a sample population (at-risk population) of 94,651 international assignees and their dependents based in 181 countries for 2009. The sample population generated 227 hospitalization medical cases, and 74 aeromedical evacuation cases.

(2) Database DB0910: contains hospitalization and aeromedical evacuation cases for the calendar years 2009 and 2010. This data set includes 5725 aeromedical evacuations and 17,828 hospitalization cases. However, this database does not include information concerning the size and characteristics of the at-risk population.

Analyses

Because of the large number of countries (224), including many with small at-risk populations and few events, countries were aggregated into several larger groups for analysis using two different country medical risk rating tools:

(1) International Human Development Index (HDI)⁶: This is a composite index based on a country's average achievements in three basic aspects of human development: health, knowledge, and income. One hundred sixty-eight countries are grouped into four categories: very high development, high development, moderate development, and low development.

(2) Provider Country Medical Risk Rating (CMR): Country Medical Risk Ratings (Table 1) were developed by the provider to assist international organizations in assessing the relative country-specific medical risk. Eight criteria were evaluated by the provider's regional medical experts and were collated. Two hundred

From the International SOS Assistance Inc (Drs Druckman and Quigley), Trevose, Pa; Dr Philip Harber, PLLC (Dr Harber), Tucson, Ariz; UCLA (Dr Harber), Los Angeles, Calif; and Department of Family Medicine (Dr Liu), David Geffen School of Medicine, UCLA, Los Angeles, Calif.
Dr. Druckman and Dr. Quigley are employed by International SOS Assistance, Inc.
Address correspondence to: Robert L. Quigley, MD, DPhil, International SOS Assistance, Inc., 3600 Horizon Blvd., Suite 300, Trevose, PA 19053 (Robert.quigley@internationalsos.com or Theresa.mchale@internationalsos.com).
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TABLE 1. Provider Country Medical Risk Rating Index Methodology

Criteria	Low (3)	Moderate (2)	High (1)	Extreme (0)
1 Health care service	Highest quality	High quality but not consistent	Average to poor care	Poor to nonexistent
2 Medical expertise/training	Highest quality, International standard	High quality but not consistent	Average to poor	Poor
3 Infectious disease	Low Risk	May be moderate risk	High risk, including malaria, dengue, etc	Highest risk
4 Emergency services	Highest quality	High quality but not consistent	Average to poor, unreliable	Poor to nonexistent
5 Highest level of medical care	Tertiary	Some Tertiary but not consistent	Basic care	Basic to first aid only
6 Dental care	Highest quality	High quality but not consistent	Basic to poor	Poor to nonexistent
7 Medications	High quality and available	High quality but not consistent	Unreliable	Unreliable to nonexistent
8 Medical evacuation requirements	None	Cases requiring specialized expertise	Most cases requiring definitive care	Most simple to moderate clinical cases

twenty-four countries were grouped into four categories: low, moderate, high, and extreme medical risk. Criteria guiding the classification are summarized in Table 1.

The aforementioned country medical risk rating tools were evaluated by determining the total number of hospitalizations and aeromedical evacuations using both databases, and the annual rate of events per person at risk by using DB09. As described earlier, at risk per person for the DB0910 database could not be explicitly calculated because the data do not include an at-risk population. However, as a surrogate measure, the ratio of the number of cases to the percentage of international assignees in the at-risk population of DB09 was utilized in DB0910. In addition, for both data sets, the proportion of hospitalization cases requiring aeromedical evacuation—the medical evacuation proportion (MEP)—was calculated. See Table 2 for results for specific countries.

Data for analysis were derived from the providers' database using SQL queries specifying years and information fields desired. Data were then de-identified and transferred for analysis using Microsoft Access and SAS for PC, version 9.1 (SAS Institute, Cary, NC). Descriptive summary statistics were generated using frequency table programs. As appropriate, hypothesis testing used chi-squared, Mantel-Haenszel chi-squared, or Spearman rank correlation. Two-sided alpha levels of *P* values less than 0.05 were considered to be statistically significant. Graphical displays were prepared using Microsoft Excel.

RESULTS

Country Medical Risk Rating Tool Comparison (HDI vs CMR)

Both country medical risk rating tools used a four-level categorization, termed "risk" by CMR and "development level" by HDI. HDI did not categorize 55 of the 224 countries ranked by CMR. For purposes of analysis, the HDI category of "very high development" was matched with the CMR "low-risk" category, and so forth. Table 3 shows significant concordance between the two risk rating tools. In 109 of 169 countries (65%), the rankings were concordant, and there were none in which the rankings differed by more than one category. Figure 1 shows that HDI distributed the countries more evenly among the four categories, whereas CMR had proportionately fewer in the two most extreme categories. (Thailand, Angola, South Africa, Papua New Guinea, Mozambique, Tanzania, Ghana, and Kenya were placed in higher-risk categories by HDI, whereas

Kazakhstan, Azerbaijan, United Arab Emirates, Mongolia, Equatorial Guinea, and South Korea were placed in higher-risk categories by CMR.)

Results for DB09

The number of persons at risk according to country medical risk category for DB09 is shown in the first several rows of Tables 4 and 5. Most international assignees and their dependents are in the two lower-risk categories. For example, 83% by CMR and 79% by HDI are in risk categories 1 and 2.

Tables 4 and 5 also summarize the frequency of medical cases according to country medical risk category for DB09. Results are shown separately for aeromedical evacuations (Table 4) and hospitalizations (Table 5). Because all aeromedical evacuations were considered to have been initially hospitalized, an individual may appear under both categories. Two metrics were utilized—likelihood of evacuation by country and likelihood of evacuation per person.

Table 4 reveals that the likelihood of requiring aeromedical evacuation differs considerably according to country medical risk category. Overall, approximately 10% of countries had at least one evacuation case during the year. Despite the much smaller international assignee population in the higher-risk category countries, the likelihood of having at least one evacuation was homogeneous across the risk categories. The total number of aeromedical evacuations in each region was related to its medical risk category (*P* < 0.0001 for both indices). In addition, the number of evacuations by region was related to the country medical risk category by either the HDI or the CMR indices (*P* < 0.0001).

When expressed as likelihood of evacuation per person in a category, the HDI showed a highly significant relationship. In the "low development" countries, the rate was 86 per 10,000 persons, compared to 1.8 per 10,000 persons in the "very high development" countries. The results by the CMR index did not reach statistical significance when analyzed in four categories, but did reach statistical significance when categories 3 and 4 were combined.

Figure 1 graphically illustrates the concentration of risk of requiring aeromedical evacuation in the upper two categories. This is particularly remarkable when the per person metric is examined because the countries in the upper two risk groups had many more evacuations despite much smaller at-risk populations.

For hospitalizations, the same pattern is observed as shown in Table 5. However, the magnitude of the differential risk by country category was less than for aeromedical evacuations. For example, the

TABLE 2. Country List by Proportion of Hospitalizations Requiring Aeromedical Evacuation

Country	MV	Hospitalization	Proportion	Country	MV	Hospitalization	Proportion
Liberia	15	15	100%	Vietnam	295	701	42%
British Indian Ocean Territory	12	12	100%	Poland	18	43	42%
Burundi	11	11	100%	Ukraine	20	48	42%
Vanuatu	10	10	100%	Macao, SAR	5	12	42%
Chad	20	21	95%	Ecuador	7	17	41%
Sierra Leone	17	18	94%	Czech Republic	13	32	41%
Haiti	32	34	94%	Bulgaria	4	10	40%
Niger	24	26	92%	Indonesia	547	1383	40%
Benin	10	11	91%	Netherlands	15	40	38%
Malawi	49	54	91%	Kenya	34	94	36%
Congo	43	48	90%	Peru	16	45	36%
Ethiopia	48	54	89%	Brunei Darussalam	5	15	33%
Guinea	16	18	89%	Saudi Arabia	14	44	32%
Madagascar	84	95	88%	Bahrain	12	40	30%
Equatorial Guinea	62	72	86%	Oman	9	32	28%
Turkmenistan	35	41	85%	United Arab Emirates	72	264	27%
Sudan	33	39	85%	Tajikistan	3	11	27%
Congo, Democratic Republic	81	96	84%	Sweden	4	15	27%
Uganda	30	36	83%	Mauritius	5	19	26%
Zambia	77	94	82%	France	43	164	26%
Georgia	9	11	82%	Kuwait	9	35	26%
Angola	263	327	80%	Ireland	3	12	25%
Mongolia	52	65	80%	Qatar	17	70	24%
Botswana	16	20	80%	United States	58	243	24%
Laos	58	73	79%	New Caledonia	4	17	24%
Gabon	46	58	79%	Germany	65	291	22%
Yemen	14	18	78%	Tunisia	11	52	21%
Cameroon	34	44	77%	Sri Lanka	10	48	21%
Ghana	61	79	77%	Australia	69	354	19%
Tanzania	71	92	77%	South Africa	53	289	18%
Mali	20	26	77%	Austria	10	55	18%
Bahamas	10	13	77%	Jordan	4	22	18%
Kyrgyzstan	9	12	75%	Mexico	18	101	18%
Maldives	9	12	75%	Turkey	13	75	17%
Nigeria	240	321	75%	New Zealand	5	29	17%
Papua New Guinea	75	102	74%	Guatemala	2	12	17%
Afghanistan	71	97	73%	India	54	338	16%
Serbia	8	11	73%	Brazil	15	103	15%
Namibia	25	35	71%	Dominican Republic	3	21	14%
Libya	29	41	71%	Canada	5	40	13%
Mozambique	52	74	70%	El Salvador	2	16	13%
Uzbekistan	7	10	70%	Spain	9	75	12%
Algeria	43	62	69%	Greece	5	42	12%
Iraq	47	69	68%	Taiwan	8	68	12%
Kazakhstan	93	137	68%	Hungary	2	17	12%
East Timor	19	28	68%	Italy	8	71	11%
Cambodia	107	162	66%	Belgium	8	73	11%
Zimbabwe	20	31	65%	United Kingdom	29	270	11%
Jamaica	7	11	64%	Argentina	2	19	11%
Fiji	11	18	61%	Chile	7	67	10%
Myanmar	25	42	60%	Malaysia	49	546	9%
Burkina Faso	19	32	59%	South Korea	37	415	9%
Nepal	16	28	57%	Philippines	37	458	8%

(Continued)

TABLE 2. (Continued)

Country	MV	Hospitalization	Proportion	Country	MV	Hospitalization	Proportion
Azerbaijan	81	144	56%	Panama	3	38	8%
Morocco	16	29	55%	Switzerland	8	118	7%
Rwanda	11	20	55%	Venezuela	1	15	7%
Cote d'Ivoire	19	35	54%	Japan	15	230	7%
Romania	23	44	52%	Thailand	99	1855	5%
Bangladesh	29	56	52%	Colombia	2	39	5%
Senegal	17	33	52%	Hong Kong (SAR)	35	710	5%
Honduras	17	35	49%	US Virgin Islands	2	44	5%
Egypt	37	78	47%	Lebanon	1	22	5%
Trinidad and Tobago	6	13	46%	Portugal	1	23	4%
Pakistan	15	33	45%	Singapore	48	1250	4%
China	853	1962	43%	Israel	0	16	0%
Russia	153	355	43%	Malta	0	12	0%

Countries with 10 hospitalizations or more are given. MV, medical evacuations.

TABLE 3. Comparison of HDI and CMR Country Risk Categorizations

HDI Country Rating	CMR Country Rating				HDI Total
	Low Risk (1)	Moderate Risk (2)	High Risk (3)	Extreme Risk (4)	
Very high development (1)	27	15	0	0	42
High development (2)	0	29	14	0	43
Moderate development (3)	0	12	24	6	42
Low development (4)	0	0	13	29	42
Not rated by HDI	11	32	7	5	55
CMR Total	38	88	58	40	224

CMR, Country Medical Risk Index; HDI, International Human Development Index.

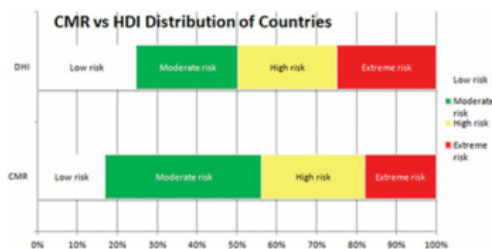


FIGURE 1. Comparison of International Human Development Index (HDI) and Country Medical Risk Index (CMR). The figure shows the distribution of percentage of countries in each of the four risk categories according to the CMR and HDI tools. Countries not rated by HDI were excluded from calculation of percentages for HDI but included for CMR distribution.

ratio of hospitalization likelihood per person comparing the highest and lowest country categories by HDI was only eightfold in comparison to 49-fold for evacuation.

Results for DB0910

Tables 6 and 7 summarize aeromedical evacuations and hospitalizations for the larger data set DB0910. In contrast to DB09

described earlier, the number of international assignees and dependents at risk in each country is not known. Therefore, comparison of risk per international assignee according to country for these analyses assumed the proportional distribution of assignees was the same as in the DB09 data set. The "relative risk ratio" represents the number of cases divided by the proportion of international assignees estimated to be living in the region with normalization so that the lowest risk region is at a ratio of 1.0.

Both the pattern and the magnitude of differences between the DB0910 data and the DB09 data are very comparable. This is notable because results are based on a much larger number of cases (eg, 5725 versus 74 evacuations), more countries (224 versus 181), and 2 years rather than 1 year of data. The numbers of both aeromedical evacuations and hospitalizations was much higher in the two highest categories than in the lower two. In addition, the magnitude of the effect of country medical risk was much greater for evacuations than for hospitalizations (eg, relative ratios of approximately 46 for aeromedical evacuations versus 6 for hospitalizations for the CMR indices).

Table 8 shows the proportion of hospitalization cases that eventually required evacuation (MEP) according to HDI and CMR risk categories. The likelihood that a hospitalized patient will require medical evacuation is clearly associated with the country's medical risk ($P < 0.0001$ for both HDI and CMR indices). Overall, about a third of international assignees requiring hospitalization subsequently required medical evacuation. There was a monotonic trend showing increased proportion of hospitalization patients evacuated as the country medical risk category increased. The distinction

TABLE 4. Aeromedical Evacuation Cases (DB09)

	HDI					CMR				
	Very High	High	Moderate	Low	Total	Low	Moderate	High	Extreme	Total
Risk score (1 = low)	1	2	3	4		1	2	3	4	
Number of countries	33	36	31	34	134	31	73	48	29	181
Number of expatriates	51 093	21 572	15 561	3373	91 599	43 647	34 841	13 395	2768	94651
Countries with ≥1 evacuation	5	2	6	6	19	3	5	8	4	20
Percent of countries with ≥1 evacuation	15%	6%	19%	18%	14%	10%	7%	17%	14%	11%
	FE <i>P</i> = 0.31; MH <i>P</i> = 0.42					FE <i>P</i> = 0.35; MH <i>P</i> = 0.24				
Total number of evacuations	9	4	28	29	70	7	8	50	7	72
Average no. of evacuations per country	0.27	0.11	0.90	0.85	0.52	0.23	0.11	1.04	0.24	0.40
	SC <i>r</i> = 0.60; <i>P</i> = 0.40					SC <i>r</i> = 0.60; <i>P</i> = 0.40				
Risk/assignee (per 10,000)	1.76	1.85	17.99	85.98	7.64	1.60	2.30	37.33	25.29	7.61
Relative risk ratio*	1.00	1.05	10.22	48.81		1.00	1.43	23.27	15.77	
	SC <i>r</i> = 1.0; <i>P</i> < 0.0001					SC <i>r</i> = 0.80; <i>P</i> = 0.20				

CMR, Country Medical Risk Index; FE, Fisher exact test; HDI, International Human Development Index; MH, Mantel-Haenszel test; SC, Spearman rank correlation test.
*The relative risk ratio is the likelihood scaled so the lowest category equals 1.00.

TABLE 5. Hospitalization Cases (DB09)

	HDI					CMR				
	Very High	High	Moderate	Low	Total	Low	Moderate	High	Extreme	Total
Risk score (1 = low)	1	2	3	4		1	2	3	4	
Number of countries	33	36	31	34	134	31	73	48	29	181
Number of expatriates	51093	21572	15561	3373	91599	43647	34841	13395	2768	94651
Countries with ≥1 hospitalization	16	13	11	7	47	13	18	13	5	49
Percent of countries with ≥1 hospitalization	48%	36%	35%	21%	35%	42%	25%	27%	17%	27%
	CS <i>P</i> = 0.12; MH <i>P</i> = 0.02					CS <i>P</i> = 0.16; MH = 0.07				
Total number of hospitalization	66	28	96	34	224	53	67	98	9	227
Average no. of hospitalizations per country	2.00	0.78	3.10	1.00	1.67	1.71	0.92	2.04	0.31	1.25
	SC <i>r</i> = 0; <i>P</i> = 1.00					SC <i>r</i> = -0.40; <i>P</i> = 0.60				
Risk/assignee (per 10,000)	12.92	12.98	61.69	100.80	24.45	12.14	19.23	73.16	32.51	23.98
Relative risk ratio*	1.00	1.00	4.77	7.80		1.00	1.58	6.03	2.68	
	SC <i>r</i> = 0.95; <i>P</i> = 0.05					SC <i>r</i> = 0.80; <i>P</i> = 0.20				

The tables summarize results for evacuations and hospitalizations. Assignees include employees and their dependents. The relative risk ratio is the likelihood scaled so the lowest category equals 1.00. CMR, Country Medical Risk Index; CS, chi-squared test; FE, Fisher exact test; HDI, International Human Development Index; MH, Mantel-Haenszel test; SC, Spearman rank correlation test.

*The relative risk ratio is the likelihood scaled so the lowest category equals 1.00.

TABLE 6. Aeromedical Evacuation Cases (DB0910)

	HDI					CMR				
	Very High	High	Moderate	Low	Total	Low	Moderate	High	Extreme	Total
Risk score (1 = low)	1	2	3	4		1	2	3	4	
Number of countries	42	43	42	42	169	38	88	58	40	224
Countries with ≥1 evacuation	33	40	40	42	155	23	70	55	39	187
Percent of countries with ≥1 evacuation	79%	93%	95%	100%	92%	61%	80%	95%	98%	84%
	CS <i>P</i> = 0.003; MH <i>P</i> = 0.0005					CS <i>P</i> < 0.0001; MH <i>P</i> < 0.0001				
Total number of evacuations	624	699	2570	1672	5565	430	913	3133	1249	5725
Average no. of evacuations per country	14.86	16.26	61.19	39.81	32.93	11.32	10.38	54.02	31.23	25.56
	SC <i>r</i> = 0.80; <i>P</i> = 0.20					SC <i>r</i> = 0.60; <i>P</i> = 0.40				
Relative risk ratio*	1.00	2.65	13.52	40.59		1.00	2.66	23.74	45.80	
	SC <i>r</i> = 1.0; <i>P</i> < 0.0001					SC <i>r</i> = 1.0; <i>P</i> < 0.0001				

CMR, Country Medical Risk Index; CS, chi-squared test; HDI, International Human Development Index; MH, Mantel-Haenszel test; SC, Spearman rank correlation test.
*The relative risk ratio is the likelihood scaled so the lowest category equals 1.00.