JOURNAL OF INSURANCE MEDICINE

ORIGINAL ARTICLE

Mortality Analysis of Complete Right and Left Bundle Branch Block in a Selected Community Population

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ABSTRACT: A twenty year follow up of a selected, community population with complete right and left bundle branch block is reviewed by comparative mortality analysis. In this population, where cases and controls were free of hypertension and heart disease at entry, the presence of complete right bundle branch block does not have excess mortality. Complete left bundle branch block exhibits excess total and cardiac mortality.

MORTALITY ARTICLE 318M-1

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Key Words: Bundle Branch Block
Left Bundle Branch Block
Right Bundle Branch Block

Received: April 1, 1997

Accepted: May 1, 1997

Journal of Insurance Medicine
1997, 29:91-99

Considerable controversy exists as to the long term mortality of complete bundle branch block (BBB). Complete right bundle branch block (RBBB) is considered to be a low risk impairment, but how low? Is an individual with RBBB a preferred risk? Conversely, complete left bundle branch block (LBBB) is considered to be a marker of underlying cardiac disease and thus indicative of a substandard risk but how substandard?

Robinson et al studied the Natural History of Isolated Bundle Branch Block.[1] From 1968 to 1993, the Irish Heart Foundation screened a population of 110,000 subjects for the presence of cardiovascular disease and its risk factors. All subjects with BBB were identified. Criteria for complete RBBB and LBBB were based on Minnesota codes 7-2-1 and 7-1-1, respectively, at the time of screening. BBB was defined as isolated in the absence of a history of heart disease or hypertension in those with normal blood pressure at the time of screening. The overall prevalence of BBB was 0.44 percent; whereas the prevalence of isolated BBB was 0.28 percent. Isolated RBBB, 0.18 percent, was more common than isolated LBBB, 0.10 percent.

The study group (cases) was composed of 310 individuals with BBB who were free from any clinical evidence of heart disease or hypertension. Controls without BBB were selected from the same screened population by random matching according to age and gender. They were also free of heart disease or hypertension. Heart disease was excluded by history and clinical examination. Author's stated no differences were present between cases and controls in blood pressure, total cholesterol or percentage who smoked. However, as will be subsequently noted, there were differences in the percent of smokers between LBBB cases and controls as well as between LBBB and RBBB cohorts. Follow up in cases was 98 percent and controls 97 percent. Mean and median follow up times for the entire cohort were 9.5 and 8.75 years respectively.

Data Analysis

Baseline comparisons between study (case) and control groups were performed with Student's *t* test or Pearson's chi-square test as appropriate. Kaplan and Meier curves were illustrated for 20 years of follow up for total survival and freedom from cardiac death for the study and control groups and were compared using the log rank test. The power of the study was such that for those with RBBB, the chances of detecting a doubling and tripling of the risk of death were 90 percent and 70 percent, respectively. For those with LBBB, the chance of detecting a doubling of the risk of death was 70 percent. The Mantel-Haenszel test was used to detect age-related trends in the prevalence of BBB. The time to development of cardiac disease after screening was not available in all subjects, and therefore the risk of developing cardiac disease could not be analyzed by actuarial methods. Instead, the proportions of study and control subjects who had developed cardiac disease at the end of the follow-up period were comparing using Pearson's chi-square test. Cox's multiple regression model was used to adjust for differences in age between certain groups. End points were defined as total mortality and cardiac mortality. A p value <0.05 was considered statistically significant.

Mortality Analysis

Criticisms of this review are, one, the extraordinary small number of total and cardiac deaths over the 20 year follow up period, two, the case and control populations were preselected to be free from heart disease and hypertension and three, confounding variables produced by disparities of age and smoking histories. The strengths of this review are: one, the extraordinary long follow up period of 20 years, and two, by using selected cases and a similarly matched control (expected) population, the mortality of BBB unencumbered by antecedent heart disease and hypertension can be assessed.

Refer to Table 1 for definitions of abbreviations used in the text and construction of the single decrement and comparative mortality tables listed in Table 2. Despite the 20 year follow up, with so few deaths, small intervals were inappropriate. I elected to demonstrate two, 10 year and an overall 20 year interval for each table. Lives (l) were from the author's data. Each illustrated Kaplan-Meier survival curve was enlarged. Deaths (d) of cases and controls were counted from the survival curves in each ten year interval and confirmed from the tabular data in the article. Cardiac deaths included myocardial infarction, heart failure and sudden death. Additionally, I included deaths from stroke as cardiac deaths. Control mortality was used as expected mortality since it was an age and gender matched population.

In this study, there are a number of latent confounding variables. These variables and their possible effect on mortality results are as follows:

Age: LBBB cases/controls 51 ± 13/12 years
RBBB cases/controls 44 ± 13 years

When comparing LBBB and RBBB the mortality of LBBB could be spuriously more adverse compared to RBBB since their age was seven years older.

Gender: LBBB cases/controls 73% male
RBBB cases/controls 86% male

When comparing LBBB and RBBB the mortality of RBBB could be fictitiously more adverse compared to LBBB since the group had 13% more males.

Smoking: LBBB controls 23%
LBBB cases 29%
RBBB controls 32%
RBBB cases 30%

Smoking differences create potential complex intra and intergroup confounding variables.

LBBB cases had a six percent higher smoking rate than controls potentially producing a higher observed mortality thus increasing MR and EDR for the LBBB group. Overall, smoking was more prevalent in the RBBB groups potentially increasing its mortality compared to LBBB.

The net effect of these three confounding variables is impossible to assess. Could these factors contribute to the MR less than one and negative EDR in many intervals? Could they produce a difference between the mortality of LBBB and RBBB. The answers are unknown.

Total deaths counted from the illustrated survival curves matched those listed in the article for the 20 year follow up except for the control (expected) total survival cohort without RBBB. For this cohort, the author stated there were 19 deaths. However, counting deaths from the Kaplan-Meier survival curve, only 15 deaths were recorded. After discussion with the author's statistician, the following explanation was given. Two deaths occurred after the end of the 20 year observation period. The cause of one death was non-vascular, the other unknown. These two were included in the tabular data but appropriately excluded from the Kaplan-Meier survival curve. I also excluded them from analysis. The other two deaths did occur within the observation period. However, their interval and cause were unknown. These two deaths were included in the tabular data but inappropriately excluded from the Kaplan-Meier analysis by the author. Since these two deaths did occur within the observation period, they should be included in the control (expected) mortality of RBBB, but where? I arbitrarily placed one death within each 10 year interval. Since they were control (expected) deaths, their exclusion would have a major impact on comparative mortality. Their elimination from the control population by the author would have underestimated control (expected) deaths thereby increasing mortality ratios and excess death rates in RBBB. This effect is further exacerbated by virtue of there being so few deaths in the group.

Interval mortality rates q were calculated from lives (l) divided by deaths (d). Subsequently, p (interval survival rate), P (cumulative survival rate) and $\breve{q}$ (geometric average annual mortality rate) were calculated. Single decrement mortality tables, observed and expected, were constructed (tables A,B,D,E,G,H,J,K). Carrying out calculations to three decimal places may seem inappropriate. However, when initial life tables were constructed to two decimal places inaccuracies of rounding produced unacceptable inconsistencies in much of the data. For comparative mortality analysis, (tables C,F,I,L) the average annual excess death rate (EDR) is the difference between the geometric average annual mortality rate ($\breve{q}$), cases (observed) and control (expected). Excess death rates (EDR) were rounded to the nearest whole number. Mortality ratios (MR) are the quotient of $\breve{q}$ cases (observed) and control (expected). Mortality ratios are rounded as follows: 0-199 to one percent, 200-995 to five percent.

Some minor inconsistencies in the analysis need to be noted. In tables A, B, D, E, F, G and K either P and/or p for the interval of 0-20 years or P calculated from the product of p 0-10 and 11-20 is 0.001 different from P (0-20). This is due to the three decimal rounding and has no consequence in the practical result of the analysis.

Discussion

This study compares the mortality of individuals with RBBB and LBBB. When interpreting comparative mortality data one must keep in mind both control and case populations were selected to be free of heart disease and hypertension. Potential confounding variables of age, gender and smoking are present.

Visual inspection of the published Kaplan-Meier survival curves reveal unusual pat-

terns. For total case survival with RBBB in the first 10 year interval, control (expected) survival is about equal to case (observed) survival. In the second, 10 year interval case (observed) survival is better than control. Comparative total mortality (Table F) reveals negative EDR and mortality ratios less than one hundred percent for both 10 year intervals. For the first, 10 year interval EDR is -1, MR 0.750%. The subsequent 10 year interval reveals EDR to be -3, MR 0.400%. For RBBB cardiac mortality (Table L), cases (observed) also had a better survival compared to controls (expected). Why case (observed) survival is better than control (expected) survival is unclear. As noted earlier, both case and control groups were selected to be free from hypertension and heart disease. One does not believe the presence of RBBB conveys a survival advantage. A possible explanation may be the small number of deaths in each group yields the difference not to be statistically significant. Confounding variables may contribute to or cause this anomaly. Overall, one can assume that RBBB itself has no apparent total nor cardiac mortality impact and can be underwritten as such.

The same does not hold true for LBBB. Comparative mortality of total case survival (Table C) reveals as time progress the negative EDR and the MR of less than one hundred percent in the first, 10 year interval become positive and greater than one hundred percent in the second, 10 year interval. For the first, 10 year interval EDR is -2, MR 0.600%. These increase to 7 and 450%, respectively, in the second, 10 year interval. Over the 20 year interval for total case mortality EDR for LBBB is 2 and MR is 150% indicating excess mortality. One cannot answer whether the deterioration of EDR and MR in the second, 10 year interval would become worse with longer follow up. Percent smoking differences between cases and controls may have confounded these results. Turning our attention to cardiac mortality, we see LBBB (Table I) has an adverse survival compared to RBBB (Table L). For the entire 20 year follow up in RBBB, cardiac mortality EDR is -2, MR 0.333%. For LBBB, EDR is 3, MR 400%. This confirms past preconceptions that the presence of LBBB is a marker for increased cardiac mortality whereas RBBB is not. I leave it to the expertise of the Medical Director to decide the degree of excess risk for LBBB.

One needs to keep in mind those with both RBBB and LBBB were free of hypertension and heart disease at entry into the study. Might their mortality be worse without these exclusions? Since heart disease was a historical and clinical exclusion we can assume some of these individuals would have been diagnosed with heart disease had diagnostic testing been done. BBB is considered a marker of heart disease and not a causative factor. An advantage of this study is, by exclusion of antecedent hypertension and heart disease, one can theoretically observe the pure effect of the presence of BBB on future mortality. When comparing the mortality of RBBB and LBBB the reader needs to consider the previously discussed confounding variables.

My conclusions are at variance with those of the authors. They state "the presence of left BBB or right BBB is not associated with increased overall mortality." Comparative mortality analysis does not substantiate their conclusion. LBBB does have an increased total case mortality compared to RBBB. I do agree with their conclusion that LBBB is associated with an increased cardiac mortality compared to RBBB.

Table 1:

Definitions of abbreviations used in the text and Tables

ℓ: living entrants

d: deaths, observed

d′: deaths, expected

P: cumulative survival rate, observed

P′: cumulative survival rate, expected

q: interval mortality rate, observed

q′: interval mortality rate, expected

p: interval survival rate, observed

p′: interval survival rate, expected

$\breve{q}$: geometric average annual mortality rate, observed

$\breve{q}'$: geometric average annual mortality rate, expected

MR: geometric average annual mortality ratio

EDR: geometric average annual excess death rate

Table 2:

Single Decrement and Comparative Mortality Tables for Total Case and Cardiac Mortality in LBBB and RBBB

Table A: Single Decrement Table Illustrating Total Case (Observed) Mortality with Complete Left Bundle Branch Block

Table B: Single Decrement Table Illustrating Control (Expected) Total Case Mortality without Complete Left Bundle Branch Block

Table C: Comparative Mortality Analysis of Total Case Survival in Complete Left Bundle Branch Block

Table D: Single Decrement Table Illustrating Total Case (Observed) Mortality with Complete Right Bundle Branch Block

Table E: Single Decrement Table Illustrating Control (Expected) Total Case Mortality Without Complete Right Bundle Branch Block

Table F: Comparative Mortality Analysis of Total Case Survival in Complete Right Bundle Branch Block

Table G: Single Decrement Table Illustrating Case (Observed) Cardiac Mortality with Complete Left Bundle Branch Block

Table H: Single Decrement Table Illustrating Control (Expected) Mortality for Cardiac Mortality Group Without Complete Left Bundle Branch Block

Table I: Comparative Mortality Analysis of Cardiac Survival in Complete Left Bundle Branch Block

Table J: Single Decrement Table Illustrating Case (Observed) Cardiac Mortality with Complete Right Bundle Branch Block

Table K: Single Decrement Table Illustrating Control (Expected) Mortality for Cardiac Mortality Group without Complete Right Bundle Branch Block

Table L: Comparative Mortality Analysis of Cardiac Survival in Complete Right Bundle Branch Block

Table A:

Single Decrement Table Illustrating Total Case (Observed) Mortality with Complete Left Bundle Branch Block

Years	ℓ	d	q	p	P	$\breve{q}$
0-10	112	3	.027	.973	.973	.003
11-20	109	9	.083	.917	.892	.009
0-20	112	12	.107	.893	.892	.006

Table B:

Single Decrement Table Illustrating Control (Expected) Total Case Mortality without Complete Left Bundle Branch Block

Years	ℓ	d	q′	p′	P′	$\breve{q}$
0-10	112	6	.054	.946	.946	.005
11-20	106	2	.019	.981	.928	.002
0-20	112	8	.071	.929	.928	.004

Table C:

Comparative Mortality Analysis of Total Case Survival in Complete Left Bundle Branch Block

Years	MR	EDR
0-10	0.600%	-2
11-20	450%	7
0-20	150%	2

Table D:

Single Decrement Table Illustrating Total Case (Observed) Mortality with Complete Right Bundle Branch Block

Years	ℓ	d	q	p	P	$\check{q}$
0-10	198	6	.030	.970	.970	.003
11-20	192	4	.021	.979	.950	.002
0-20	198	10	.051	.949	.950	.003

Table E:

Single Decrement Table Illustrating Control (Expected) Total Case Mortality Without Complete Right Bundle Branch Block

Years	ℓ	d	q′	p′	P′	$\check{q}$
0-10	198	8	.040	.960	.960	.004
11-20	190	9	.047	.953	.915	.005
0-20	198	17	.086	.914	.914	.004

Table F:

Comparative Mortality Analysis of Total Case Survival in Complete Right Bundle Branch Block

Years	MR	EDR
0-10	0.750%	-1
11-20	0.400%	-3
0-20	0.750%	-1

Table G:

Single Decrement Table Illustrating Case (Observed) Cardiac Mortality with Complete Left Bundle Branch Block

Years	ℓ	d	q	p	P	$\breve{q}$
0-10	112	5	.045	.955	.955	.005
11-20	107	3	.028	.972	.928	.003
0-20	112	8	.071	.929	.928	.004

Table H:

Single Decrement Table Illustrating Control (Expected) Mortality for Cardiac Mortality Group Without Complete Left Bundle Branch Block

Years	ℓ	d	q′	p′	P′	$\breve{q}$
0-10	112	2	.018	.982	.982	.002
11-20	110	0	0	1.0	.982	0
0-20	112	2	.018	.982	.982	.001

Table I:

Comparative Mortality Analysis of Cardiac Survival in Complete Left Bundle Branch Block

Years	MR	EDR
0-10	250%	3
11-20	*	*
0-20	400%	3

* For this interval there were no deaths in the cardiac case (control) population.

Table J:

Single Decrement Table Illustrating Case (Observed) Candiac Mortality with Complete Right Bundle Branch Block

Years	ℓ	d	q	p	P	$\breve{q}$
0-10	198	2	.010	.990	.990	.001
11-20	196	1	.005	.995	.985	.001
0-20	198	3	.015	.985	.985	.001

Table K:

Single Decrement Table Illustrating Control (Expected) Mortality for Cardiac Mortality Group Without Complete Right Bundle Branch Block

Years	ℓ	d	q'	p'	P'	$\breve{q}'$
0-10	198	5	.025	.975	.975	.003
11-20	193	5	.026	.974	.950	.003
0-20	198	10	.051	.949	.949	.003

Table L:

Comparative Mortality Analysis of Cardiac Survival in Complete Right Bundle Branch Block

Years	MR	EDR
0-10	0.333%	-2
11-20	0.333%	-2
0-20	0.333%	-2

References

1. Fahy GJ, Pinski SL, Miller DP et al. Natural History of Isolated Bundle Branch Block. Am J. Cardio 1996;77:1185-1190.