Use and Dissemination of the Brisbane 2000 Nomenclature of Liver Anatomy and Resections

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Introduction: The Brisbane 2000 Nomenclature of Hepatic Anatomy and Resections was created to standardize terminology in an area, which previously was characterized by redundant and confusing terms. The purpose of this study was to evaluate the use and dissemination of the nomenclature 10 years after its introduction.

Methods: Two strategies were used to evaluate implementation of the terminology. The first depended on an examination of terms used to describe the anatomy and resection of one half of the liver over the 20-year period from 1990 to 2009. The second approach evaluated the use of the terms “section,” “sectionectomy,” and “trisectionectomy,” which, in reference to the liver, are unique to the Brisbane 2000 Nomenclature.

Results: The use of the Brisbane 2000 terms “right and left hemihepatectomy/hepatectomy” increased dramatically versus the use of the discarded terms “right and left hepatic lobectomy” after the Nomenclature was introduced in 2000. This was especially true in the Americas and Asia where the terms were used in less than 50% of papers from 1990 to 1999 but reached 80% utilization by 2006. Likewise, use of the terms “section,” “sectionectomy,” and “trisectionectomy” increased sharply especially in between 2006 and 2009.

Conclusions: The Brisbane terminology is being adopted worldwide but its adoption is still incomplete.

Keywords: Liver anatomy, liver surgery, nomenclature, terminology

Clear terminology is essential to classification and communication in medicine and science. The need for simple, stable, and internationally accepted systems for naming objects of the natural world has generated several formal systems—one of the best known being the biological nomenclature that governs the scientific names of organisms. The Brisbane 2000 Nomenclature of Hepatic Anatomy and Resections was adopted by the General Assembly of the International Hepato-Pancreato-Biliary Association at the fourth biennial meeting of that society in Brisbane, Australia in 2000. It was based on the recommendations of an international ad hoc committee on nomenclature of hepatic anatomy and resections formed 2 years earlier referred to as the International Hepato-Pancreato-Biliary Association Brisbane 2000 Nomenclature Committee.

The stimulus for the formation of a terminology committee by the International Hepato-Pancreato-Biliary Association was the chaotic state of anatomical nomenclature of the liver, as well as the terminology used for liver resections. This was described in a paper by one of the authors (S.M.S.) in 1997. Before the late 19th century, terminology of hepatic anatomy was limited to surface markings, because little was known about the internal structure of the organ. As this began to change, based on publication of studies that injected the blood vessels and bile ducts of the liver, new terms were introduced by individual authors who had performed the studies. Unfortunately, these terms were often anatomically and linguistically incorrect. Also, because there was no governing body to sanction these terms, multiple terms came to be used for the same structure or operation whereas conversely, some individual terms were used for more than one structure or operation. One example of the former is that in 1997 there were 13 terms in use for the plane that defines the watershed between the right and left hemilivers, which is now referred to as the midplane of the liver. An example of the latter is that “lobe,” “lobectomy,” “segment,” and “segmentectomy” were in use for different parts of the liver or different resections depending on whether one was in the United States or France. European authors strongly favored terminology used by Couinaud whereas American writers tended to use terminology employed by Cantlie and American authors, such as Healey and Goldsmith. The problem was summarized by Bismuth who presented a table comparing “French” and “American” nomenclatures for liver and anatomy and resection. Until 2000, no international body had attempted to rectify this unacceptable situation.

The goals of International Hepato-Pancreato-Biliary Association Brisbane 2000 Nomenclature Committee were to correct the confusing state, which existed by preparing a nomenclature that had the following 8 attributes:

1. Anatomically correct
2. Anatomical and surgical terms in agreement
3. Consistent
4. Self-explanatory
5. Linguistically correct
6. Precise
7. Concise
8. Translatable.

The details of these attributes and how they were woven into a unifying terminology have been presented previously. The purpose of this article was to examine the use and dissemination of the Brisbane 2000 Nomenclature 10 years after its inception. New, simpler figures illustrating the terminology are presented, so that the reader may follow the assessment of its use in the literature by year and region since its introduction.

METHODS

Two strategies were used to determine use and dissemination of the Brisbane 2000 Nomenclature. The first depended on an examination of certain terms used to describe the anatomy and resection of one half of the liver over the 20-year period from 1990 to 2009. The second approach evaluated the use of the terms “section,” “sectionectomy,” and “trisectionectomy,” which, in reference to the liver, are unique to the Brisbane 2000 Nomenclature.

Classically, the English language literature, stimulated by the work of Cantlie, used the terms “right lobe” and “left lobe” to describe the 2 halves of the liver, separated by a plane that intersects the gallbladder fossa and the groove for the inferior vena cava. The corresponding terms for resection of these parts of the liver were “right hepatic lobectomy” and “left hepatic lobectomy” (or “right lobectomy”...
FIGURE 1. Three orders of ramification of the proper hepatic artery are shown color coded. First order (red) is division into right (A) and left (B) hepatic arteries. The second order is division into sectional arteries (green) including the right anterior (C), the right posterior (D), the left medial (E), and the left lateral (F) sectional arteries. The third order division (blue) is into segmental arteries, which are numbered and correspond to the Couinaud segments. The 3 orders supply hemilivers or livers, sections, and segments. Note that the second order and third order for the left medial sectional artery and artery to segment 4 are identical (banded green and blue). Segment 1, which is separate from the 2 hemilivers is supplied by arteries that arise from the right and left hepatic arteries (not shown). Ramification of the bile ducts is identical to that of the arteries.

and “left lobectomy”). The French literature used the terms “right liver” and “left liver” or “hemiliver” and the corresponding surgical terms of “right and left hepatectomy or hemihepatectomy.”5 However, the terms lobe and lobectomy, were anatomically incorrect,1,2 caused confusion with the different “lobes” of surface anatomy, and were consequently rejected by the Brisbane 2000 Nomenclature Committee in favor of the latter terms. Therefore, to determine whether the Brisbane 2000 Nomenclature was being adopted, it was evaluated whether there was a relative decrease in use of the specific terms “right and left hepatic lobectomy” and an increase in the use of “right and left hepatectomy or hemihepatectomy” over the past 20 years. Also, to ascertain whether any observed shift was specifically related to the timing of the introduction of the terminology in 2000, the annual use during the 2 decades was calculated. The evaluations were both global and regional, the latter based on the 3 International Hepato-Pancreato-Biliary Association geographic regions. Where numbers allowed, tabulation of use in the literature from individual countries was also carried out.

The literature was searched using OVID for papers using the keywords “right hepatic lobectomy”(A), “left hepatic lobectomy”(B), “right hepatectomy”(C), “left hepatectomy”(D), “right hemihepatectomy”(E), and “left hemihepatectomy”(F) either in the title or abstract. The searches were limited to human studies. Papers were accepted in English or other languages. For papers other than in English to be accepted, a translation of the title and/or abstract into English had to be available and contain one of the terms described earlier. The country of origin was also determined. All papers including case reports and reviews were accepted, but letters were not. Papers originating

FIGURE 2. A, First-order division of the liver into hemilivers or livers. Midplane of liver shown in red. B, Second-order division of liver into sections. RPS, right posterior section; RAS, right anterior section; LMS, left medial section; LLL, left lateral section. The intersectional planes are shown in green. C, Third-order division into numbered segments.
from any discipline were allowed, the great majority coming from depart-
ments of surgery. The papers were classified by year, by region, and by country. These results were expressed as percent utilization of the Brisbane 2000 Nomenclature, which was calculated as follows
\[
\frac{(C + D + E + F)}{(A + B + C + D + E + F)} \times 100.
\]

In the second strategy, the literature was searched using OVID for papers using the terms, “section,” “sectionectomy,” and “trisectionectomy” in titles and abstracts of human papers in any language, provided a title and abstract were available in English. As noted earlier, these terms are unique to the Brisbane 2000 Nomenclature in as much as they had not been used to describe liver anatomy or resections before the introduction of the Nomenclature. The term “trisectionectomy” appears only in papers related to liver resection but as “section” and perhaps “sectionectomy” can refer to other organs the search was limited to cases in which the 2 latter terms were prefaced by the 4 hepatic localizing terms “right anterior,” “right posterior,” “left medial,” and “left lateral.” Each paper that was identified was then checked to confirm that the use of the term was in relation to liver surgery.

### FIGURE 3. Resectional terminology for excision of a hemiliver or liver.

<table>
<thead>
<tr>
<th>Anatomical Term</th>
<th>Couinaud Segments</th>
<th>Term for Surgical Resection</th>
<th>Diagram (pertinent area is shaded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Liver OR Hemiliver</td>
<td>Sg 5-8</td>
<td>Right Hepatectomy OR Right Hemihepatectomy</td>
<td><img src="image1" alt="Diagram" /></td>
</tr>
<tr>
<td>Left Liver OR Hemiliver</td>
<td>Sg 2-4</td>
<td>Left Hepatectomy OR Left Hemihepatectomy</td>
<td><img src="image2" alt="Diagram" /></td>
</tr>
</tbody>
</table>

### FIGURE 4. Resectional terminology for excision of a section.

<table>
<thead>
<tr>
<th>Anatomical Term</th>
<th>Couinaud Segments</th>
<th>Term for Surgical Resection</th>
<th>Diagram (pertinent area is shaded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Anterior Section</td>
<td>Sg 5,8</td>
<td>Right anterior sectionectomy</td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td>Right Posterior Section</td>
<td>Sg 6,7</td>
<td>Right posterior sectionectomy</td>
<td><img src="image4" alt="Diagram" /></td>
</tr>
<tr>
<td>Left Medial Section</td>
<td>Sg 4</td>
<td>Left medial sectionectomy</td>
<td><img src="image5" alt="Diagram" /></td>
</tr>
<tr>
<td>Left Lateral Section</td>
<td>Sg 2,3</td>
<td>Left lateral sectionectomy</td>
<td><img src="image6" alt="Diagram" /></td>
</tr>
</tbody>
</table>
RESULTS

Illustration of the Brisbane 2000 Terminology of Hepatic Anatomy and Resections

The anatomic basis for Brisbane 2000 Nomenclature is the branching pattern of the hepatic arteries and bile ducts, which are identical in the prevailing or commonest anatomic pattern (Fig. 1). The ramification of the portal veins is also identical on the right side of the liver, but different on the left. The 3 orders of branching result in successive division of the liver into 2 hemilivers (or livers), 4 sections, and 8 segments (Fig. 2A–C). The divisions are based on watersheds of the arteries and bile ducts, and these watersheds are demarcated by the midplane of liver, 2 intersectional planes and several intersegmental planes (Fig. 2A–C). The terminology of liver resections is based directly on the anatomic terminology and these resections are termed hemihepatectomies or hepatectomies, sectionectomies, and segmentectomies (Figs. 3–5). Extended resections of 3 sections are called trisectionectomies (Fig. 6).

Use and Dissemination of the Nomenclature

Use of the Brisbane 2000 Terms “Right and Left Hemihepatectomy/Hepatectomy” Versus Use of the Discarded Terms “Right and Left Hepatic Lobectomy” From 1990 to 2009

A total of 1377 papers, which used the selected terms, were identified in titles and/or abstracts in the 20-year period from 1990 to 2009. In the period from 1990 to 1999, hepatic lobectomy was used in 143 papers and hemihepatectomy/hepatectomy in 315 papers. These represented 31% and 69% of the papers during that decade, respectively. In the period from 2000 to 2009, the use of hepatic lobectomy decreased slightly to 124 papers, whereas the use of hemihepatectomy/hepatectomy increased sharply to 723 papers. These represented 15% and 85% of the papers during that decade, respectively. The relationship between the sets of terms is shown in Figure 7, in which the use of hemihepatectomy/hepatectomy is expressed as a percent of the total of the papers using either set of terms. Note that
FIGURE 7. Percent utilization of hemihepatectomy/hepatectomy in titles and/or abstracts of papers, 1990 to 2009. Arrow indicates time when the Brisbane terminology was introduced.


FIGURE 9. Percent utilization of hemihepatectomy/hepatectomy in titles and/or abstracts of papers in the Americas and in the Asia/Pacific regions, 1990 to 2009. Arrow indicates time when the Brisbane terminology was introduced.

FIGURE 10. Use of section, sectionectomy, or trisectionectomy, 2000 to 2009.

The relationship fluctuated between 53% and 76% with a mean of 66% between 1990 to 1999 but that there was no trend to change up or down during that period. In contrast, in the decade following the introduction of the Brisbane Nomenclature in 2000, there was a steady increase in the percent utilization of hemihepatectomy/hepatectomy reaching 90% in 2006.

The data from the 3 International Hepato-Pancreato-Biliary Association regions during the 2 decades were also compared (Fig. 8). Note that the use of hemihepatectomy/hepatectomy was already high in the European/African region in the 1990 to 1999 period. This was to be expected because hemihepatectomy/hepatectomy were the terms used by Couinaud, and were already used widely across Europe. However, in the Asia/Pacific region and Americas hemihepatectomy/hepatectomy was used in fewer than 50% of papers in the first decade and greater than 70% of papers in the second decade. To fully appreciate the dissemination of the terminology into these areas, one must examine the yearly usage in the Asia/Pacific and Americas regions. This is shown in Figure 9. Note that in the first decade there was some fluctuation but no clear up or down trend, whereas in the second decade after the adoption of the Brisbane terminology, there was a steady and dramatic increase in percent utilization reaching 80% in 2006.

The same data were available in more than 25 papers in each decade for a number of countries. For France, Italy, and Germany the percent utilization of hemihepatectomy/hepatectomy was steady in the 2 decades and between 95% and 100%. Japan had by far the highest total of papers with 415 in the 2 decades. The utilization of hemihepatectomy/hepatectomy doubled from 35% in the first decade to 71% in the second decade in papers emanating from Japan. The corresponding figures for the United States were 29% and 73%, respectively.

The Use of the Brisbane 2000 Terms Section, Sectionectomy, and Trisectionectomy Between 2000 to 2009

These terms were new when introduced and they are unique to the Brisbane 2000 terminology. Also there are many fewer papers dealing with resections of one quarter of the liver than of one half of the liver. In the 10-year period since the introduction of the terminology, 89 papers have used the terms in the title or abstract of papers. The utilization was slow at first but has steadily increased in the later years of the decade (Fig. 10). In 2009, the terms appeared in 31 titles and/or abstracts of papers. The terms are being used in all regions of the world, although currently there are not sufficient data to provide a meaningful analysis of regional use.

DISCUSSION

Before the introduction of the Brisbane 2000 Nomenclature, the surgical literature was confounded by confusing, redundant, and inappropriate terminology. For example, many surgeons referred to both the second- and third-order divisions of the liver as “segments.” This led to terms such as trisegmentectomy (tri = 3), which denoted...
resection of Couinaud segments 4 to 8 (5 segments) or left lateral segmentectomy (1 segment), which denoted resection of Couinaud segments 2 and 3 (2 segments). A right lobectomy in France was a right trisegmentectomy in the United States, and a right lobectomy in the United States was a right heptectomy in France. The French terminology relied on internal vascular anatomy for most resections, but fell back to surface anatomy when describing resections through the umbilical fissure. Planes were called lines or sometimes fissures, even though the fissures existed only in corrosion casts. It was not unusual for serious misunderstandings to occur with regard to the part of liver being referred to both in the literature or during paper presentations and discussions at international meetings. Nor was it unusual to find different terms used for the same structure or resection within 1 issue of a journal or within 1 multiauthored textbook. The entire array of problems and their historical origin has been described in detail in prior publications. The highly unsatisfactory situation, detailed in a paper by one of the authors in 1997 (S.M.S.), led to the development of the Nomenclature as described in the introduction.

The conclusion of this study is that there is a clear trend to the adoption of the Brisbane 2000 Nomenclature of Liver Anatomy and Resections around the world. The specific terms used in the analysis could be searched for in the titles and abstracts of articles, and on the basis of this literature, the results justify the foregoing conclusion. However, the utilization of the terms in the body of literature papers cannot be determined by current literature search engines such as OVID. Therefore, the values expressed in the text, such as the percent utilization, should not be taken as an exact measure of dissemination of the terminology. Likely, many articles contain the specific terms only in the body of the articles and this usage cannot be determined. Moreover, less specific terms such as “right lobectomy” and “left lobectomy” (as opposed to “right and left hepatic lobectomy” have not been included in the analysis because they cannot be easily evaluated. Therefore, although the Brisbane Nomenclature is being adopted increasingly and widely, the high percentages given in our data are likely an overestimation of its use in the overall literature.

Because the Nomenclature has not been universally adopted, efforts to increase implementation of the terminology must continue in the future. The terminology is available on the Web at http://www.ihpba.org/mc/page.do?sitePageId=103192&orgId=ihpba or by searching the International Hepato-Pancreato-Biliary Association Web site (http://www.ihpba.org) for “literature” and then “liver resections.” Also, it would seem timely for editors of surgical journals and textbooks to consider its use as a matter of policy. The disadvantage of having a term used for a particular structure, varying on the basis of authorship within 1 issue of a journal or 1 edition of a textbook, is obvious. Stated otherwise, the trend toward adoption of a universal, easily understood terminology is encouraging but work remains to be done.

REFERENCES