EDITORIAL

From Couinaud to molecular biology: the seven virtues of hepato-pancreato-biliary surgery

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It is an immense honour and a privilege to serve as President at the 12th Annual Meeting of the Americas Hepato-Pancreato-Biliary Association (AHPBA). This presentation is dedicated to those young and old who continue to be passionate students of hepato-pancreato-biliary (HPB) disorders. The talk is a tribute to Claude Couinaud, a French surgeon, and his passion for liver anatomy (Fig. 1). It is also about the crossroads between his and our passion for HPB surgery. In trying to identify the best term to describe these seven crossroads between Couinaud’s world and today’s world, I first thought of using the terms essentials, principles or reasons, but they sounded too detached and impersonal. I also considered using the terms passions, loves or elations, but I found them to be too emotional. So I chose the term virtues, which is used in ancient and modern philosophy, in psychology, and in many religious traditions (Table 1).

Knowledge of liver anatomy

The first virtue is of course knowledge of liver anatomy. Couinaud was 30 years old when he began to study the liver with corrosion casts. His early work described precisely the anatomy of the liver based on hepatic veins. He was the first to coin the word sector based on planes of hepatic veins. Couinaud spent his mornings with Henri Mondor and would focus on research in the afternoon. Couinaud was well prepared to understand the vascular distribution of the liver as he had investigated lung anatomy with Phillip Allison in Leeds, England. In 1954, he first described eight liver segments, in La Presse Médicale (Fig. 2).1

The work of Couinaud is summarized in his book Le Foie (Fig. 3), a true summa hepatica.2 The book is divided into sections on portal, biliary and hepatic arterial anatomy, and includes the anatomy of other species, such as rhinoceroses and giraffes, and the embryology of the liver. Half of the book summarizes hepatic resection techniques.3

Respect and credit to mentors

The second virtue is giving respect and credit to your mentors. In 1888, 9 years before James Cantlie, Hugo Rex clearly described the main plane of the liver and the four hepatic sectors in an original article on the liver anatomy of the suckling.4 (Fig. 4) Couinaud said of Rex: ‘I have nothing to add to his description of the portal anatomy of the liver’. Couinaud also insisted on calling the Glisson sheath the Walean sheath because it was described by Walaeus in 1640, 2 years before Glisson had described it (Fig. 5).5

As I stand here, in the role of AHPBA president, I do so with respect for my predecessors. Each of them contributed enormously to the development of HPB surgery (Table 2). As stated by Reid Adams during last year’s presidential address, ’It was the dream of our founders’. Today we are indebted to the past Presidents for their ongoing support of the association and foundation.

Surgical technique

The third virtue is recognition of an excellent surgical technique as being essential. The field of surgical technique advances in waves, and timely contributions are essential. In 1952, Jean-Louis Lortat-Jacob performed the first extended right hepatectomy in the West with a so-called controlled technique: ligating individual inflow vessels.6 The same year, Couinaud described the first left hepatectomy with primary ligation of the left Walean sheath.7 This work paved the way for multiple subsequent descriptions of the sheath technique in Europe, Japan and Australia. Couinaud’s anatomical studies prefigured important advances in liver surgery. In 1956, Jacques Hepp and Claude Couinaud described the end-to-side technique of a hepaticojejunostomy.8 This technique is still used by many surgeons to maximize the mucosal surface of the...
anastomosis after bile duct injuries. Mike Farnell and the Mayo Clinic group reported excellent results with the technique in 1999. In 1989, Couinaud described the loose precaval space between the vena cava and the liver, which Jacques Belghiti later used to perform the hanging manoeuver. The technique is now utilized for the anterior approach to the large right upper quadrant tumours.

In anyone’s career, true captains command respect for their technical skills and clinical judgment. For me, three captains with these attributes stand out: John C. Bowen, a technically superb surgeon; Leslie H. Blumgart, a generous and enthusiastic leader; and Edward M. Copeland, a Southern gentleman who gave me a unique understanding of surgery in the cancer patient.

Research focus

The fourth virtue is research focus. Couinaud focused his research on anatomic variants of liver anatomy. In his 111 casts, 23% of patients did not have a right portal vein. The variants include portal vein trifurcations, staged divisions and the absence of portal vein bifurcation, all of which may markedly increase the difficulty of major liver resections (Fig. 6). Not described in Couinaud’s work is the very rare total absence of a hepatic portal

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Figure 1 Claude Couinaud working with his collection of liver casts at the school of medicine in Paris, 1988. Reprinted with permission from Sutherland and Harris (2002)

Figure 2 Liver segments described by Couinaud. Adapted from La Presse Médicale, 1954
vein. Patients with this variant have a large hepatic artery. This
variant is often associated with hepatic neoplasms.\textsuperscript{13}

This is in contrast with the consistency of the proximal left
portal vein and bile duct, which are present in most patients. Only
2\% of patients have no left hepatic duct (Fig. 7). This left-sided
regularity is the basis for surgical procedures such as the Hepp-
Couinaud hepaticojunostomy\textsuperscript{8,9} and portal vein bifurcation
resection with left-sided venous reconstruction in patients with
Klatskin tumours as proposed by Peter Neuhaus in Germany.\textsuperscript{14}

Couinaud’s research was mainly descriptive, focusing on the
frequency of anatomic variations. AHPBA has advanced the field
with consensus conferences relating to hepatocellular carcinoma
(2004 and 2010), pancreas cancer (2008) and colorectal liver
metastases (2006 and 2012), and is now organizing Patient Care
Guidelines meetings, with the first such symposium, on deep vein
thrombosis, held during this 2012 annual meeting. Nevertheless,
much remains undone in the field of research. As a next step,
AHPBA should prioritize registries and multicentre studies that
will advance the field.

Sharing of knowledge and expertise

The fifth virtue is sharing knowledge and expertise. In 1975, Dr
Couinaud retired. In 2000, Eddie Abdalla and I visited him in his

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Figure 3 Cover of Le Foie. Études Anatomiques et Chirurgicales, 1957\textsuperscript{2}
upscale apartment in the XVI arrondissement of Paris. To our amazement, he had continued to work and had self-published four more books between his retirement and 1999.\textsuperscript{10,13–17} Couinaud welcomed us into his apartment filled with antiques. We had many questions. Our first question was, ‘How did you come up with the segment numbers? Were they numbered according to the Paris sections?’ The answer was, ‘Absolutely not. It all came from Rex’ . Couinaud went on to pull the coloured lithograph from Rex’s original article (Fig. 8).\textsuperscript{4}

Our second question regarded the caudate lobe. In the late 1990s, Couinaud had proposed a new segment IX consisting of the caudate process and paracaval caudate.\textsuperscript{18} Papers reporting segment IX had even been published in major journals and at meetings of academic societies, such as the French Academy of Surgery. The problem was that there was no defined portal triad inflow for this new segment IX. Should we really consider a new segment IX? Without real evidence to support the new segment, Claude Couinaud, in a gesture of great intelligence, retracted the concept of segment IX and wrote with us a paper that defined, once and for all, segment I as a single segment.\textsuperscript{19}

Couinaud’s work opened a new world to surgeons; his followers have since further advanced the field. The earliest Couinaud follower in the West was Henri Bismuth, who published \textit{Surgical Anatomy and Anatomical Surgery of the Liver} in 1982.\textsuperscript{20} In 2000, Steven Strasberg proposed a universal nomenclature for resection that would eliminate the word lobectomy from our vocabulary and replace it with \textit{right} hepatectomy and \textit{left} hepatectomy; he also coined the word section to describe a surgically resectable anatomical structure.\textsuperscript{21} In the East, one of the less well-known followers of Couinaud, Ken Takasaki, has published a remarkable treatise of surgical technique based on the Walean approach.\textsuperscript{22}

\begin{figure}
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\includegraphics[width=\textwidth]{Figure4}
\caption{The main plane and the sectoral anatomy of the liver were clearly described by Rex (1888).\textsuperscript{4}}
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\includegraphics[width=\textwidth]{Figure5}
\caption{Walean sheaths as depicted by Couinaud. Adapted from \textit{Le Foie. Études Anatomiques et Chirurgicales}. 1) The hilar approach. 2) The extrahepatic division of a segmental branch can also involve a branch for an adjacent segment. 3) The hilar plate. 4) Right paramedian pedicle sheath. 5) Penetration via the right portal fissure. 6) The peripheral sheath approach involves pedicle structures dedicated to a specific segment. Reprinted with permission.\textsuperscript{2}}
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\textbf{Table 2} AHPBA presidents and their major developments in HPB surgery \tabularnewline
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J. Michael Henderson – Distal splenorenal shunt \tabularnewline
William C. Meyers – Laparoscopic cholecystectomy \tabularnewline
Henry A. Pitt – Cholangiocarcinoma \tabularnewline
Steven M. Strasberg – Bile duct injuries \tabularnewline
C. Wright Pinson – Liver transplantation \tabularnewline
Theodore N. Pappas – Advanced teaching in HPB surgery \tabularnewline
Sean J. Mulvihill – Outcome studies in HPB surgery \tabularnewline
Bruce D. Schirmer – Fellowship training and accreditation \tabularnewline
Mark P. Callery – Laparoscopic evaluation in HPB \tabularnewline
W. Scott Helton – Staging and treatment of hepatocellular carcinoma \tabularnewline
Reid B. Adams – Hepatic ultrasonography \tabularnewline
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Team building

The sixth virtue is team building. Couinaud teamed up with others in his office and hunted with his dog Rama during his free time. The officers of AHPBA teamed up at the 2010 meeting of the International Hepato-Pancreato-Biliary Association (IHPBA) in Argentina. It was a turning point for AHPBA. The association was renamed: American was changed to Americas to better indicate that AHPBA is a regional association for the entire continent. The officers decided that Postgraduate Courses would be held every other year in South America. We initiated on-site collaborations with our Southern colleagues.

There was not much snow for the first Postgraduate Course in Chile in July 2011, but the course was well attended. The highlight of the course was the invocation of the newly created Chilean Chapter of AHPBA with its officers Xabier de Aretxabala, Nicolas Jaruffe and Mario Uribe. Other highlights of this year included the trips organized by the officers to Nicaragua, the Bahamas, Costa Rica and Ecuador (Table 3). Gazi Zibari joined me for the on-site collaboration to Nicaragua, a country of 6 million with one liver surgeon and only two interventional radiologists. William Jarnagin led the team to Costa Rica. Their host, Efrain Cambronero, organized the 2nd Costa Rican Gastrointestinal Oncology Congress. The team performed a combined bile duct resection with a partial hepatectomy for hilar cholangiocarcinoma.

Translational research

The seventh and last virtue is translational research. Couinaud defined the functional units of the liver but left an open field for the next generation. Five years ago, I thought we should leave molecular biology to our children. But the future is now. The goal is not to compete with basic scientists, but basic science should answer questions relevant to HPB practice. Many mutations may predict the efficacy of chemotherapy. Today, KRAS is the only mutation used by clinicians to predict a response to anti-EGFR antibodies. In colorectal liver metastases, the main question relates...
to margin width. Should it be 10 mm or less? The answer is 2–4 mm based on two studies analysing not only KRAS but multiple somatic mutations in the tissue surrounding the tumour.\textsuperscript{23,24} Recently, systematic analysis of gene mutations has become feasible with novel techniques such as mass spectrometry. These techniques may help us analyse multiple somatic mutations.\textsuperscript{25} Molecular biology may help us refine predictors of survival after resection of colorectal liver metastases. In a recent analysis of somatic mutations in a small number of patients, mass spectrometry identified mutations in 10 of 40 patients undergoing resection. The prognosis was markedly different in patients with no

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**Table 3** AHPBA onsite collaborations 2011–2012

- Ecuador – Apr. 2012 (WC Chapman, DM Nagorney, JA Lowell, B Poulose)
mutations and patients with one or more mutations (MD Anderson Cancer Center, unpublished data). HPB translational research, tying basic research with patient care, will be exciting. In colorectal liver metastases, the future may include molecular evidence for surgical procedures and peri-operative intervention (Table 4).

**Conclusion**

Claude Couinaud passed away in 2008. His remains lie almost anonymous in Bagneux cemetery: no marble, no epitaph, no flowers – just a name and two dates. I suggest an epitaph based on a quotation from one of Couinaud’s books:

> We are like dwarves sitting on the shoulders of giants. We see more things than the ancients did and see farther, but this is not effected by the keenness of our sight nor our own height: this is because they carry us elevated on the top of their gigantic height.

Bernard de Chartres (? –1124)

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**Conflicts of interest**

The authors have no conflict of interest.

**References**