
Supplementary information to:

Genomics: data sharing needs an international code of conduct

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PCAWG Evolution & Heterogeneity Working Group

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PCAWG Portals and Visualization Working Group

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PCAWG Mitochondrial Genome and Immunogenomics Working Group

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PCAWG Pathogens Working Group

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Providers of tumour-sequencing data

PCAWG Tumour-specific providers (ovarian cancer) in Australia

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PCAWG Tumour-specific providers (pancreatic cancer) in Australia

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PCAWG Tumour-specific providers (skin cancer) in Australia

Lauri A Aaltonen⁴¹⁷, Andreas Behren⁴¹⁸, Hazel Burke⁴¹⁹, Jonathan Cebon⁴¹⁸, Rebecca A Dagg⁴²⁰, Ricardo De Paoli-Iseppi⁴¹⁹, Ken Dutton-Regester²⁹⁵, Matthew A Field⁴²¹, Anna Fitzgerald⁴²², Sean M Grimmond³⁴⁸, **Nicholas K Hayward**^{#295,419}, Peter Hersey⁴¹⁹, Oliver Holmes^{295,296}, Valerie Jakrot⁴¹⁹, Peter A Johansson²⁹⁵, Hojabr Kakavand⁴¹⁹, Stephen H Kazakoff^{295,296}, Richard F Kefford⁴²³, Loretta MS Lau⁴²⁴, Conrad R Leonard^{295,296}, Georgina V Long⁴¹⁹, **Graham J Mann**^{#393,419,419}, Felicity Newell^{295,296}, Katia Nones^{295,296}, Ann-Marie Patch^{295,296}, John V Pearson^{295,296}, Hilda A Pickett⁴²⁴, Antonia L Pritchard²⁹⁵, Gulietta M Pupo³⁹³, Robyn PM Saw⁴¹⁹, Sarah-Jane Schramm³⁹³, **Richard A Scolyer**^{#409,413,419}, Mark Shackleton¹⁷⁸, Catherine A Shang⁴²², Ping Shang⁴¹⁹, Andrew J Spillane⁴¹⁹, Jonathan R Stretch⁴¹⁹, Varsha Tembe³⁹³, John F Thompson⁴¹⁹, Ricardo E Vilain⁴²⁵, Nick M Waddell²⁹⁶, Nicola Waddell^{295,296}, James S Wilmott⁴¹⁹, Scott Wood^{295,296}, Qinying Xu^{295,296} and Jean Y Yang⁴²⁶

PCAWG Tumour-specific providers (pancreatic cancer) in Canada

John Bartlett^{427,428}, Prashant Bavi⁴²⁹, Ivan Borozan⁹, Dianne E Chadwick⁴³⁰, Michelle Chan-Seng-Yue⁴²⁹, Sean Cleary^{429,431}, Ashton A Connor^{431,432}, Karolina Czajka⁷⁶, Robert E Denroche⁴²⁹, Neesha C Dhani⁴³³, Jenna Eagles⁷⁶, Vincent Ferretti^{44,65}, Steven Gallinger^{429,431,432}, Robert C Grant^{429,432}, David Hedley⁴³³, Michael A Hollingsworth⁴³⁴, **Thomas J Hudson**^{#75,76}, Gun Ho Jang⁴²⁹, Jeremy Johns⁷⁶, Sangeetha Kalimuthu⁴²⁹, Sheng-Ben Liang⁴³⁰, Ilinca Lungu^{429,435}, Xuemei Luo⁹, Faridah Mbabaali⁷⁶, **John D McPherson**^{#476,429,436}, Treasa A McPherson⁴³², Jessica K Miller⁷⁶, Malcolm J Moore⁴³³, Faiyaz Notta^{429,437}, Danielle Pasternack⁷⁶, Gloria M Petersen⁴³⁸, Michael H A Roehrl^{125,429,430,439,440,441}, Michelle Sam⁷⁶, Iris Selander⁴³², Stefano Serra³⁹⁴, Sagedeh Shahabi⁴³⁰, **Lincoln D Stein**^{#9,10}, Morgan L Taschuk⁴⁴, Sarah P Thayer⁴³⁴, Lee E Timms⁷⁶, Gavin W Wilson^{9,429}, Julie M Wilson⁴²⁹ and Bradly G Wouters¹²⁵

PCAWG Tumour-specific providers (prostate cancer) in Canada

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PCAWG Tumour-specific providers (gastric cancer) in China

Shuai Ding⁴⁴⁹, Daiming Fan⁴⁵⁰, Yong Hou^{38,235}, Yi Huang^{144,145}, Lin Li³⁸, Siliang Li^{38,235}, Dongbing Liu^{38,235}, Xingmin Liu^{38,235}, **Youyong Lu**^{#28,29,30}, Yongzhan Nie^{450,451}, Hong Su^{38,235}, Jian Wang³⁸, Kui Wu^{38,235}, Xiao Xiao¹⁴⁵, Rui Xing³⁰, **Huanming Yang**^{#38}, Shanlin Yang⁴⁴⁹, Yingyan Yu⁴⁵², Xiuqing Zhang³⁸, Yong Zhou³⁸ and Shida Zhu^{38,235}

PCAWG Tumour-specific providers (renal cancer) in the EU & France

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PCAWG Tumour-specific providers (breast cancer) in the EU & United Kingdom

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PCAWG Tumour-specific providers (malignant lymphoma) in Germany

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PCAWG Tumour-specific providers (paediatric brain cancer) in Germany

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PCAWG Tumour-specific providers (prostate cancer) in Germany

Yassen Assenov⁵⁵⁰, Benedikt Brors^{79,112,262}, Juergen Eils^{63,64}, Roland Eils^{50,52,63,64}, Lars Feuerbach¹¹², Clarissa Gerhauser²⁶⁸, Jan O Korbel^{7,8}, Chris Lawerenz⁶⁴, Hans Lehrach⁵⁴⁶, Sarah Minner⁵⁵¹,

Christoph Plass²⁶⁸, **Guido Sauter**^{#552}, Thorsten Schlomm^{107,553}, Nikos Sidiropoulos¹⁰⁸, Ronald Simon⁵⁵², **Holger Sültmann**^{#79,554}, Hans-Jörg Warnatz⁵⁴⁶, Dieter Weichenhan²⁶⁸, Joachim Weischenfeldt^{8,107,108} and Marie-Laure Yaspo⁵⁴⁶

PCAWG Tumour-specific providers (oral cancer) in India

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PCAWG Tumour-specific providers (pancreatic cancer) in Italy

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PCAWG Tumour-specific providers (biliary tract cancer) in Japan

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PCAWG Tumour-specific providers (gastric cancer) in Japan

Hiroyuki Aburatani^{#256}, Yasuhito Arai³³, Masashi Fukayama⁵⁶², Natsuko Hama³³, Fumie Hosoda³³, Shumpei Ishikawa⁵⁶³, Hitoshi Katai⁵⁶⁴, Mamoru Kato³⁵¹, Hiroto Katoh⁵⁶³, Daisuke Komura⁵⁶³, Genta Nagae^{256,267}, Hiromi Nakamura³³, Hirofumi Rokutan³⁵¹, Mihoko Saito-Adachi³⁵¹, **Tatsuhiko Shibata**^{#33,34}, Akihiro Suzuki^{256,565}, Hirokazu Taniguchi³⁴, Kenji Tatsuno²⁵⁶, Yasushi Totoki³³, Tetsuo Ushiku⁵⁶², Shinichi Yachida^{33,566} and Shogo Yamamoto²⁵⁶

PCAWG Tumour-specific providers (liver cancer) in Japan

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PCAWG Tumour-specific providers (biliary tract cancer) in Singapore

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PCAWG Tumour-specific providers (blood cancer) in South Korea

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PCAWG Tumour-specific providers (chronic lymphocytic leukaemia) in Spain

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PCAWG Tumour-specific providers (bone cancer) in the United Kingdom

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PCAWG Tumour-specific providers (chronic myeloid disorders) in the United Kingdom

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PCAWG Tumour-specific providers (oesophageal cancer) in the

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Integration, phasing, and validation of germline variant callsets

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De La Vega^{45,46,76}, Xavier Estivill^{47,82} and Jan O Korbelt^{7,8}

Validation, benchmarking and merging of somatic variant calls

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Data and code availability

Junjun Zhang¹⁵, Christina K Yung¹⁵, Sergei Yakneen⁸, Denis Yuen¹¹, George L Mihaiescu¹⁵, Larsson Omberg⁸³ and Vincent Ferretti^{15,84}

Scientific insights from PCAWG data

Pan-cancer burden of somatic mutations

Junjun Zhang¹⁵ and Peter J Campbell^{1,2}

Panorama of driver mutations in human cancer

Radhakrishnan Sabarinathan^{85,86,87}, Oriol Pich^{85,87} and Abel Gonzalez-Perez^{85,87,88}

PCAWG tumours with no apparent driver mutations

Esther Rheinbay^{3,6,18}, Amaro Taylor-Weiner³, Radhakrishnan Sabarinathan^{85,86,87}, Peter J Campbell^{1,2} and Gad Getz^{3,4,5,6}

Patterns and oncogenicity of kataegis and chromoplexy

Matthew W Fittall⁸⁹, Jonas Demeulemeester^{89,90}, Maxime Tarabichi^{2,89}, Nicola D Roberts², Peter J Campbell^{1,2}, Jan O Korbelt^{7,8} and Peter Van Loo^{89,90}

Patterns and oncogenicity of chromothripsis

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Timing clustered mutational processes during tumour evolution

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Germline genetic determinants of the somatic mutation landscape

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Replicative Immortality

David Haan⁹, Lina Sieverling^{126,127}, Lars Feuerbach¹²⁶, Lincoln D Stein^{11,12} and Joshua M Stuart^{9,10}

Box 1: Ethical considerations of genomic cloud computing

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Box 2: Online resources for data access, visualisation, exploration and analysis

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Supplementary Methods

Pilot-63 Analysis

1.1 Validation Process

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Sahinalp^{144,152,153}, Iman Sarrafi^{144,153}, Chip Stewart³, Miranda D Stobbe^{49,73}, Grace Tiao³, Jeremiah A Wala^{3,6,154}, Jiayin Wang^{27,58,155}, Wenyi Wang³², Sebastian M Waszak⁸, Joachim Weischenfeldt^{8,97,98}, Michael C Wendt^{27,35,156}, Johannes Werner^{28,157}, Zhenggang Wu¹⁴⁵, Hong Xue¹⁴⁵, Sergei Yakneen⁸, Takafumi N Yamaguchi¹¹, Kai Ye^{58,59}, Venkata D Yellapantula^{35,67}, Junjun Zhang¹⁵, David A Wheeler^{33,34}, Li Ding^{26,27,35} and Jared T Simpson^{11,36}

1.2 Processing of Validation Data

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2. Whole Genome Sequencing Somatic Variant Calling

Junjun Zhang¹⁵, Christina K Yung¹⁵ and Solomon I Shorser¹¹

2.1 Whole Genome Alignment

Keiran M Raine², Junjun Zhang¹⁵ and Brian D O'Connor^{15,37}

Variant Calling Pipelines Used During Production

2.2.1 DKFZ Pipeline

Kortine Kleinheinz^{28,30}, Tobias Rausch⁸, Jan O Korbel^{7,8}, Ivo Buchhalter^{28,29,30}, Michael C Heinold^{28,30}, Barbara Hutter^{137,146,147}, Natalie Jäger²⁸, Nagarajan Paramasivam^{28,137} and Matthias Schlesner^{28,31}

2.2.2 EMBL Pipeline

Joachim Weischenfeldt^{8,97,98}

2.2.3 Sanger Pipeline

Keiran M Raine², Jonathan Hinton², David R Jones², Andrew Menzies² and Lucy Stebbings²

2.2.4 Broad Pipeline

Gordon Saksena³, Dimitri Livitz³, Esther Rheinbay^{3,6,18}, Julian M Hess^{3,149}, Ignaty Leshchiner³, Chip Stewart³, Grace Tiao³, Jeremiah A Wala^{3,6,154}, Amaro Taylor-Weiner³, Mara Rosenberg^{3,18}, Andrew J Dunford³, Manaswi Gupta³, Marcin Imielinski^{162,163}, Matthew Meyerson^{3,6,154}, Rameen Beroukhim^{3,6,164} and Gad Getz^{3,4,5,6}

2.2.5 MuSE Pipeline

Yu Fan³² and Wenyi Wang³²

2.3 Consensus Somatic SNV/Indel Annotation

Andrew Menzies², Matthias Schlesner^{28,31}, Jüri Reimand^{11,17}, Priyanka Dhingra^{70,72} and Ekta Khurana^{69,70,71,72}

2.4.1 Somatic SNV and indel Merging

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2.4.2 Somatic SV Merging

Joachim Weischenfeldt^{8,97,98}, Francesco Favero¹⁶⁵ and Yilong Li²

2.4.3 Somatic Copy Number Alteration Merging

Stefan C Dentro^{2,65,89}, Jeffrey A Wintersinger^{36,166,167} and Ignaty Leshchiner³

2.5.3 Oxidative Artefact Filtration

Dimitri Livitz³, Ignaty Leshchiner³, Chip Stewart³, Esther Rheinbay^{3,6,18}, Gordon Saksena³ and Gad Getz^{3,4,5,6}

2.5.4 Strand Bias Filtration

Matthias Bieg^{136,137}, Ivo Buchhalter^{28,29,30}, Johannes Werner^{28,157} and Matthias Schlesner^{28,31}

2.6 miniBAM generation

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3. Germline Variant Identification from WGS

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4. RNA-Seq analysis

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5. Clustering of tumour genomes based on telomere maintenance-related features

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6. Clustered mutational processes in PCAWG

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Korbel^{7,8} and Peter Van Loo^{89,90}

7. Tumours without detected driver mutations

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8. Panorama of driver mutations in human cancer

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SUPPLEMENTARY NOTES

1. Pilot-63 benchmarking, variant consensus development and validation

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4. Production somatic variant calling on the PCAWG Compute Cloud

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Steven J Newhouse⁷, David Torrents^{40,74} and Lincoln D Stein^{11,12}

5. PCAWG data portals

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Denotes a **working group or project co-leader**

* Denotes a *junior scientist* who made major contributions to the section

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