Clinical genetic care in diseases predisposing to sudden cardiac death
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Preferences of cardiologists and clinical geneticists for the future organisation of genetic care in hypertrophic cardiomyopathy: a survey

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Abstract

Objectives: In view of the increasing demands for genetic counselling and DNA diagnostics in cardiogenetics, the roles of cardiologists and clinical geneticists in the delivery of care need to be redefined. We investigated the preferences of both groups of professionals with regard to the future allocation of six cardiogenetic responsibilities in counselling and testing, using hypertrophic cardiomyopathy (HCM) as a prevalent model disease.

Design: Cross-sectional survey.

Participants: Dutch cardiologists (n=643) and clinical geneticists (n=60), all members of professional societies.

Results: Response rates were 33 and 82%, respectively. In both groups, the majority preferred to perform most of the tasks described above in collaboration. Informing HCM patients about the genetics of HCM and requesting DNA testing in symptomatic patients was viewed by 43 and 35% of cardiologists, respectively, as their sole responsibility, however, and 39 and 59% of clinical geneticists did not object to these views. Both groups felt that the task of discussing the consequences of HCM for offspring and that of discussing the results of DNA diagnostics should be shared or performed by clinical geneticists. Both groups considered co-ordination of family screening the sole responsibility of clinical geneticists. Opinions on who should request DNA diagnostics in asymptomatic relatives were divided: 86% of clinical geneticists considered it their exclusive responsibility, 10% of cardiologists believed that this task could be performed individually by either group and 30% preferred to collaborate. Most professionals said that they would appreciate education programmes and clinical guidelines.

Conclusion: Both cardiologists and clinical geneticists prefer to share rather than divide most cardiogenetic responsibilities in caring for HCM patients. Consequently, capacity problems in both groups are to be expected. To safeguard current professional standards in genetic counselling and testing, deployment of non-medical personnel might be essential.
**Introduction**

Genetics has come of age: genes for common diseases are discovered, DNA diagnostics have become accessible for clinical use and genetic knowledge increasingly becomes part of routine preventive and clinical practice [1]. Traditionally, clinical geneticists (and, more recently, genetic counsellors in some countries) were superspecialists who took full responsibility for both genetic counselling and testing, and consequently, it is professionals in the field of clinical genetics who developed guidelines for preconception and predictive testing and counselling in various diseases in collaboration with other professionals [2–4].

The aim of genetic counselling has been defined in various ways. In a nutshell, this aim is to enable patients to make an informed choice on the basis of extensive delivery of information, respect for the patient's autonomy, non-directiveness of advice and choice-independent psychosocial support, taking into account family dynamics [5–9].

In the last decade, developments in the field of oncogenetics, in particular the discovery of genes predisposing for hereditary breast/ovarian and colorectal cancer, have resulted in an unprecedented increase in referrals for genetic counselling and predictive DNA testing, such that the minimal requirements for adequate and timely genetic care can barely be met [10, 11]. The next expansion of clinical genetic care is already pending: in cardiogenetics, the discovery of genes responsible for relatively rare hereditary primary arrhythmias (e.g. the long QT and Brugada syndromes) and common cardiomyopathies, as in oncogenetics, has led to pleas for screening, monitoring and treatment of mutation carriers [1, 12–16].

Cardiogenetic care in hypertrophic cardiomyopathy (HCM) may currently be the main challenge in numerical terms: the estimated carrier prevalence is at least one in 500, with the majority of carriers yet to be identified [17]. Diagnostic DNA testing in HCM, currently the clinical geneticists' sole responsibility in the Netherlands, enables the identification of the causative mutation in the majority of patients now, rendering cascade screening of relatives a literally viable option. With an expected exponential increase in demand for cardiogenetic counselling and testing, organizational adaptations will be inevitable, e.g. the involvement of more clinical geneticists and co-workers and, possibly, of cardiologists.

Rethinking future cardiogenetic care, we can formulate the following questions:

1. Are cardiologists willing to take joint responsibility for genetic care? If this is the case, what model do they prefer?
2. Are clinical geneticists willing to transfer some of their current responsibilities, and which task(s) do they perceive as their core business, not to be taken over by other medical specialists?

To find an answer to these questions, we investigated the views of Dutch cardiologists and clinical geneticists on their future roles, responsibilities and needs in the various stages of cardiogenetic care, with HCM as a prevalent model disease, and analysed their preparedness to change and to make adaptations in their professional responsibilities.
Methods

Background

Eight clinical genetic centres, all attached to university hospitals, currently deliver clinical genetic care in the Netherlands. DNA diagnostics are always integrated with genetic counselling. For complex genetic counselling and clinical genetic testing, permission from the Dutch Minister of Health is required. Only clinical geneticists employed in clinical genetic academic medical centres may provide complex genetic counselling within the scope of predictive molecular testing [18, 19]. For a decade now, genetic counsellors (the majority having a paramedical or nursing background) have taken part in genetic counselling, under the supervision of clinical geneticists. Dutch cardiologists are not expected to request molecular testing in their HCM patients independently. Due to agreements with the health insurance companies dating from 1995, they have to refer these patients to clinical geneticists [20]. Sufficient facilities for DNA testing, genetic counselling and monitoring are available. Counselling as well as DNA testing is reimbursed under the fee-for-service remuneration system.

In the case of cardiogenetics, in most centres regular joint outpatient clinics are held in the presence of a clinical geneticist and a cardiologist at the same session, with the involvement of psychosocial workers where needed. Given the still very specialized character of diagnosing and DNA testing in cardiogenetics, the role of general practitioners in cardiogenetic care is currently highly limited. In 1996, when we started the first Dutch cardiogenetic outpatient clinic in our Amsterdam hospital, 5% of new counselling sessions related to cardiological problems. In 2004, these numbers had increased to 25% (345 of 1376 sessions). Nationally, these numbers are steadily increasing as well (with 989 cardiogenetic sessions out of 15,916 new counselling sessions in 2003).

Survey

We developed a dedicated questionnaire to assess the views of cardiologists and clinical geneticists on their involvement in the following successive stages of cardiogenetic counselling and testing, selecting HCM as a model disease:

1. Informing the symptomatic HCM patient about the hereditary nature of the disease.
2. Discussing the consequences of HCM carriership for existing and/or future offspring with the symptomatic patient.
3. Requesting DNA diagnostics in the symptomatic HCM patient.
4. Interpreting and discussing the results DNA of diagnostics with the symptomatic patient.
5. Co-ordinating family (cascade) screening.
6. Requesting DNA diagnostics for asymptomatic relatives (predictive testing and counselling, cascade screening).

'Symptomatic' is defined here as 'being under the surveillance of a cardiologist and showing clinical signs of the disease' (complaints and/or signs of HCM at cardiological testing).

The response mode to the question 'Which professional(s) has (have) to take responsibility?'
for each particular stage was formulated follows:
1. The cardiologist should perform this task,
2. The clinical geneticist should perform this task
3. Both professionals should collaborate symmetrically, or
4. Each professional may individually perform the task, depending on the situation at hand

The option of using genetic counsellors for these tasks was deliberately left out, because the primary aim of this study was to investigate the perceived final responsibilities of cardiologists and clinical geneticists in cardiogenetic care beyond the mere practical execution.

We also investigated the views of cardiologists and clinical geneticists regarding four preformatted non-exclusive measures to improve cardiogenetic care for HCM patients. Additional comments on preformatted answers were encouraged. Also added were questions on the respondents' characteristics and caregivers' experience with HCM patient care.

The feasibility of the questionnaire was tested among 20 cardiologists attending a genetics course. Their remarks were noted, and adaptations were made accordingly. The questionnaire is available on request free of charge.

Questionnaire management

Questionnaires were mailed to all 800 members of the Dutch Society of Cardiology (NVvC). Approximately, 70% of these members are clinical cardiologists, covering 90% of all 643 cardiologists in the Netherlands. Similar questionnaires were sent to all 60 members of the Dutch Society of Clinical Genetics (VKGN). The VKGN consists of all clinical geneticists (57 clinical geneticists and three paediatricians who work as clinical geneticists) actively involved in patient care in the Netherlands. Both professions were informed of the aim of the study by a cover letter and were invited to respond to the questionnaire anonymously. The NVvC supplied reference data on the age and the gender of the cardiologists; reference data for clinical geneticists were unavailable. Reminders were sent twice to the cardiologists and once to the clinical geneticists.

Analysis

The chi-square-test was used to analyse differences in preferred allocation of responsibilities between professions and the effects of caregivers' gender and experience with HCM patient care ('experienced' being defined as having at least 10 HCM patients in care annually) on the preferred allocation of responsibilities. A two-sided p-value of <0.05 was considered statistically significant. Selective participation was checked by comparing the age distributions – a proxy for education and experience – of the responding and non-responding cardiologists.
Results

The views of 49 actively working clinical geneticists (response rate 82%) and 189 cardiologists (response rate 33%) were analysed. The age distribution in both groups was similar (mean 44 vs 46 years). Sixty-seven percent of clinical geneticists and 12% of cardiologists were female. Sixty-seven per cent of responding cardiologists had patients with HCM under surveillance; the median number of HCM patients was five. The majority of cardiologists reported that most of their HCM patients were (very) mildly affected. Twenty-three per cent of responding cardiologists were working in university hospitals.

Cardiologists' response rates may seem low but are perfectly comparable with response rates in other surveys in which no incentives for response were given. More importantly, the age and gender distributions of the participating and nonparticipating cardiologists did not differ, indicating that our sample may be representative of all invited cardiologists. Reasons why the non-participants did not respond could not be investigated as the survey was fully anonymous and non-responding cardiologists could not be identified nor reminded individually.

Figure 1 displays the views of clinical geneticists and cardiologists, both between and within professional groups, with regard to the six successive stages in cardiogenetic care. Forty-three per cent of the cardiologists felt that informing HCM patients about the hereditary nature of their disease should be the sole responsibility of cardiologists, while only 6% of clinical geneticists shared that view (p < 0.001). About half of the clinical geneticists (46%) and cardiologists (41%) preferred the collaborative model according to which both specialists are mutually responsible. According to 33% of clinical geneticists, either profession might give information about heredity depending on the situation at hand. Only 15% of the clinical geneticists regarded informing symptomatic HCM patients about the hereditary aspects of their disease as their sole responsibility.

There was considerable disagreement within each profession regarding the discussion of the consequences of HCM for offspring. Almost half of the specialists (45% of cardiologists and 41% of clinical geneticists) preferred collaboration, but a sizeable proportion (35% of cardiologists and 51% of clinical geneticists) considered that task to be the sole responsibility of clinical geneticists.

Both professions expressed significantly different views regarding requesting DNA diagnostics for symptomatic patients (p < 0.001). Approximately, one-third of each profession (34% of cardiologists and 33% of clinical geneticists) preferred the collaborative model. Thirty-five per cent of cardiologists considered requesting DNA diagnostics in HCM patients as their sole responsibility, however, while only 12% of clinical geneticists entirely shared that view. By contrast, 47 percent of clinical geneticists chose the option each professional may individually perform the task, depending on the situation at hand; which may be more in line with the cardiologists' views.

More than half of both specialists (52% of cardiologists and 53% of clinical geneticists) preferred to collaborate in the interpretation and discussion of the results of DNA diagnostics with the symptomatic HCM patient. Approximately, one-third (35% of cardiologists and 29% of clinical geneticists) viewed that task as the exclusive responsibility of clinical geneticists.
Figure 1. Proposed allocation of cardiogenetic responsibilities in HCM, as desired by clinical genetics and cardiologists respectively

<table>
<thead>
<tr>
<th>Task</th>
<th>Percentage clinical geneticists</th>
<th>Percentage cardiologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inform patient about the hereditary nature of HCM</td>
<td>15 &amp; 6</td>
<td>9 &amp; 43</td>
</tr>
<tr>
<td>Discuss consequences HCM for offspring</td>
<td>2 &amp; 35</td>
<td>9 &amp; 45</td>
</tr>
<tr>
<td>Request DNA diagnostics for symptomatic patient</td>
<td>8 &amp; 12</td>
<td>33 &amp; 75</td>
</tr>
<tr>
<td>Interpret and discuss the results of DNA diagnostics with patient</td>
<td>29 &amp; 35</td>
<td>35 &amp; 52</td>
</tr>
<tr>
<td>Coordinate family screening</td>
<td>83 &amp; 2</td>
<td>70 &amp; 6</td>
</tr>
<tr>
<td>Request DNA diagnostics for asymptomatic family members</td>
<td>2 &amp; 8</td>
<td>19 &amp; 8</td>
</tr>
</tbody>
</table>
Regarding the co-ordination of family (cascade) screening, a majority of both specialists (70% of cardiologists and 83% of clinical geneticists) viewed that task as the sole responsibility of clinical geneticists.

Almost all clinical geneticists (86%) viewed requesting DNA diagnostics for asymptomatic family members as their sole responsibility; 53% of cardiologists shared that view. Thirty percent of cardiologists compared with 8% of clinical geneticists preferred to collaborate. Between the professions, opinions differed significantly (p < 0.001).

Personal background influenced opinions to some extent: experienced cardiologists (about 8% of their group) more often preferred collaboration options compared with their less experienced colleagues. Owing to small numbers of experienced cardiologists, significance was reached only for the task requesting DNA diagnostics for symptomatic patients (30.8% of non-experienced cardiologists vs 60% of those experienced in HCM preferred to collaborate, p = 0.021). Apparently, the collaborative model is appreciated in particular by experienced cardiologists, the majority of whom are already involved in cardiogenetic outpatient clinics.

Table 1 summarizes respondents' views on four measures to improve cardiogenetic care in HCM. Both professions reported a need for regular refresher education courses (95% of cardiologists and 84% of clinical geneticists) and for clinical genetic guidelines on HCM (94% of cardiologists and 77% of clinical geneticists). Cardiologists more often (84%) reported a need for improving access to existing knowledge than clinical geneticists (37%). Improving interdisciplinary working relationships was considered desirable albeit less urgent (67% of cardiologists and 48% of clinical geneticists).

<table>
<thead>
<tr>
<th>Proposed measure</th>
<th>Clinical geneticist (%)</th>
<th>Cardiologist (%)</th>
<th>Clinical geneticist (%)</th>
<th>Cardiologist (%)</th>
<th>Clinical geneticist (%)</th>
<th>Cardiologist (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular refresher education courses about HCM and genetics</td>
<td>41 (84)</td>
<td>179 (95)</td>
<td>1 (2)</td>
<td>2 (1)</td>
<td>7 (14)</td>
<td>8 (4)</td>
</tr>
<tr>
<td>Developing clinical guidelines regarding the use of genetic knowledge in HCM patients and their families</td>
<td>37 (77)</td>
<td>178 (94)</td>
<td>5 (10)</td>
<td>4 (2)</td>
<td>6 (13)</td>
<td>6 (3)</td>
</tr>
<tr>
<td>Improving access to existing knowledge (e.g. website)</td>
<td>18 (37)</td>
<td>159 (84)</td>
<td>16 (33)</td>
<td>12 (6)</td>
<td>15 (31)</td>
<td>17 (9)</td>
</tr>
<tr>
<td>Changing or improving current working relationships</td>
<td>23 (48)</td>
<td>127 (67)</td>
<td>11 (23)</td>
<td>27 (14)</td>
<td>14 (29)</td>
<td>34 (18)</td>
</tr>
</tbody>
</table>

*Missing values per question range from 0 to 2.
Discussion

Our survey addressed the preferences of the medical specialists involved for the organization of cardiogenetic care in the Netherlands, one of the few countries where cardiogenetic care for HCM patients has been reimbursed from the time that scientific developments enabled molecular genetic testing in increasing numbers of patients.

Admittedly, our health care system differs from that in other countries, and compared with many other countries, our cardiogenetic health care system is relatively well developed and facilitated. By contrast, Dutch cardiologists are currently less involved in genetic testing than their colleagues in other countries, due to restrictive reimbursement of molecular testing and of genetic counselling. Genetic testing for HCM in the UK is still in its pilot stage (within the scope of the London IDEAS HCM programme, as part of a British Heart Foundation programme). Cardiologists are already involved in genetic testing, however. In the US, predictive genetic testing is not yet covered by Medicare, and private health plans are highly influenced by Medicare policy [21]. In France, the situation is comparable with that in the Netherlands [14].

Commercial molecular testing for HCM is currently offered by DNA laboratories in the Netherlands, the UK (Cambridge), the US (Harvard), Norway (Oslo), Germany (Goettingen) and Spain (Madrid), according to the GeneTests and Eddnal websites [22]. We are aware that some of the results of our survey may relate specifically to the Netherlands. Nevertheless, we show how professions envisage the organization of cardiogenetic care when faced with the rapid accumulation and dissemination of knowledge about genetic disease in clinical practice. Other countries will face similar changes in the near future once facilities and financial means have become widely available.

According to the survey, there is room for change in the organization of cardiogenetic care. The majorities in both professions clearly express a sense of mutual responsibility, the intention to collaborate and the willingness to share tasks. However, the extent to which professions are prepared to transfer and take responsibilities differs according to the stage of the cardiogenetic counselling and testing process. Although many clinical geneticists are prepared to transfer the first stages of cardiogenetic care aimed at symptomatic HCM patients, and cardiologists are often willing to assume full responsibility, many other professionals prefer a shared collaborative model. Symmetric collaboration in discussing the consequences of the disease for (future) offspring is advocated as well, although one-third of cardiologists and the majority of clinical geneticists prefer the current soloist role of clinical geneticists in this regard. Requesting DNA diagnostics in symptomatic HCM patients is regarded by many as the (future) responsibility of cardiologists, but the interpretation and discussion of the results should be a collaborative effort of clinical geneticists and cardiologists. According to this survey, both professions agree that the co-ordination (organization) of family screening (cascade screening) should remain the sole responsibility of clinical geneticists. Experienced cardiologists prefer to collaborate even more than their less experienced colleagues. This may be due to the fact that they are more acquainted with the clinical genetic profession already and therefore are familiar with the requirements of predictive testing and the way geneticists can collaborate in or take over this time-consuming task, which may also be less in line with the cardiologists' job expectations [23].

Professions obviously disagree about who should be responsible for the next step, genetic
counselling and predictive DNA testing in asymptomatic family members, potentially the most
time-consuming job in cardiogenetics. The numbers of mutation carriers yet to be identified
are large, and the demands for proper pre-test and post-test counselling are considerable if
professional clinical genetic standards are to be upheld. Almost half of cardiologists prefer
either sole or joint responsibility in collaboration with clinical geneticists, but clinical geneticists
strongly prefer to keep all steps in cascade screening a clinical geneticist’s responsibility.

These different views may originate from the different practice models in which each
profession works. Cardiologists work in a medical model where many evidence-based choices
are regarded as obvious, whereas clinical geneticists work in a counselling model in which
choices (even regarding DNA testing for preventable or treatable diseases) lack default answers
and actions. Many cardiologists are currently unaware of the paradigms of genetic counselling
and testing and may not feel at ease with its client centredness and its focus on information;
in their view, predictive DNA testing is more like standard prevention, with emphasis on the
reduction of morbidity and mortality, and less emphasis on informed choice [23, 24]. Moreover,
cardiologists in the Netherlands and, to our knowledge, in other countries as well are not
(yet) reimbursed for genetic counselling tasks, so that the time demands of genetic services
according to current standards provide a strong economic disincentive to introducing clinical
genetic standards in cardiology and other specialities as well [25]. These factors may hamper
the proper transfer of responsibilities between professions.

Clinical geneticists, on the one hand, understandably fear erosion of the high standards that
currently characterize their professional behaviour, and this is probably the reason why they
choose to keep the tasks of predictive counselling and testing for themselves. On the other
hand, we believe that clinical geneticists must accept that rapid accumulation of knowledge
about genes and genetic disease will indeed alter their profession in many specialist areas, as
genetic knowledge also changes many presymptomatic traits into treatable disorders. As a
result, pre-test counselling in HCM testing and the consent procedures for diagnostics in non-
inherited chronic diseases, with which cardiologists are more familiar, increasingly converge. In
this respect, the views of cardiologists on their responsibilities in cardiogenetics mirror earlier
changes in oncogenetic and familiar hypercholesterolaemia testing, where opportunities for
prophylaxis and treatment have increased the roles of non-genetic specialists in genetic care.

The first task that could profitably be transferred to the cardiologists is the responsibility
in requesting DNA diagnostics in symptomatic HCM patients, provided that cardiologists gain
knowledge about the informed consent procedures concerned.

Nowadays, Dutch cardiologists care for a median of five HCM patients per cardiologist, and
only 8% of cardiologists take care of more than 10 patients [23]. About 29,000 Dutch HCM mutation
carriers have yet to be identified, resulting in 90 relatives of HCM patients per cardiologist (or
966 relatives per clinical geneticist) to be counselled and tested. Given the autosomal dominant
mode of inheritance, each cardiologist has to care for approximately 45 carriers in annual follow-
up according to the HCM consensus guidelines [17]. The current working force of cardiologists
and clinical geneticists is far too small to accomplish that formidable task, particularly when the
preference for collaborative care at the critical stages and the preservation of key values of genetic
counselling (informed choice) are also taken into account.
Three measures to cope with the discrepancy may be considered. Firstly, an absolute increase in the working force of cardiologists and clinical geneticists in the long term is inevitable. Secondly, the stringent consensus guidelines for annual cardiological follow-up of mutation carriers may be loosened in selected carriers (e.g. by individual or familial risk stratification). Finally, assistance of specialized genetic counsellors who are knowledgeable in cardiology and genetic counselling might be considered, thereby separating execution of task from responsibility. This second stage of transfer and assimilation of care from medical to nursing or paramedical personnel has proved valuable in the management of heart failure in cardiology and in genetic testing in oncogenetics [26–31]. Specialized genetic counsellors can organize and perform family screening, provide continuous education to cardiologists in academic and non-academic hospitals and continuity in follow-up and treatment of mutation carriers and prevent compliance problems such as the ones that were described in carriers of familial hypercholesterolaemia [32]. In this way, efficiency and capacity will be enhanced, and cardiologists will become increasingly involved without the crowding-out of the key values of genetic counselling defended by the clinical genetic profession. Genetic counsellors without a nursing background, increasingly employed in Anglo-American countries and of great use in other branches of genetic counselling, would seem to be less equipped for this cardiogenetic 'liaison' work, because they lack the medical background needed for these tasks. Moreover, cardiologists are expected to more readily accept the assistance and interference of nurses (preferably with experience in cardiology). Interdisciplinary working groups of cardiologists, clinical and molecular geneticists, genetic counsellors, psychosocial workers and patients may serve as think tanks for the reorganization of care and the development of guidelines.

The transitions of professional responsibilities, induced by the expansion of applicable genetic knowledge and inevitably leading to adaptations in the organization of care, are obviously not restricted to cardiogenetics only. The same developments are to be expected in other clinical fields, as soon as the genetic aspects of other preventable and/or treatable monogenetic and multifactorial diseases are unravelled and also when currently untreatable diseases of which the genetic aspects are already clear become treatable.

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