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Silicone Gel Breast Implant Adverse Event Reports to the Food and Drug Administration, 1984–1995

SYNOPSIS

Objectives. To characterize the adverse event reports on silicone gel breast implants (SGBIs), including death reports, submitted to the Food and Drug Administration (FDA) from 1984 through 1995 and to analyze changes in the type and complexity of reports following extensive media coverage of breast implants.

Methods. The authors analyzed mandatory and voluntary reports from the adverse events reporting system for medical devices at the FDA.

Results. In 1988, adverse event reports related to SGBIs accounted for 2.4% of the 14,473 mandatory reports entered into the FDA database on medical devices. In 1992, SGBI-related reports accounted for 30.3% of the total 66,476 mandatory reports of adverse events. The most frequently reported adverse event in 1988, before the widespread publicity on breast implants, was implant *burst* or rupture. In contrast, in 1992 the most frequently reported event was *reaction*, a term used to describe a range of adverse effects.

Conclusions. The numbers of mandatory and voluntary reports of SGBI-related adverse events increased exponentially, as did the complexity of the reports, following publicity over the lack of safety data on breast implants and a short voluntary moratorium on their sale. A significant proportion of reports lacked information on specific medical symptoms or diagnoses.

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Silicone gel-filled breast implants (SGBI), which are composed of a silicone elastomer envelope filled with silicone gel,[1] have been marketed in the United States since 1962. The estimated prevalence of breast implants was 1% of the adult female population, or about 1 million women, as of the late 1980s and early 1990s.[2-5] Breast implants may be used after mastectomy related to breast cancer or fibrocystic breast disease, or after traumatic accidents resulting in the loss of the breast or other medical conditions, but it has been estimated that up to 80% of breast implants are performed for cosmetic breast enlargement.[6]

Implantable breast prostheses are medical devices and as such became subject to regulation by the Food and Drug Administration (FDA) in 1976 with the passage of the Medical Device Amendments. Medical devices that had been marketed prior to the passage of the Amendments were allowed to stay on the market, but manufacturers were required to provide scientific evidence of the safety and effectiveness of their devices to the FDA.

In 1978, the FDA General and Plastic Surgery Devices Panel recommended that breast implants be classified as Class II medical devices—devices for which the safety and effectiveness is well established but that require special measures to control risks. (These special measures for Class II devices may include performance standards, postmarket surveillance studies, user education, or other measures.) The FDA disagreed with that recommendation and, after providing an opportunity for public comment, designated breast implants as Class III medical devices, necessitating the submission of a premarket approval to establish the safety and effectiveness of these devices after a required minimum 30-month waiting period.

In late 1991, after reviewing the data submitted by breast implant manufacturers, the General and Plastic Surgery Devices Panel voted that manufacturers had not presented adequate scientific data to support the safety and effectiveness of breast implants but recommended that these devices should stay on the market while adequate data were being collected.

In January 1992, the FDA called for a voluntary moratorium on the use of SGBIs until emerging information could be reviewed by the Panel. In February 1992, the Panel met again and advised the FDA to restrict the use of SGBIs to women who need them for reconstruction after mastectomy or for other medical purposes until adequate data on their safety and effectiveness can be collected.[6-11] (For the current status of other breast implants, see the Breast Implants Information Update on the FDA website at **www.fda.gov/oca/hotopics.htm**.)

Reporting adverse events. Manufacturers, health care providers, and consumers have been voluntarily reporting adverse events associated with medical devices since 1973, initially filing them through the Problem Reporting Program and after 1993, through the FDA MedWatch program. Mandatory reporting for medical devices was initiated with the MDA of 1976, but it was not until 1984 that the final reporting regulations were implemented. Under these regulations, manufacturers and importers were required to report to the FDA when they became aware of information which reasonably suggested that one of their marketed devices might have caused or contributed to a death or serious injury. Manufacturers were also required to report any malfunction of the device, defined as failure to meet performance specifications or to perform as intended, if the malfunction would be likely to cause or contribute to a death or serious injury if it were to recur. The rules were revised in 1993 to require distributors to report *deaths* and *serious illnesses or injuries* to the FDA and the manufacturer and to report *malfunctions* to the manufacturer only. In 1995, the rules were extended to include mandatory reports from facilities such as hospitals, ambulatory surgical facilities, outpatient diagnostic and treatment facilities, and nursing homes. The FDA continues to accept voluntary reports, typically from health care providers and consumers.

In 1995, the FDA first accepted summary reports from manufacturers on some frequently reported adverse events related to breast implants because there was so much repetition of the same types of reports. Manufacturers summarized the counts of these frequently reported events (such as ruptures, leaks, or capsular contracture [contraction of the scar capsule around the implant, which causes pain, hardness, or distortion of the breast]) in the form of quarterly reports to the FDA.

Both mandatory and voluntary reports of adverse events associated with medical devices are entered into a computer database at the Center for Devices and Radiological Health. The Center uses a code list of a few hundred terms and descriptive keywords or phrases that summarized the central adverse event in each report; staff assigned the relevant code(s) to each adverse report as it was entered into the database.

For the present study, we retrieved all reports of SGBI-related adverse events submitted to the FDA from 1984 through 1995. We first determined the number of

"Implantable breast prostheses are medical devices... subject to regulation by the Food and Drug Administration."

mandatory and voluntary reports by year, then characterized the mandatory reports by type of event (injury, malfunction of device, or death). We also characterized both mandatory and voluntary reports by the primary adverse event reported. We then looked at changes in adverse event reports from 1988 through 1992, before and after the 1991–1992 barrage of publicity on breast implants. The media coverage reflected concern about the safety of these devices. We were therefore interested in finding out if the adverse events entered in the database prior to the media coverage were different from those entered afterward. Because the most frequently reported adverse event in 1992 was described by the uninformative term "reaction," we characterized a sample of the *reaction* reports entered in 1988, 1990, and 1992 to compare pre- and post-publicity reports. The number of signs, symptoms, or diagnoses listed in these *reaction* reports were also examined to try to characterize the complexity of the reports. We also characterized the mandatory reports of deaths of women with SGBIs with respect to the reported cause of death and the complexity of the death reports.

The limitations of adverse event report data must be acknowledged. First, many adverse events are unreported. Second, the counts of reported events do not represent incidence rates for a given problem in the absence of a clearly defined denominator—the number of individuals at risk for a given adverse event. And finally, these reports do not establish a causal link between a death or injury and the listed device; they simply make the assertion that a device was in use when the event occurred. Even thousands of reports cannot establish a causal link, yet these mandatory and voluntary reports are useful for generating hypotheses that can be tested in epidemiologic or controlled laboratory studies.

METHODS

Characterization of adverse event reports. We retrieved all SGBI-related reports entered in the FDA's mandatory reporting system between December 13, 1984, and December 31, 1995. We sorted the mandatory reports by year, report type (death, injury, device malfunction), and code and sorted both mandatory and voluntary reports by the primary adverse event reported.

Pre- and post-publicity. To examine the differences in adverse event reports before and after widespread publicity over adverse events related to SGBIs, we compared the one-year periods from January 1 through December 31 for the years 1988, 1990, and 1992.

Analysis of reaction reports. Because the most frequently recorded code overall in the mandatory reports was *reaction* (see Results), we performed separate analyses of a subset of the reports to which the *reaction* code was assigned—all reports for the years 1988 and 1990 and a sample of the 1992 reports. We entered the signs as observed by medical providers, symptoms as described by patients, and diagnoses listed in these reports into an EpiInfo database and analyzed the types of signs/symptoms/diagnoses described, the number of signs/symptoms/diagnoses described, and the type of SGBIs involved (see below for a description of types).

Historically, coding of adverse events associated with medical devices has described the event in terms of the device rather than the patient for devices such as wheelchairs, splints, electrode cables, heating pads, diagnostic kits, and magnetic resonance imaging equipment. In most cases, the codes used for SGBI-related adverse events focused on the device; for example, the code *burst* refers to the implant (not the patient!) bursting.

Reaction was defined in the code list as "adverse effect, irritation, swelling." Given that most event codes were descriptions of what happened to the device rather than what happened to the patient, this code was selected by the coder when there was no description of the event in terms of the device. The adverse events reported under this code are consequently very broad and do not provide specific information about the patient.

We first reviewed all mandatory reports for 1988 and 1990 that were assigned the *reaction* code. Due to the large number of such reports in 1992, we reviewed a random sample of 300 of the 10,687 reports. The sample size was based on the expected proportion of reports that did not describe any signs/symptoms/diagnoses; a sample of 300 would yield an estimate of the percent of such reports with a less than 5% error.

These reports contained references to signs (for example, fever), symptoms (for example, fatigue) and diagnoses (for example, chronic fatigue syndrome). Because of the complexity of the reports, we could not objectively select a principal or primary sign, symptom, or diagnosis for each report. Therefore, we recorded up to 10 signs/symptoms and 10 diagnoses for each report.

Analysis by type of implant. We classified silicone gel breast implants into two basic types for a post hoc analysis to understand differences between adverse events reported in 1988, 1990, and 1992: (*a*) single or multiple lumen silicone gel breast implants contained in a silicone elastomer shell (single lumen implants are filled with silicone gel; multilumen implants have multiple lumens containing silicone gel and saline); (*b*) polyurethane foam–coated single or multiple lumen silicone gel implants.

Analysis of death reports. We reviewed printouts of all mandatory reports of deaths entered in the database during the study period and recorded the following information: (*a*) mention of the cause of death; (*b*) mention of cancer, autoimmune disease, or connective tissue disease; (*c*) the numbers of signs/symptoms and diagnoses reported prior to death.

RESULTS

Characterization of adverse event reports. The FDA received 4303 voluntary SGBI-related adverse event reports and 94,120 SGBI-related mandatory reports from December 13, 1984, through December 31, 1995 (Table 1). The vast majority of mandatory reports were for injuries and not deaths or device malfunctions.

The numbers of mandatory reports entered in the database remained fairly steady from 1984 to 1990 (Table 2). In 1990, the 729 mandatory SGBI reports accounted for 2.6% of the 28,248 mandatory reports of adverse events associated with medical devices. In 1992, SGBI reports increased dramatically to 20,160, accounting for 30.3% of the total of 66,476 mandatory reports on all medical devices. By 1994, the 32,884 SGBI reports entered into the mandatory report system accounted for 35.3% of all mandatory medical device–related adverse event reports entered that year.

Table 1. Mandatory reports of adverse events related to silicone gel breast implants; Center for Devices and Radiological Health; December 13, 1984, through December 31, 1995

Type of report	*Number*
Injury	93,641
Malfunction of device	394
Death	76
Other	9
Total	94,120

NOTE: These totals do not include events included in the summary reports prepared by manufacturers starting in 1995.

In 1995, the FDA first accepted quarterly summary reports from breast implant manufacturers. Because the data from summary reports are not entered into the device adverse event database but are reviewed sepa-

Table 2. Mandatory and voluntary reports of adverse events related to silicone gel breast implants, Center for Devices and Radiological Health, by year, 1984–1995

	Mandatory reports	*Voluntary reports*
Year	*Number*	*Number*
1984	—	3
1985	226	1
1986	183	0
1987	226	2
1988	344	16
1989	407	37
1990	729	33
1991	1010	262
1992	20,160	1570
1993	30,025	679
1994	32,884	1098
1995	7926	602

NOTE: FDA did not begin receiving mandatory reports until December 13, 1984; mandatory reports received in 1984 were not entered until 1985. 1995 totals do not include events included in the summary reports prepared by manufacturers.

rately, the observed decline in reports from 1994 to 1995 can be accounted for, at least in part, by this change in reporting procedures.

Primary adverse events, 1984–1995. Table 3 shows the top 25 SGBI-related primary adverse events reported from December 13, 1984, through December 31, 1995, under the mandatory and voluntary programs, excluding the manufacturers' summary reports.

Overall, the events reported in the voluntary and mandatory reports were similar. More than a quarter of all mandatory reports and almost half of all voluntary reports had *reaction* listed as the primary event. The second largest category of primary events was *nonspecific* for mandatory reports; *burst* was the third. *Burst* was the second most frequently reported event in the voluntary reports.

Pre- and post-publicity. We compared the top 10 adverse event codes assigned to mandatory reports for the years 1988, 1990, and 1992 (Table 4) to see whether there was a change in the events reported to the FDA. In 1988, four of the top five reported events in mandatory reports were related to breast implant leak or rupture (*burst, deflate/inflate, tear, rip or hole*, and *leak*); these accounted for 87% of all mandatory adverse event reports that year. In 1990, while *burst* remained the principal event reported, and three of the top five reported events were related to implant rupture (53%), reports of

Table 3. Primary events noted in mandatory and voluntary reports of adverse events related to silicone gel breast implants; Center for Devices and Radiological Health; December 13, 1984, through December 31, 1995

	Mandatory reports (n=94,120)			*Voluntary reports (n=4303)*		
Rank	*Code*	*Number*	*Percent of total PSGBI reports*	*Code*	*Number*	*Percent of total SGBI reports*
1	Reaction	24875	26.4	Reaction	1231	47.1
2	Nonspecific	23538	25.0	Burst	607	23.2
3	Burst	15630	16.6	Leak	241	9.2
4	Capsular contracture	9806	10.4	Capsular contracture	117	4.5
5	Leak	6789	7.2	Identified diagnosis	93	3.6
6	Identified diagnosis	3564	3.8	Migration	92	3.5
7	Malfunction	1918	2.0	Disintegrate	61	2.3
8	Deflate/inflate	1424	1.5	Infection	49	1.9
9	Other	1382	1.5	Tear, rip, or hole in device	28	1.1
10	Infection	1123	1.2	Safety/injury	20	0.8
11	Migration	1067	1.1	Collapse	16	0.6
12	Disintegrate	730	0.8	Deflate/inflate	12	0.6
13	Rash	666	0.7	Rash	12	0.6
14	Collapse	594	0.6	Size	7	0.3
15	Tear, rip, or hole in device	494	0.5	Separates	5	0.2
16	Pain	231	0.2	Design/structure	5	0.2
17	Size	74	0.1	Nonspecific	4	0.1
18	Toxin-children	57	0.1	Break	3	0.1
19	Separates	44	0.0	Bend/kink	2	0.1
20	Break	25	0.0	Discolored	2	0.1
21	Multiple	14	0.0	Short fill	1	0.0
22	Discolored	12	0.0	Instructions	1	0.0
23	Extrusion	12	0.0	Other	1	0.0
24	Crack	8	0.0	Contamination	1	0.0
25	Bend/kink	7	0.0	Frayed	1	0.0

NOTE: These totals do not include events included in the summary reports prepared by manufacturers starting in 1995.

Table 4. Top ten coded events in 1988, 1990, and 1992 for mandatory reports of adverse events related to silicone gel breast implants

	Mandatory reports, 1988 n = 344			Mandatory reports, 1990 n = 729			Mandatory reports, 1992 n = 20,160		
Rank	Code	Number	Percent	Code	Number	Percent	Code	Number	Percent
1	Burst	204	59.3	Burst	234	32.1	Reaction	10687	53.0
2	Deflate/inflate	50	14.5	Reaction	207	28.4	Burst	4339	21.5
3	Tear, rip, or hole	25	7.3	Tear, rip, or hole	84	11.5	Leak	1982	9.8
4	Leak	20	5.8	Deflate/inflate	65	8.9	Other	915	4.5
5	Reaction	18	5.2	Infection	53	7.3	Malfunction	778	3.9
6	Multiple	7	2.0	Leak	25	3.4	Disintegrate	384	1.9
7	Break	5	1.4	Disintegrate	15	2.1	Migration	270	1.3
8	Infection	3	0.9	Migration	13	1.8	Infection	246	1.2
9	Separates	3	0.9	Separates	10	1.4	Deflate/inflate	233	1.2
10	Other	2	0.6	Collapse	6	0.8	Collapse	138	0.7

NOTE: These totals do not include events included in the summary reports prepared by manufacturers starting in 1995.

reactions had moved up into second place from fifth place. In 1992, the majority of mandatory reports involved *reactions*. The voluntary reports from these time periods were quite similar except that reaction reports were the top reported events for all years (data not shown).

Reaction reports. The *reaction* reports from 1988, 1990, and 1992 included diverse signs, symptoms, and diagnoses including allergies, alopecia, arthritis, asthma, autoimmune disorder, blindness, bronchitis, bubbles under the skin, bursitis, calcification, cancer or tumor of the breast, cancer or tumor not of the breast or not specified, capsular contracture, chronic fatigue syndrome, coldness of breast, deformity of breast, dermatomyositis, discharge from nipple, dizziness, endocarditis, exhaustion, fatigue, fever, flu like symptoms, gangrene, granulomas, gynecologic problems (chronic pelvic inflammatory disease, chronic cervicitis, proliferative endometrium) headaches, hematoma, hemorrhaging, hives, inflammation, irritable bowel syndrome, itching, jaundice, joint pain, lumps in the breast or elsewhere, memory loss, menstrual problems, multiple sclerosis, nausea, necrosis, numbness or tingling, polymyositis, polymyalgia, poor wound healing, rashes, Raynaud's disease, rejection of the implant, scleroderma, seroma, scar tissue, shortness of breath, Sjögren's syndrome, soreness, stress, swollen breasts, swollen glands, tendonitis, tightened breast, weight loss, wrinkling, and yellow fingers/toes.

The most frequently reported signs/symptom/diagnosis in *reaction* reports for all of the sample years (1988, 1990, 1992) was capsular contracture (data not shown). Because of the frequency with which this complication was reported, a code for *capsular contracture* was added to the database after 1992. The second most frequently reported *reaction* was pain in 1988; seroma, hematoma, or hemorrhage in 1990; and pain in 1992.

Only one sign/symptom/diagnosis was listed in most reports in 1988 (72.2%) and 1990 (92.8%). In 1992, however, fewer than half of the mandatory *reaction* reports in the sample had a single sign/symptom/diagnosis listed (41%); 44% had two or more signs/symptoms/diagnoses listed. Another change was in the number of reports filed with no signs/symptoms/diagnoses listed—from a small percentage in 1988 and 1990 to 15% in 1992. Thus, although the reports were more complex, the number of reports lacking information had increased.

Type of implant. Originally, we had planned to use 1990 as our pre-publicity reference year in analyzing *reaction* reports. However, as the signs, symptoms, and diagnoses for the 207 reaction reports for 1990 were being entered into the EpiInfo database, we observed that 78% were for polyurethane foam–covered breast implants. Most of these reports were for capsular contracture or seroma. We realized that these reports followed publicity on polyurethane foam–coated breast implants. The reports filed in 1988 were filed prior to widespread publicity on

Table 5. Summary of mandatory reports of deaths in women with silicone gel breast implants, 1984–1995

	Number of reports
Total	70
Reports mentioning autoimmune or connective tissue disease	10
Reports mentioning cancer	12
Cause of death reported	17
Autoimmune or connective tissue disease	3
Cancer	8
Perioperative deaths	2
Other	4
Number of diagnoses or symptoms mentioned	
0	41
1	12
2	4
3	5
4	3
5	3
6	1
7	1

breast implants of any type; all were for either single or multiple lumen silicone gel implants. By 1992, the type of implant in *reaction* reports had shifted back to the noncoated silicone gel implants (95%); that year, polyurethane foam–coated implants accounted for only 5% of *reaction* reports.

Analysis of death reports. As of December 31, 1995, the mandatory report database contained 76 SGBI-related death reports. One, a report of four infant deaths alleged to be SGBI-related, was excluded from our analysis of adverse events in women. Two deaths were reported to the FDA twice and one four times because patients had implants from more than one manufacturer or because the implant manufacturer was unknown.

In the majority of the 70 reports that remained after excluding duplicate reports and deaths in other than women (53/70, or 76%), there was no mention of the cause of death (Table 5). Forty-one death reports did not list either cause of death or specific medical symptoms or diagnoses, referring to nonspecific complaints with terms such as pain and suffering, physical pain, mental anguish, disability, injuries, damages, or harm. Twenty-one reports listed between one and three specific signs/symptoms/diagnoses, and the remaining eight reports listed between four and seven signs/symptoms/diagnoses.

Twelve death reports mentioned cancer. Eight deaths were attributed to cancer among the 17 deaths for which a cause of death was mentioned. In one of these cases, the report claimed that the breast implant interfered with early detection of breast cancer and that the disease was not discovered until it had reached the terminal stage.

Ten death reports mentioned autoimmune disease, connective tissue disease, or human adjuvant disease, but only four of these specified the disease(s) (scleroderma, rheumatoid arthritis, or systemic lupus erythematosus).

Two deaths were attributed to breast implant surgery. One patient died during surgery to remove and replace her breast implants; the report describes anoxic encephalopathy, coma, and cardiac arrest related to anesthesia. The second report describes a hemorrhagic site noted in close proximity to the implant in a breast reconstruction patient. The patient died of massive local bleeding. The causes of death described in the four remaining reports for which cause of death was listed were stroke, "foreign body reaction" to silicone, pneumonia, and acute cardiopulmonary arrest.

DISCUSSION

The FDA received 94,120 mandatory reports of SGBI-related adverse events from 1984 through 1995. More than a quarter of these reports were for "reactions," which were defined in the code list as "adverse effect, irritation, swelling." Another quarter indicated that the implant had failed by rupturing, while another quarter of the reports were nonspecific—that is, they contained no information other than that a woman had an implant and was ill or injured as a result. Capsular contracture was the fourth most commonly reported problem overall after this code was added in 1992.

Reporting of adverse events provides a way for the FDA and manufacturers to detect and address potential problems with medical devices in a timely manner. FDA analysts review both mandatory and voluntary reports for new, previously unrecognized adverse events and for trends or clusters of adverse events over time.

The mandatory and voluntary reports for 1984–1995 both identified implant rupture as a problem. Breast implant rupture has been widely reported in the literature.[12-15] Breast implant rupture was coded under several different event codes such as *burst, leak, deflate/inflate,*

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disintegrate, tear, rip, hole, or break. If all of these coded events were combined for breast implant reports for 1984–1994, they would account for 27% of mandatory SGBI reports and 36% of voluntary reports.

In 1992, breast implant manufacturers were flooded with adverse event reports from plastic surgeons, consumers, and attorneys. In turn, manufacturers seem to have erred on the side of over-reporting events to the FDA. We found that many of these reports were devoid of useful information and others were difficult to classify by existing codes since key words were not sufficiently specific. Historically, coding of adverse events associated with medical devices has concentrated on describing the event in terms of the device, rather than the patient. Terms that described the patient event, such as capsular contracture, were added by the FDA to the list of codes from which to choose, but not until after 1992. Likewise, the term "nonspecific" was added to the list of codes in 1993 to code the numerous reports that lacked a description of the adverse event in terms of either the device or the patient. Many reports were classified as "reaction" since they were difficult to classify using the existing codes. A more specific coding manual is now in use.

Reports of *reaction*s, whether from 1988, 1990 or 1992, were principally reports of capsular contracture, which was not assigned its own code until 1992. While these reports included a panoply of signs, symptoms, and diagnoses, they were consistent in that they described capsular contracture as the most frequent diagnosis. This is consistent with the literature on breast implant adverse events, which suggests that capsular contracture may be the most frequently encountered complication of breast mammoplasty.[16-18]

The profile of both mandatory and voluntary reports from 1988, 1990 and 1992 was of note because while the reported events were quite similar for the three time periods, the complexity of the reports filed under the term *reaction* was quite different for the three years. In 1988 and 1990, the majority of *reaction* reports described a single adverse event, usually capsular contracture or formation of a hematoma or seroma. In contrast, fewer *reaction* reports in 1992 mentioned only one sign/symptom/diagnosis and many lacked any information on the patient's signs/symptoms/diagnoses, resulting in the addition of the term "nonspecific" as described above.

There were also differences with respect to the type of implant cited in the report. The reports filed in 1988 were submitted prior to widespread publicity on breast implants and typically described the single diagnosis: capsular contracture resulting in explant of the breast implant. The reports from 1990 followed publicity over concerns of the carcinogenicity of breakdown products from polyurethane foam–coated breast implants.[11,19] In 1990, the majority of *reaction* reports were for polyurethane foam–coated SGBIs. Most of these reports were for capsular contracture or seroma. By 1992, the type of implant involved most frequently in *reaction* reports had shifted; few reports were for polyurethane foam–coated implants. As has been reported with regard to surveillance of pharmaceuticals, widespread publicity changes the reporting environment and results in increased reporting of adverse events.[20]

Medical device reports are categorized as reports of injury, malfunction, or death. While the overwhelming majority of reports for SGBIs in 1984–1995 were for injuries (99.5%), the death reports (< 0.1%) are a high priority at the FDA. Manufacturers are required to report a death to the FDA within five days of becoming aware of the event. From 1984 through 1995, the FDA received 76 death reports, which described 70 deaths in women with SGBIs. The majority of these reports did not mention a cause of death, and many were so vague that they did not mention a single sign, symptom, or diagnosis.

Among the 17 death reports that provided an underlying cause of death, about half (8/17) attributed the death to cancer. While several case series have described cancers in women with SGBIs,[21-26] controlled studies have not demonstrated a higher risk of cancer in women with breast implants.[27-29] The next largest group of deaths in this small sample (3/17) was attributed to autoimmune or connective tissue disease. Published case series have described

women with breast implants and autoimmune disease;[30-32] epidemiologic studies have ruled out a large increase in risk for these diseases overall in women with breast implants[33-35] but have not ruled out an association with rare connective tissue disease, an association that would be exceedingly difficult to detect, or an association with an atypical syndrome or "silicone related disease."[36] Two of the 17 deaths were attributed to perioperative complications and thus were not directly attributable to the implants. None of the 17 death reports clearly established a causal link between SGBIs and the reported death.

Since 1992, SGBIs are available to women in the United States only for medical need, primarily reconstruction after breast cancer, and only if they enroll in an "adjunct" study conducted by the manufacturer.[6] The FDA continues to receive adverse event reports on silicone breast implants from breast implant manufacturers, health care providers, and consumers.

The opinions or assertions presented in this article are the private views of the authors and are not to be construed as conveying either an official endorsement or criticism by the U.S. Department of Health and Human Services, the Public Health Service, or the Food and Drug Administration. The present article is an edited version of a more detailed report. The full report is available by request from the corresponding author.

References

1. Cronin TD, Gerow FJ. Augmentation mammaplasty: a new "natural feel" prosthesis. Excerpta Medica 1964;41-9.
2. Bright RA, Jeng LL, Moore RM. National survey of self-reported breast implants: 1988 estimates. J Long-Term Effects Med Implants 1993;3:81-9.
3. Cook RR, Harrison MC, LeVier RR. The breast implant controversy. Arthritis Rheum 1994;37:153-7.
4. Terry MB, Skovron ML, Garbers S, Sonnenschein E, Toniolo P. The estimated frequency of cosmetic breast augmentation among US women, 1963-1988. Am J Public Health 1995;85:1122-4.
5. Silverman BG, Brown SL, Bright RA, Kaczmarek RG, Arrowsmith-Lowe JB, Kessler DA. Reported complications of silicone gel breast implants: an epidemiologic review. Ann Intern Med 1996;124:744-56.
6. Rohrich RJ, Clark CP III. Controversy over the silicone gel breast implant: current status and clinical implications. Texas Med 1993;89:52-8.
7. American Medical Association, Council on Scientific Affairs. Silicone gel breast implants. JAMA 1993;270:2602- 6.
8. Kessler DA. The basis of the FDA's decision on breast implants. New Engl J Med 1992;326:1713-15.
9. Kessler DA, Merkatz RB, Schapiro R. A call for higher standards for breast implants. JAMA 1993;270:2607-8.
10. History of the ASPRS: the breast implant crisis. Plast Reconstr Surg 1994;94:91A-99A.
11. Palley HA. The evolution of FDA policy on silicone breast implants: a case study of politics, bureaucracy, and business in the process of decision-making. Int J Health Serv 1995;25:573-91.
12. Rolland C, Guidoin R, Marceau D, Ledoux R. Nondestructive investigations on ninety-seven surgically excised mammary prostheses. J Biomed Mater Res 1989;23:285-98.
13. Brown SL, Silverman BG, Berg WA. Rupture of silicone-gel breast implants: causes, sequelae, and diagnosis. Lancet 1997;350:1538-41.
14. de Camara DL, Sheridan JM, Kammer BA. Ruptures and aging of silicone gel breast implants. Plast Reconstr Surg 1993;91:828-34.
15. Robinson OG, Bradley EL, Wilson DS. Analysis of explanted silicone implants: a report of 300 patients. Ann Plast Surg 1995;34:1-6.
16. Burkhardt BR. Capsular contracture: hard breasts, soft data. Clin Plast Surg 1988;15:521-32.
17. Cairns TS, De Villiers W. Capsular contracture after breast augmentation—a comparison between gel- and saline-filled prostheses. S Afr Med J 1980;57:951-3.
18. Gabriel SE, Woods JE, O'Fallon WM, Beard CM, Kurland LT, Melton LJ III. Complications leading to surgery after breast implantation. New Engl J Med 1997;336:677-82.
19. Epstein SS. Implants pose poorly recognized risks of breast cancer. J Occup Med Toxicol 1995;4:315-42.
20. Sachs RM, Bornichak EA. An evaluation of spontaneous adverse drug reaction monitoring systems. Am J Med 1986;81(Suppl 5b):49-55.
21. Benavent WJ. Treatment of bilateral breast carcinomas in a patient with silicone-gel breast implants. Plast Reconstr Surg 1973;51:588-9.
22. Bingham HG, Copeland EM, Hackett, Caffee HH. Breast cancer in a patient with silicone breast implants after 13 years. Ann Plast Surg 1988;20:236-7.
23. Duvic M, Moore D, Menter A, Vonderheid EC. Cutaneous T-cell lymphoma in association with silicone breast implant. J Am Acad Dermatol 1995;32:939-42.
24. Morgenstern L, Gleischman SH, Michel SL, Rosenberg JE, Knight I, Goodman D. Relation of free silicone to human breast carcinoma. Arch Surg 1985;120:573-7.
25. Kitchen SB, Paletta CE, Shehadi SI, Bauer WC. Epitheilialization of the lining of a breast implant capsule. Cancer 1994;73:1449-52.
26. Sendagorta E, Ledo A. Sezary syndrome in association with silicone breast implant. J Am Acad Dermatol 1995;33:1060-1.
27. Brinton LA, SL Brown. Breast implants and cancer. J Natl Cancer Inst 1997;89: 1341-9.
28. Bryant H, Brasher P. Breast implants and breast cancer: reanalysis of a linkage study. New Engl J Med 1995;332:1535-9.
29. Deapen DM, Brody GS. Augmentation mammaplasty and breast cancer: a 5-year update of the Los Angeles study. Plast Reconstr Surg 1992;89:660-5.
30. Kumagai Y, Shiokawa Y, Medsger TA, Rodnan GP. Clinical spectrum of connective tissue disease after cosmetic surgery. Arthritis Rheum 1984;27:1-12.
31. Silver RM, Sahn EE, Allen JA, Sahn S, Greene W, Maize JC, Garen PD. Demonstration of silicone in sites of connective-tissue disease in patients with silicone-gel breast implants. Arch Dermatol 1993;129:63-8.
32. Spiera H, Kerr LD. Scleroderma following silicone implantation: a cumulative experience of 11 cases. J Rheumatol 1993;20:958-61.
33. Gabriel SE, O'Fallon WM, Kurland LT, Beard CM, Woods JE, Melton LJ. Risk of connective-tissue diseases and other disorders after breast implantation. New Engl J Med 1994;330:1697-1702.
34. Hennekens CH, Lee I-M, Cook NR, Hebert PR, Karlson EW, LaMotte F, et al. Self-reported breast implants and connective-tissue diseases in female health professionals: a retrospective cohort study. JAMA 1996;275:616-21.
35. Sanchez-Guerrero J, Colditz GA, Karlson EW, Hunter DJ, Speizer FE, Liang MH. Silicone breast implants and the risk of connective-tissue disease and symptoms. New Engl J Med 1995;332:1666-70. ■